United States
Department
of Agriculture

Forest Service

**International Institute
of Tropical Forestry
San Juan, PR**

**Rocky Mountain
Research Station
Fort Collins, CO**

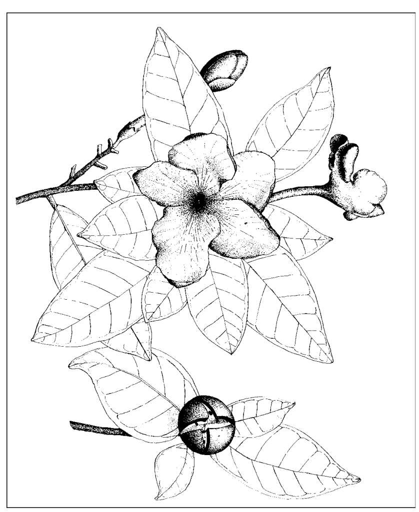
General Technical
Report IITF-GTR-26

July 2004

Wildland Shrubs of the United States and Its Territories: Thamnic Descriptions:

Volume 1

John K. Francis, Editor



Abstract

Francis, John K. ed. 2004. **Wildland shrubs of the United States and its Territories: thamnic descriptions: volume 1**. Gen. Tech. Rep. IITF-GTR-26. San Juan, PR: U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry, and Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 830 p.

A discussion of the general characteristics of shrubs as a life form and their distribution within the United States is followed by 311 short monographs containing general descriptions, ranges, ecology, reproductive habits, growth and management, and benefits to humans, animals, and the environment.

Keywords: Asteraceae, Rosaceae, Fabaceae, Cactaceae, woody plants, hardwoods, shrubs, perennials

The U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry operates in cooperation with the University of Puerto Rico, Río Piedras, PR, 00936-4984

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Wildland Shrubs of the United States and Its Territories: Thamnic Descriptions:

Volume 1

John K. Francis, Editor

Foreword

Shrubs are an important life form that is difficult to circumscribe because of variations in individual species that may be classified as shrubs in some circumstances but as trees or herbs in others. Nevertheless the term shrub conjures up an image of a woody plant of limited stature; usually with mature specimens of one-third to twice human heights and often with multiple stems. Shrubs are important components in many kinds of habitats including a role as landscape dominants or icons as well as integrated components of other vegetation types. Whereas there are numerous national and regional handbooks on trees and grasses and floras of continental, regional, state, and local scales, handbooks of shrubs are limited to regional areas or to horticultural, agronomic, ornamental, or wildlife biology applications. This volume begins an effort to provide important characteristics for native and naturalized shrubs of the United States and its territories. Editor John Francis and other contributors provide descriptive, distributional, ecological, reproductive, growth, management, and use information on more than 300 shrub species in this volume; in all there are more than 5,000 shrub species in the United States and its territories. There is more work to do.

I believe that it is appropriate that this effort was undertaken by the USDA Forest Service Institute of Tropical Forestry and the Rocky Mountain Station's Shrub Sciences Laboratory. These institutions represent foci of significant shrub diversity. Shrub diversity is enhanced both by warm, mesic and tropical conditions and by aridity and diverse topography. The two institutions—one in the tropics and one in the continental Western United States desert--represent those contrasting situations.

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Introduction

The evolution of the Wildland Shrub Manual begins a long time ago with the observation and description of plants; however, its direct ancestor is the U.S. Silvics Manual: "Silvics of North America" Volumes 1 and 2 (Burns and Honkala 1990a, 1990b) in which the editor participated as a species author. After this, a regional silvics manual developed at the International Institute of Tropical Forestry was published as single species' separate publications and later translated into Spanish and compiled into a single volume, "Bioecología de Árboles y Exóticos de Puerto Rico y las Indias Occidentales" (Francis and others 2000). Besides the numerous botanical references cited in the following section and in the species descriptions, other important references were important contributing sources for this effort. The "Woody-Plant Seed Manual" (Schopmeyer 1974 and the update in progress, Bonner and Nisley 2003) is cited in many of the species descriptions. The "Fire Effects Information System" database (Fire Sciences Laboratory 2003) contributed a significant portion of the information used is a number of the mainland U.S. species in this volume. The Wildland Shrub Manual differs from its predecessors by the extensive use of Internet information sources that have not been available previously.

Latin family, genus, species, and authority of plant names were checked against the "Plants" database (Natural Resources Conservation Service 2003). In a few cases, individual authors disagreed with the name given in the database and have cited their reasons for using the name in the form they did. Common names, for which there is really no central authority and which are likely to take another generation to stabilize, were left to the discretion of the authors. Common names cited were generally chosen from the many in existence for each species because they were more widely used or because they were unique or especially descriptive.

Although somewhat simplified, the format of each shrub description generally follows that used in the silvical descriptions. Sections: General Description, Range, Ecology, Reproduction, Growth and Management, and Benefits, are followed by References cited. Each description carries a botanical drawing or a photo to aid in recognition. Because the number of shrubs to be described is so great, it was decided to make descriptions summaries rather than complete treatises of all information available. Also, to make the information useful to as wide an audience as possible, authors were encouraged to use wording that is as simple as possible without sacrificing technical accuracy. Although arranged in alphabetical order by genus name, a table of contents is provided to make the process of turning to an individual species easier. A glossary of technical terms and an index of common names are also provided.

These descriptions have been previously published on the Internet (Francis 2003) and the number of shrub descriptions continues to be added to. The Internet allows revisions of existing descriptions so that Internet versions of the descriptions may vary somewhat from descriptions contained in this volume. Volume 1 of the Wildland Shrub Manual contains descriptions of 311 shrub species, a number determined more by the time permitted for the project than anything else. It is anticipated that the process of compiling information and describing shrubs will continue and other volumes will follow. The number of shrubs in the United States and its Territories easily justifies the publication of five or more volumes of descriptions. I sincerely hope that shrub scientists in the coming years will continue the effort of publishing thamnical descriptions to facilitate the management of our wildland shrub natural resource.

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Acknowledgments

I especially want to thank John A. Parrotta, then Team Leader at the International Institute of Tropical Forestry, USDA Forest Service, for his appreciation of the need to package species information for popular benefit and his encouragement to embark on the Shrub Manual project. I must also thank Ariel E. Lugo, IITF Director, for allowing me to dedicate almost 3 years nearly full time to shrub research and E. Durant McArthur, Project Leader, Shrub Sciences Laboratory, Rocky Mountain Research Station, USDA Forest Service, for graciously welcoming me to work at the Shrub Sciences Laboratory and furnishing considerable financial support to the project. These and some 36 other authors wrote thamnical descriptions to contribute to the book. More than 100 scientists participated in reviewing the manuscripts before they were edited. Isaac Nordlund helped with graphics and programming. I owe as much as any other to Louise Kingsbury, Director of Publishing Services for the Rocky Mountain Research Station, for personally and promptly editing every one of the manuscripts.

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Contents

Wildland Shrubs

According to the dictionary (Merriam-Webster Inc 1984), the word "shrub" came from the Old English *scrybb* wood, which is akin to the Norwegian *skrubbebaer* that means a dwarf hardwood species. The implication seems to be that a shrub is a dwarf tree--not far from the current usage of the word. The designation of this life form is driven by the need for a category between trees and herbs.

If a tree is "a woody perennial plant, typically large and with a single well-defined stem carrying a more or less definite crown" (Ford-Robertson 1971), then a shrub must necessarily be smaller. Most definitions require that a shrub should have more than one main stem caused by branching below or above the ground level (Allaby 1994, Viereck and Little 1972). Other frequent qualifications include the need for the plant to be perennial and to be lignified (woody), at least in some of its parts (Allaby 1994, Ford-Robertson 1971, Orshan 1989). Shrubs are distinguished from herbs in that herbs do not develop persistent woody tissue above ground (Ford-Robertson 1971). However, Lawrence (1955) admits that the term shrub is "not subject to precise circumscription".

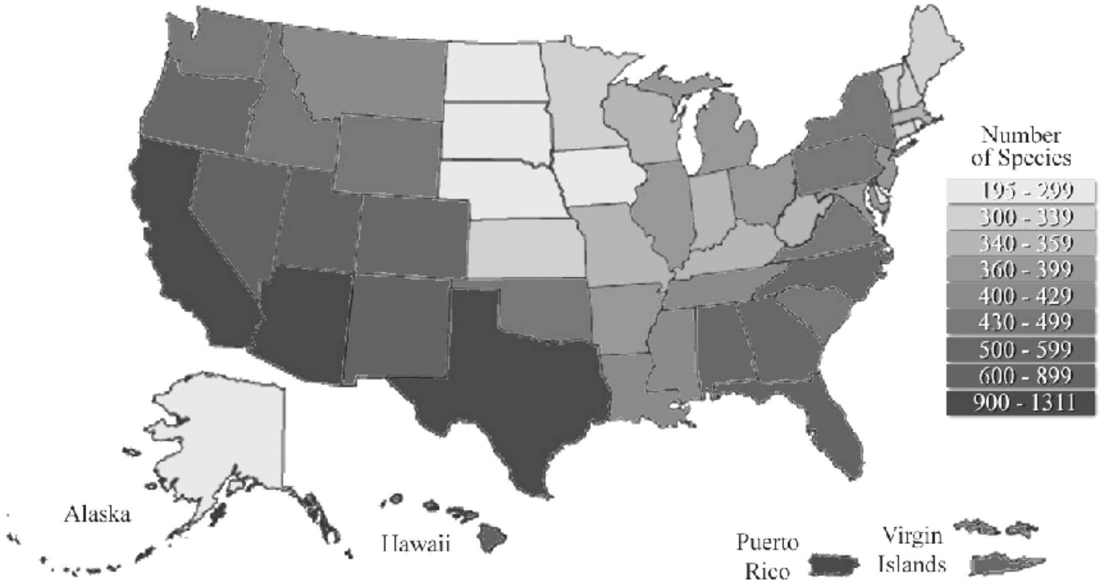
There are several reasons why shrubs cannot be precisely defined. Many species are trees in fertile habitat or favorable conditions and shrubs in difficult habitat. Certain species may grow as shrubs in large portions of their range and become trees in limited areas. Most large shrubs will produce an occasional individual with a clearly tree-like habit. It is not possible to define exactly what "large" is (referring to stem size). A number of species normally develop single stems but only reach stem sizes below that normally associated with trees. The degree of lignification is another source of ambiguity. Many annual herbs become quite lignified before dieing, and some perennial shrubs have little or no woody tissue. Finally, the concept of perennial looses much of its meaning in the humid tropics where a shrub may complete its life cycle in a year of continuous growth, and an herb may live without dieback for many years.

There are many subtypes of shrubs including dwarf shrubs, half-shrubs (sub-shrubs), cushion plants, woody vines (lianes and climbers), scrambling and prostrate forms, woody parasitic plants, and various forms of succulents and semi-succulents. A description of these forms can be found in Lawrence (1955), and a discussion of criterion for classification of shrub forms may be found in Orshan (1989).

The concept of the shrub layer, which is populated by functional shrubs, sidesteps the ambiguity of classifying species. In this system, the forest is divided into vertical layers (canopies or horizons). In their simplest form, the layers are: the tree layer, consisting of trees and tree-sized plants, the shrub layer, including all plants with any diameter at breast height (d.b.h.) that is less than some arbitrary upper d.b.h. limit such as 5.0 cm, and the herb layer, which does not reach breast height. The principal components of the shrub layer are actually young trees. This concept is useful in studies of wildlife habitat, plant ecology, and biomass and carbon distribution.

Because of their large size, influence on the environment, and considerable economic value, trees have received most of the attention in forest research and ecological descriptions. However, shrubs are more important than is generally realized, especially in terms of biodiversity. Little (1979) lists 679 species of trees native and naturalized in the continental United States. Another 60 native tree species with an additional number of naturalized species grow in Hawaii (Little and Skolmen 1989). Puerto Rico and the U.S. Virgin Islands support 547 native tree species (Little and others 1974) and at least 118 species of naturalized exotics (Francis and Liogier 1991). With allowances for species represented in more than one area, the U.S. and its territories support about 1,300 tree species. Shrub species in the same area are much more numerous.

Estimating the number of shrub species in the U.S. and its territories is challenging because the life-form is subject to the perception of authors and compilers and not indicated or consistently identified in many of the checklists and floras. However, it is possible to count the shrub species indicated in the floras of several of the states or regions. Alaska has about 110 species of shrubs (Viereck and Little 1972), California about 800 species (McMinn 1951), Hawaii about 170 (Degener 1946, Degener 1957, Degener and Degener 1963), Idaho about 160 (Davis 1952), Pennsylvania about 264 (Rhoads and Klein 1993), Puerto Rico about 540 (Liogier 1985, Liogeir 1988, Liogier 1994, Liogier 1995, Liogier 1997), and tropical Florida about 250 (Long and Lakela 1971). These totals (with duplication eliminated) plus other miscellaneous sources (Abrams 1940, Abrams 1944, Abrams 1951, Abrams and Ferris 1960, Benson 1969, Correll and Johnston 1970, Everitt and Drawe 1993, Great Plains Flora Association 1986, Jones 1975, Morley 1969, Nelson 1996) exceed 2800 species and seems to account for most of the shrub species in the United States and its territories. The Natural Resources Conservation Service (2003) "Plants" database recently made it possible to search and list shrub species by region within the United States and its territories (Puerto Rico and the U.S. Virgin Islands). Although sums for growth habits (life-forms) are higher than if each species were exclusively assigned to a single growth habit (eg. *Salix exidua* Nutt. appears as both tree and shrub), the figures are instructive, especially for comparing areas, life-forms, and taxonomic divisions. Searching all plant species that carry the growth habit designates, "shrub" or "sub-shrub," yielded 5,281 species for the U.S. and territories. There was a great deal of variation between political divisions (see figure below, not drawn to scale). California and Texas supported the greatest numbers of species with 1,311 and 1,300 respectively. North Dakota and Alaska had the lowest with 195 and 200 respectively. The U.S. Virgin Islands had the highest average shrub biodiversity with 527 shrub species in only 349 km^2 of territory.



Several factors influence the amount of shrub diversity found within a political unit. Numbers of shrub species, as well as all plant species, increase as one travels from the harsh boreal regions to the humid tropics. Diversity of habitat, such as mountain peaks, deserts, riparian areas, and sea shore, is also very important. Southwestern deserts where shrubs are the dominant vegetation also tend to have high shrub diversity.

Using searches of the "Plants" database mentioned above, the shrubs of the U.S. and territories were found to be divided among 166 families. The most important families were: Asteraceae, 618 species; Rosaceae, 510 species; Fabaceae, 342 species; Cactaceae, 193 species; Ericaceae, 189 species; Scrophulariaceae, 182 species; Rubiaceae, 165 species; Malvaceae, 148 species; Euphorbiaceae, 128 species; Lamiaceae, 124 species; Polygonaceae, 123 species; Companulaceae, 112 species; Boraginaceae, 106 species; Ramnaceae, 103 species; and 152 additional families with 82 to 1 species each.

Reaching or maintaining a high biodiversity is important to ecosystem health. Managers and the public are beginning to realize that subordinate species, as well as the tree canopy, are important. It will not be enough, as formerly called for in management plans, to establish a tree cover and wait for natural succession to fill in the subordinate species. Shrubs, which are near-climax in ecosystems such as subtropical deserts, are, thus, the principal species to be maintained or reestablished. In moister wildlands, wildlife managers have long sought to achieve a certain portion of the landscape in the “brush” stage, preferably in disbursed, irregular patches within more advanced forest.

The use of shrubs as well as all other types of native plants for reclamation and restoration of damaged sites is becoming a very important topic (Hansen 1989). Shrubs are planted as seedlings of various types and seeded using the same techniques employed with trees (Alder and Ostler 1989), except that densities must often be higher. Because it costs less, establishment by site manipulation and natural seeding and succession is preferred whenever possible.

Shrubs yield many benefits to humankind directly and indirectly. Berries and similar small fruits are the most important shrub-derived foods. There are many hundreds of kinds of edible, wild berrylike fruits throughout the world. Seasonally harvested and preserved, they were once very important to hunter-gatherer tribes and still are important in certain rural areas. All our commercial berries descended from wild shrubs, and their wild ancestors remain a source of genetic material for breeders. Wildland shrubs also furnish nuts, seeds, herbs, greens, and medicinal materials to rural peoples.

Fuel is another major direct benefit from shrubs. Although wood from shrubs is not present in quantities as great as tree wood in forests, its accessibility and ease of harvest have made it a very important fuel source in underdeveloped areas and during recreational camping, especially when collected by women and children. Shrubs are even harvested to make charcoal in areas with few trees. It has also been suggested that shrub stands could be harvested mechanically for industrial biomass fuel (Young and others 1989).

Humans benefit indirectly from shrubs through animals that eat them. Grazing domestic goats, camels, and, to a lesser extent, sheep and cattle obtain a large part of their forage from woody browse. Many wild ruminants preferentially browse shrubs even when grass is available. Others supplement their diet of grasses and forbs with forage from shrubs. A multitude of birds, mammals, amphibians, and reptiles obtain forage, mast (fruits and seeds), and insects from shrub hosts. The cover provided by shrubs is critical for a vast number of wild animals.

Finally, wild shrubs are an important esthetic component of our forests, prairies, and deserts. As greenbelts and semi-wild urban parks become more widespread, wild shrubs will be more appreciated and will be managed along with trees and herbaceous plants.

Shrubs also negatively impact humans. Undesirable shrubs often invade managed and semi-managed pastures, excluding the more desirable grass, and become weeds in croplands. They can temporarily suppress tree seedlings and slow reforestation. Shrubs, especially the many thorny and a few poisonous species, are the bane of cross-country hikers and woods workers. Forests with a heavy shrub layer are usually less visually pleasing than open forests. Shrub understories often are a vehicle for explosive fire spread in seasonally dry forest habitats.

In the early days of forestry, it seemed to be enough to protect and manage the forest as a whole. Later, it was realized that we needed detailed information on each of the tree species. To this end, a number of excellent references have been produced (Burns and Honkala 1990a, Burns and Honkala 1990b, Burns and others 1998, Francis and Lowe 1999). The time is coming when, if we are to manage the lesser species, we will need detailed information on each or, at least, the most important shrubs. The objective of this work is to provide an accessible reference of the biology, ecology, and management of individual species of shrubs. The study of the biology, ecology, and management of trees is called silvics, and the resulting descriptions are termed silvical descriptions. No such terms have come to general use for the study and description of shrubs. Perhaps the terms should be designated “thamnics” and “thamnical descriptions” from the Ancient Greek “thamnos”, which means shrub.

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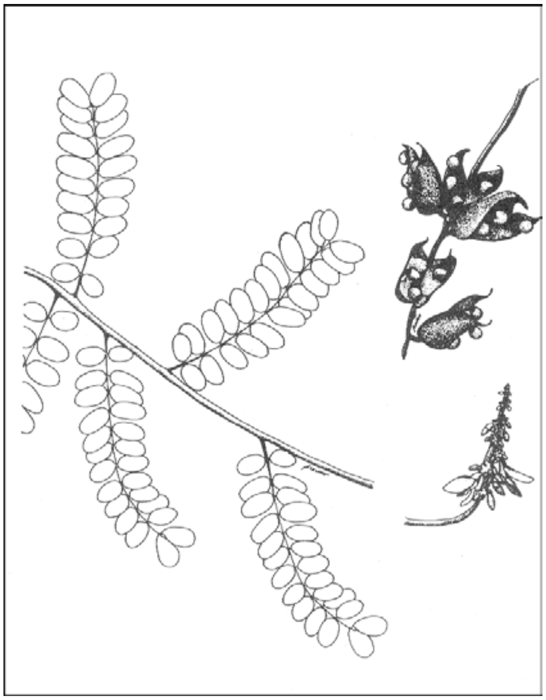
***Abrus precatorius* L.** crab's eye

FABACEAE

Synonyms: *Abrus abrus* (L.) W.F. Wright
Glycine abrus L.

John K. Francis



General Description.—Crab's eye, also known as jumbie bean and licorice plant in English, peronías and ojos de cangrejo in Spanish, and guen léglise in French (Howard 1988, Liogier 1988), is a slender woody vine that climbs shrubs and low trees. Its older stems are dark gray and the younger ones are green and very fine. The alternate, pinnately compound leaves are 5 to 10 cm long and have five to 20 pairs of leaflets. The racemes have tight clusters of white to purple flowers (Howard 1988, Liogier 1988). The most notable thing about this species is the 6-mm, spherical red and black seeds. Crab's eye produces a tap and lateral root system with abundant fine roots. The larger roots are dark reddish brown. The lateral roots produce white nodules.

Range.—Crab's eye is possibly native of India (Acevedo-Rodríguez 1985) or of Guinea in Africa (Neal 1965), but today has naturalized throughout most of the tropics (Acevedo-Rodríguez 1985).

Ecology.—In Puerto Rico, crab's eye grows in subtropical moist (1000 to 2000 mm of precipitation), subtropical dry forest (below 1000 mm of precipitation), and the lower extreme of the subtropical wet forest type on all drainage classes except very poorly drained and on soils of all textures and parent materials. All types of topography are colonized from near sea level to 1,000 m in elevation (in India) (Parrotta 2001). Crab's eye competes well with weeds and brush in abandoned farmland, disturbed areas, and early secondary forest. It requires disturbance to maintain itself in dense, closed stands. Although crab's eye produces relatively few root nodules compared to other legumes, nitrogenase activity is comparatively high by nodule weight (Pokhriyal and others 1997).

Reproduction.—A sample of crab's eye seed from Puerto Rico averaged 0.1088 $\pm$ 0.0091 g/seed. These seeds, which were not treated in any way, germinated at a final rate of 61 percent between 11 and 182 days after sowing. Germination is epigeous. Seeds are produced in abundance. Seedlings are common in suitable habitat, but few gain access to sufficient sunlight to survive. Humans have been responsible for the long-distance transport that has resulted in the current pantropical distribution. Birds may move the seeds short distances either through curiosity or by being momentarily deceived into thinking that they are edible (personal communication with Joseph Wonderly, IITF, Río Piedras, Puerto Rico). Lateral extension of the vines also disperses the seeds short distances. These plants can be controlled by heavy grazing, hand removal, and with herbicides.

Growth and Management.—Seedlings grow at a moderate rate. It takes about 6 months after germination for them to reach 30 cm in height. Mature plants may grow 2 m or more per year in each leader. They eventually reach 5 to 10 m into the canopy or a similar distance laterally (Acevedo-Rodríguez 1985). The longevity of crab's eye is not reported, but certainly it lives longer than 3 years. New plants are easily grown in the nursery and probably can be established by direct seeding into prepared seed spots. Because the species is exotic in all of the U.S. Territories and because it becomes a weed in range and semimanaged pastures (Velez and von Overgeek 1950), it is difficult to see a justification for the establishment of plantations.

Benefits.—Crab's eye seeds were used anciently as balance weights in the Eastern countries (Neal 1965) and as rosary beads by the Buddhists (Bailey 1941) because they were so uniform in weight, as well as durable. Today, the seeds are used to make necklaces and other jewelry and for the sounding weights in maracas. The seeds contain a protein-based poison called abrin (Parrotta 2001). One seed contains enough poison to kill a human, but the seeds are very hard and must be chewed or ground to release the poison (Acevedo-Rodríguez 1985). However, cooking destroys the poison so that the seeds may be eaten (Neal 1965). The leaves and roots contain glycyrrhizin, the principal component of licorice. These tissues prepared in various ways are used to treat coughs and a number of other ailments (Parrotta 2001). Crab's eye holds out promise in the treatment of *Schistosoma haematobium* infections. Extracts of the plant were shown to be lethal to adult schistosomes in hamsters (Ndamba and others 1994). Crab's eye vines are sometimes grown for vegetative screens (Bailey 1941).

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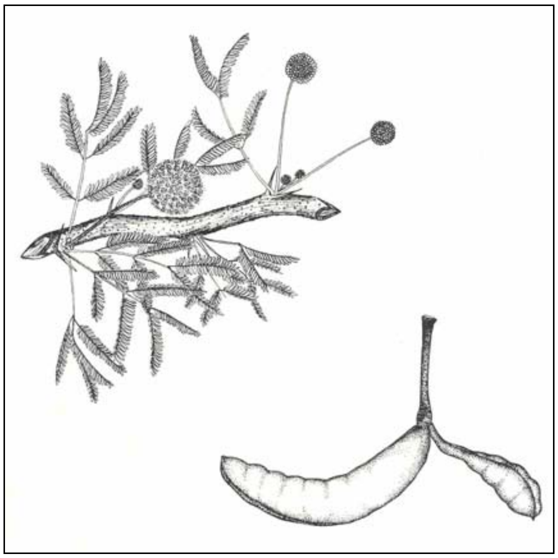
Acacia farnesiana (L.) Willd. sweet acacia
FABACEAE

Synonyms: _Acacia cavenia_ Bert.
Acacia leptophylla DC.
Vachellia farnesiana (L.) Wight & Arn.

John A. Parrotta



General Description.—Sweet acacia, also known as cassie, aroma, huisache, cambrón, espino blanco, and many other common names (Little and Wadsworth 1964), is a medium-sized shrub with many spreading branches and basal stems. The leaves are alternate, bipinnately compound with two to six pairs of pinnae, each with 10 to 25 pairs of narrow leaflets 3 to 5 mm in length. The slightly zigzag twigs are dark brown with light-colored dots (lenticels) and paired spines 3 to 20 mm in length at the nodes. The older bark is also dark brown and smooth. Its bright yellow or orange flowers, produced over a period of 2 to 4 months, depending on locality, are very fragrant and used in the perfume industry in France and elsewhere.

Range.—Sweet acacia is believed to be native to the American tropics, although precise information is lacking about its range prior to the Spanish colonial era, during which it was introduced to numerous countries throughout the tropics and subtropics where it subsequently became naturalized. Today sweet acacia is found in the southern United States from California to Florida, throughout the West Indies, Mexico, Central America, in South America as far south as Chile and Argentina, and in many parts of the Old World tropics and subtropics. Present on all continents between 30° N. and 40° S. latitudes, it is the most widely distributed species of _Acacia_ (Siegler and others 1986).

Ecology.—Sweet acacia is a drought-hardy, fire-resistant species that does not tolerate frost and grows well in areas receiving between 500 and 750 mm of rainfall with a dry season of 4 to 6 months (Webb and others 1980). Its best growth occurs on well-drained soils. It tolerates heavy clays to sands and a variety of soil conditions, including saline soils, at elevations up to 2,000 m. A light-demanding species, sweet acacia often forms dense thickets on disturbed sites and is associated with numerous other shrub and tree species in secondary thorn woodlands, shrublands, and dry forests in its tropical and subtropical American range (Rzendowski 1981). It is susceptible to attack by a number of insect species, leaf, stem, and root pathogens, though none appear to pose a serious threat to the species (Parrotta 1992).

Reproduction.—Sweet acacia produces small (to 5 mm in length) flowers that have functional male and female parts, borne in compact rounded heads 0.6 to 1.3 cm across. The flowers are very fragrant and are pollinated by bees and other insects. The thick, slightly flattened pods, 4 to 9 cm in length and 0.5 to 1.3 cm broad, are produced in abundance after about 3 years. They mature 4 to 6 months after flowering and contain a number of hard-coated, brown seeds embedded in a pulpy mesocarp. The species flowers and fruits between November and February in the Caribbean and between December and March in Central America (Hughes and Styles 1984, Little and Wadsworth 1964). Natural reproduction is abundant, particularly on disturbed sites and in active pastures where cattle readily consume the pods. In nurseries, sweet acacia is usually propagated from seed, although branch cuttings can also be rooted (Webb and others 1980). A collection of seeds from Puerto Rico contained 7,600 seeds/kg, began germinating in 6 days, and achieved 57 percent germination after 13 days (Francis and Rodríguez 1993). Although pregermination treatment is not necessary, cold- or hot-water soaking, chemical scarification, and, particularly, seed-coat scarification by abrasion with sandpaper greatly increase germination rates (Parrotta 1992).

Growth and Management.—Early growth is relatively rapid. About 1 m of height growth can be obtained during the first year, although growth rates of 30 to 50 cm during the first year under semiarid field conditions are more typical (Foroughbakhch and others 1987). Depending on the environment, maximum heights of plants generally range from 3 to 5 m, with stem diameters up to 5 cm. Because sweet acacia is intolerant of shade and does not compete well with more aggressive woody vegetation such as *Prosopis* L., management activities for enhancing growth and natural regeneration in natural and plantation stands may include control of competing vegetation and periodic soil disturbance.

Benefits.—Sweet acacia is planted in many parts of its natural and introduced tropical and subtropical range for reforestation of degraded drylands, for fuelwood and small timber, livestock fodder, and for its flowers used in the perfume industry. In some areas, it is considered a pest due to its ability to colonize pastures and other disturbed habitats. The tannin-rich bark is used for tanning leather, the gum obtained from the cut bark is used as a substitute for gum arabic (from *Acacia nilotica* (L.) Delile), and a useful black dye is obtained from the pods. Various parts of the plant are used in traditional medicine (Liogier 1990, Parrotta 2001). In Mexico, for example, the flowers are used to treat headache and indigestion, whereas a decoction of the green pods is used to treat dysentery and skin inflammations. In India, the bark, heartwood, and leaves are all used medicinally to treat a variety of ailments (Parrotta 2001).

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Acacia greggii **Gray** catclaw acacia
FABACEAE

Synonyms: *Senegalia greggii* (Gray) Britt. & Rose.

Juanita A. R. Ladyman

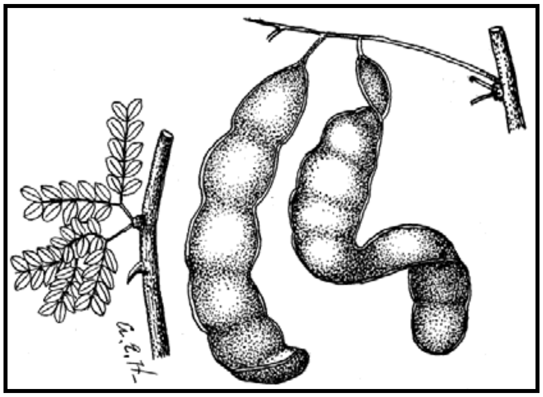

Illustration source: USDA—Forest Service collection, Hunt Institute

General Description.—*A cacia greggii* is commonly known as catclaw acacia, catclaw, Texas mimosa, tearblanket, uña de gato and wait-a-while (Epple 1995). Children sometimes call the plant "Frito" because the wide, flat fruits twist and curl like corn chips. Many of the common names are similar to those applied to *Mimosa aculeaticarpa* var. *biuncifera* which it superficially resembles. The genus name, Acacia, is derived from "akis" that means "thorn" in Greek (Gledhill 1992). Catclaw acacia is a deciduous shrub, or small tree, with grayish-green bipinnately compound leaves that are up to 7.6 cm long. Catclaw acacia exhibits foliage dimorphism (Isely 1973). The leaves clustered on spurs are small, very short petioled, and usually have one to two pairs of pinnae whereas the foliage on new growth is larger with petioles up to 1 cm long and with one to three pairs of pinnae. The short, sharp, curved spines on the branches are approximately 0.64 cm long and resemble cats' claws (Epple 1995). Two varieties exist, var. *greggii* and var. *wrightii* (Kartesz 1994). *Acacia greggii* var. *greggii* is synonymous with *A. greggii* var. *arizonica* Isely; *A. greggii* var. *wrightii* (Benth.) Isely, is synonymous with *A. wrightii* Benth. (Kartesz 1994). Variety *wrightii* can be distinguished from var. *greggii* by its wider legume and larger leaflets.

Range.—Catclaw acacia grows in New Mexico, Arizona, Nevada, southern Utah, southern Colorado, southern California, and Texas, and southwards into the Mexican states of Coahuila, Chihuahua, Sonora, and Baja California. Variety *greggii* is the most widespread. Variety *wrightii* grows in parts of western Texas and New Mexico and in Sonora, Tamaupilas, and Nuevo León, Mexico.

Ecology.—Catclaw acacia is a drought resistant, deep-rooted plant that grows between 300 m and 1,500 m in elevation in a variety of communities and soil types, from sandy or gravelly hills and slopes, to canyon bottoms and along washes and streams (Dayton 1931, McAuliffe 1995, Richardson 1995, Vines 1960). Although most commonly a 1- to 4-m tall shrub, it can grow to an 8- to 10-m tall tree, especially in deep, rich soils (USDAFS 1988). It is a frequent member of desert grasslands and is often associated with other acacia species and a variety of other shrubs (Taylor and others 1997). It is not typically a dominant member of the community but may reach co-dominance in washes (Schmutz and others 1992, Uchytil 1990). Catclaw acacia is more cold tolerant than many acacia species (Bowers 1993). However, in the northern part of its range it generally grows no taller than 2 m whereas in its southern range it will grow to nearly 7 m. Catclaw acacia is a winter-deciduous shrub that grows only when leafy, remaining dormant in the winter and early spring (McClaran 1995). Observations suggest that it is a common host to mistletoe. An ornithological study in Nevada noted that 67 percent of the catclaw acacia shrubs distributed along three 1-km transects were infested with large amounts of mistletoe, *Phorodendron californicum* Nutt. (Blake 1984).

Reproduction.—Catclaw acacia flowers from April through October with the heaviest blooms in April and May (Epple 1995, Everitt and Drawe 1993). Variety *wrightii* flowers as early as March (Vines 1960). Rain frequently prompts flowering. The creamy-yellow, fragrant flowers are insect pollinated (Bowers 1993). The fruit is a light brown to reddish legume often becoming constricted between the seeds. The circular seeds are 5- to 7-mm in diameter (Isely 1973). The wax-coated seeds delay germination for several years and need to be scarified to germinate (Bowers 1993, Epple 1995). Regions where catclaw acacia grows are prone to flash floods and the tumbling action of floodwaters in sandy, gravelly washes accomplish both seed scarification and seed dispersal (Bowers 1993).

Growth and Management.—Catclaw acacia is a thicket-forming shrub that has increased in abundance throughout the Southwestern United States since the 1890s (Bahre 1995). This increase is likely influenced if not directly caused by livestock overgrazing and fire suppression (Bahre 1995). Overgrazing has reduced native perennial grasses that, when healthy and dense, can reduce woody shrub seedling establishment and also provide sufficient fuel to carry a fire. Catclaw is susceptible to fire when young, but mature plants re-sprout from the root crown following fire (Carmichael and others 1978, McPherson 1995). Catclaw is moderately resistant to phenoxy herbicides, and after only one application the shrubs tend to re-foliate or re-sprout from the crown (Hibbert and others 1974). Successive herbicide applications kill the plants. Apparently the invasive resinbrush, *Euryops multifidus* (Thunb.) DC. out-competes, or is in some other way deleterious to, catclaw shrubs and may be a threat in some parts of its range (McAuliffe 1995).

Benefits.—Catclaw acacia shrubs provide protective cover and shade for wildlife (Dayton 1931). Pods, twigs and foliage, especially new growth, provides browse for a variety of wildlife, for example jack rabbit, white-tailed and mule deer, and the seeds are eaten by many species of small mammals and birds, for example, ground squirrels, western white-winged dove, scaled and bobwhite quail (Graham 1941, Everitt and Drawe 1993, Taylor and others 1997). The leaves contain 16 to 20 percent crude protein (Everitt and Drawe 1993). Cattle browse the shrubs especially early in the spring before the new leaves appear, when the young green twigs provide some relatively succulent forage for a short period of time, and when other forage is limited (Graham 1941, USDAFS 1988). The mature foliage and pods are unpalatable to livestock (Graham 1941, Vines 1960). The fruits were ground into a flour, or meal, called pinole by Native Americans (Epple 1995, Vines 1960). It is a food plant for both adult and larval butterflies (Taylor and others 1997) and an important "bee plant" (Dayton 1931). The lac insect, *Tachardia lacca,* feeds on the sap of catclaw acacia and produces a resinous substance that can be used in making varnish and shellac but probably not in commercial quantities (Powell 1998). The wood has been used for fuel and tool handles (Epple 1995). It is also in the ornamental and landscape trade and is a good hedge plant (Taylor and others 1997). It has been used in projects to re-vegetate degraded land but is sensitive to some pollutants such as those found in copper mine wastes (Norem and others 1982).

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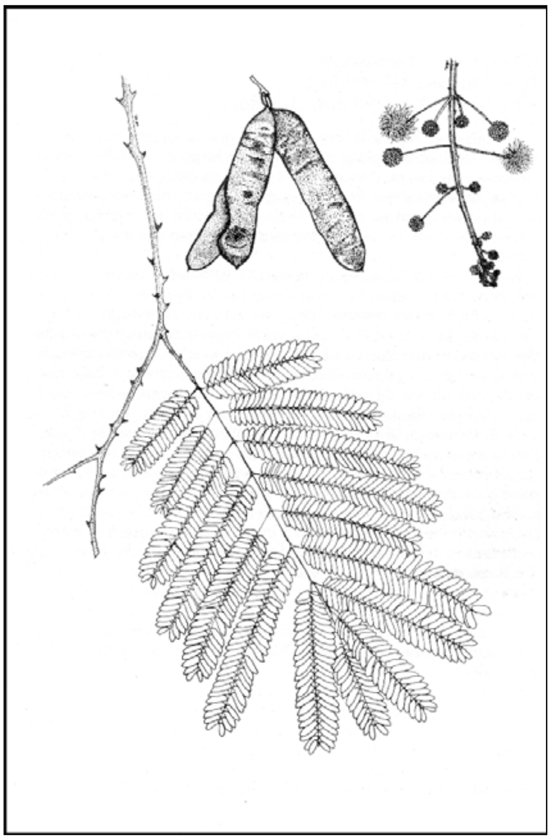
***Acacia retusa* (Jacq.) Howard** zarza brava

FABACEAE

Synonyms: *Acacia westiana* DC
Acacia riparia authors, not Kunth
Senegalia westiana (DC.) Britt. & Rose
Mimosa retusa Jacq.
Mimosa paniculata West
Acacia guadalupensis DC.
Acacia sarmentosa Griseb.

John K. Francis



General Description.—Zarza brava is also known as acacia zarza, amourette, and fleur du ben-aimé (Acevedo-Rodríguez 1985, Howard 1988, Liogier 1988). The common name zarza brava is Spanish. The modifier "brava" means fierce, which aptly describes the way its thorns grab a person trying to walk through it. Usually, zarza brava is a climber, but when open-grown, it scrambles or grows upright. It is also reported to occasionally become a slender tree (Howard 1988). The stems are gray, squarish when young and angular or fluted when older. The old and young stems and even the leaf petioles and rachises are armed with recurved spines that protect the plant and facilitate climbing. The root system consists of many robust laterals without an apparent taproot. Nodules were not seen by the author. There may be single or multiple stems from the ground level, but few branches occur on the stem until it reaches increased light in the canopy. The leaves are bipinnately compound with four to 12 pinnae and 15 to 25 leaflet pairs per pinnae (Liogier 1988). The inflorescence is a panicle of small heads. The stamens are white. The legumes are flat, brown, and 6 to 10 cm long and 1 to 2 cm wide. The seeds are oval, flat, and dark brown (Howard 1988).

Range.—Zarza brava is native to Hispaniola, Puerto Rico, the Virgin Islands, the Lesser Antilles, Trinidad, and northern South America (Howard 1988). It is not known to have been planted or naturalized elsewhere.

Ecology.—Zarza brava grows in habitat that receives from as little as 700 mm to as much as 2200 mm of annual rainfall in Puerto Rico, and is more common in the mid-range of this rainfall. Soils from all parent materials, including limestone and ultramafic rocks, are colonized. Soil textures from sand to clays and pH's from at least 5.0 to 8.0 are tolerated. Zarza brava can survive under a broken overstory. When mats are formed, only the upper surface stems produce leaves. The species is more common in disturbed habitat than in remnant old growth forests. During the abandonment of agricultural land, it invades during the brushy pasture stage and becomes very common in early secondary forest. After the canopy closes, zarza brava declines in importance, but does not disappear.

Reproduction.—Zarza brava flowers in June and

December (Acevedo-Rodriguez 1985) and ripens fruit in January and July. Fruit production can be very heavy, and pods in one sample in Puerto Rico averaged 7.97 ± 0.29 seeds/pod. The seeds averaged 0.041 ± 0.001 g/seed or 24,000 seeds/kg. Some of the seeds had been attacked by an unknown species of beetle and a lepidopteran larva. When planted in commercial potting mix, the seeds began germinating in 4 days and by 11 days had reached their final 98 percent germination. Germination is epigeal. In the wild, seedlings are produced in abundance, but few survive beyond the first year. Zarza brava sprouts vigorously and grows rapidly after fires or cutting.

Growth and Management.— Seeds are dispersed by lateral extension of the vines, by pods tumbling laterally through the air after becoming detached from vines, and by accidental dispersal by grazing animals and humans. New seedlings make relatively rapid early growth. Older plants also add length rapidly. The stems of zarza brava may eventually reach as much as 10 cm in diameter and as much as 12 m into tree canopies (Acevedo-Rodríguez 1985). No planting experience of zarza brava is known, but if establishment of plants is needed, doubtless the planting of potted nursery seedlings would succeed. The species is so aggressive that direct seeding into prepared seed spots in forest openings should also give good results.

Benefits.—Zarza brava is eaten by goats, but seldom touched by cattle. In fact, it survives as scrambling patches in overgrazed cattle pasture. On the other hand, the species is a great nuisance to the cattleman, woods workers, and hikers. It is frequently necessary to cut a path through zarza brava thickets with a machete, in order to move through vegetation in the semiarid-zones within the zarza brava range. When one contacts the vines, the tips of the spines break off in the skin, causing pain and sometimes resulting in infection. No specific control recommendations have been developed. In the past, control was attempted with mixed success by repeated cutting. Control could probably be improved by treating the sprouts with herbicides after cutting.

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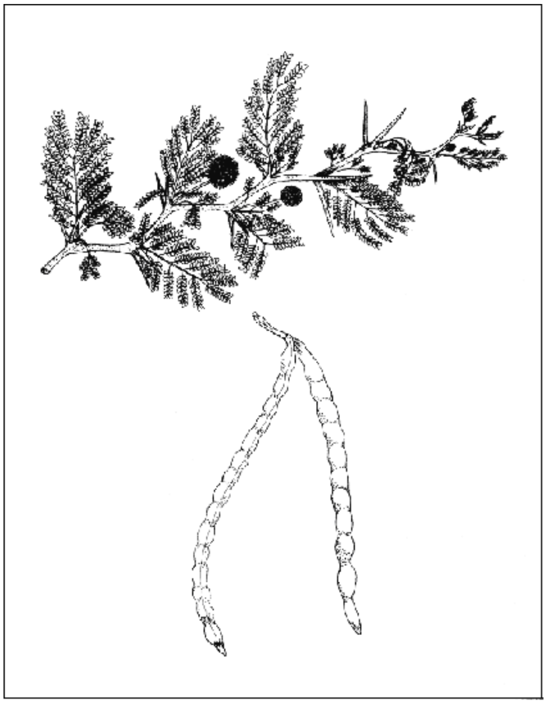
Acacia tortuosa **(L.) Willd.** twisted acacia
FABACEAE

Synonyms: *Mimosa tortuosa* L.
Poponax tortuosa (L.) Raf.
Acacia parvifolia Duss

John K. Francis



General Description.—Twisted acacia, also known as acacia-bush, wild-poponax, sweet-briar, cossie, aromo, cají torcido, and pompons jaunes, is a deciduous shrub or small tree to 6 m in height and 15 cm in trunk diameter. The plant may have single or multiple stems with gray-brown, finely fissured bark and a light brown inner bark with darker streaks. The wood is light brown and hard. The twigs are slender with a zig-zag profile, produce paired, straight spines at the nodes, and have whitish lenticels on the reddish-brown bark. Mature twisted acacia are flat topped and have a thin crown of feathery foliage. The bipinnately compound leaves are 2.5 to 9 cm long with two to eight pairs of pinnae and 10 to 20 pairs of leaflets per pinnae. Solitary or small clusters of heads of tiny, yellow-orange flowers are borne at the leaf axiles. Dark brown or black semiwoody, 8- to 14-cm pods (legumes) are straight or slightly curved and somewhat constricted between the seeds. They do not open. The ovoid seeds are brown and hard (Howard 1988, Liogier 1988, Little and others 1974). The chromosome number is 2n = 26 (Long and Lakela 1971).

Range.—Twisted acacia is native to Jamaica, Hispaniola, Puerto Rico, the Virgin Islands, the Lesser Antilles, Trinidad, and in South America, Venezuela, Colombia, and Ecuador including the Galápagos Islands (Howard 1988, Instituto Humboldt 2002, Liogier 1988, Little and others 1974). It is endangered in Florida where it may be native or introduced (Little and others 1974, Institute of Systematic Botany 2002). Although several reputable sources list Texas, Mexico, and Central America as being part of the *A. tortuosa* range (e.g., Missouri Botanic Garden 2002, Nature Conservancy 2002), Little and others (1974) and Texas A & M Herbarium (2002) maintain that this western population is in fact *A. schaffneri* (S. Wats.) Herm.

Ecology.—Twisted acacia is intolerant of shade and only moderately competitive. It finds conditions for establishment and growth to reproductive age in disturbed, dry areas. Disturbance since European colonization has been by heavy grazing, fires, excessive timber harvest, and clearing for farming or pasture improvement. One of the most common plants of disturbed areas in Curaçao is twisted acacia (Carambi Foundation 2002). It is found on shell mounds and along roadsides in Southern Florida (Nelson 1996). The species grows in coastal areas of Puerto Rico and its offshore islands in areas that receive from 750 to about 1100 mm of precipitation. The plant colonizes well-drained soils of the full range of textures derived from both sedimentary and igneous rocks. Most of these soils are neutral to mildly alkaline. Twisted acacia is not damaged by mild salt spray. It is usually ignored by cattle and tolerates browsing by goats.

Reproduction.—Twisted acacia flowers intermittently throughout the year (Little and others

1974). Bees and other insects pollinate the flowers (Treeguide 2002). A collection of pods from Puerto Rico contained an average of 12.4 seeds/pod and a range of eight to 15 seeds/pod. The air-dried seeds separated from them averaged 0.0440 $\pm$ 0.0004 g/seed or 22,700 seeds/kg. These were mechanically scarified (nicked) and incubated on moist blotter paper. Ninety-nine percent germinated between 5 and 21 days after sowing (author's observation). Because of the hard, impermeable seed coat, germination without scarification is low and erratic. Any technique that perforates the seed coat will work. One source (Treeguide 2002) recommends placing the seeds in boiling water, immediately removing the heat source and letting the seeds soak for 24 hours. Germination is epigeal. The seeds are dispersed by herbivores, particularly ruminants that eat the pods. Seedlings often emerge in large numbers, but nearly all are consumed by grazing animals before they have a chance to become woody and thorny.

Growth and Management.—Although acacias can be propagated with cuttings, the use of seeds is recommended (Bonsai Clubs International 2002). No management experience has been published; however, nursery production and field establishment will probably be as easy as it is for other acacias. Control of twisted acacia along with other secondary dry-forest species has been accomplished in several areas in Puerto Rico and the U.S. Virgin Islands by bulldozing. The use of heavy disks might be a better option where removal of woody debris is not required.

Benefits.—Twisted acacia helps protect the soil in its disturbed habitat. It is listed as a nitrogen-fixing species (Winrock International 2002). The seeds are eaten by the threatened yellow-shouldered amazon parrot (*Amazona barbadensis*) in Bonaire and probably other parts of its range (Island Resource Foundation 2002). The species serves as cover for wildlife species. Cattle and other livestock eat the pods while goats and sheep browse the foliage, especially when other forage is scarce. The wood is used to a limited extent for fuel. Twisted acacia plants are used to create bonsai plants (Bonsai Clubs International 2002). The species has been grown and pruned for hedges (Little and others 1974).

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Acer glabrum **Torr.** Rocky Mountain maple
ACERACEAE

Synonyms: *Acer tripartitum* Nutt.

John K. Francis

General Description.—Rocky Mountain maple, also known as mountain maple and Douglas maple, is an upright, deciduous shrub or small tree, that ranges in height from 2 to 10 m, depending on variety and habitat. It usually grows with multiple stems, suckering from the base, and narrow crowns, and may be spindly in closed stands. The stem bark is thin, smooth, and gray, brown, or reddish brown. Branches are opposite and sparse with reddish twigs. Roots are woody, extensive, and often deep. Leaves vary considerably, depending on variety. They are opposite, glabrous, and have three to five lobes and rarely three distinct leaflets, and range from 2 to 10 cm wide and long. The margins are serrate or doubly serrate. They may be papery or leathery, depending on location and variety. Rocky Mountain maple occurs as monoecious and dioecious trees that have small greenish flowers borne in loose, few-flowered terminal corymbose cymes. Fruits are light brown (when mature) double samaras that diverge at angles less than 45° with wings about 2 cm long. (Abrams 1951, Anderson 2001, Wasser 1982, Welsh and others 1987).

Range.—Rocky Mountain maple occurs from southern Alaska south into northern Mexico and east from the Pacific Coast to Alberta, South Dakota and Nebraska (Anderson 2001). There are currently six recognized varieties: var. *diffusum* from the Pacific Southwest, var. *douglasii* from the Pacific Northwest, var. *greenei* from California, var. *glabrum* from the inland West, var. *meomexicanum* from the inland Southwest, and var. *torreyi* from Oregon, California, and Nevada (Natural Resources Conservation Service 2003). They differ at least in leaf shape, size, and thickness.

Ecology.—Rocky Mountain maple is moderately shade tolerant. It can grow (slowly) in the understory and midstory of closed coniferous forest but grows in full sun as well. A pioneer in disturbed areas, it starts from sprouts and seeds in burned areas, clearcuts, avalanche fields, and road sides, cuts and fills. It may grow along streams in drier areas. Rocky Mountain maple is a member of a huge number of plant associations, and is frequently dominant during seral stages of succession (Anderson 2001, Johnson 1995). The species grows in soils derived from most rock types, in all soil textures, and in skeletal soils. These are moist, well-drained to somewhat poorly drained soils that are moderately acid to slightly alkaline. It may be found at elevations from 350 m in British Colombia to 3,900 m in Colorado and Utah. Rocky Mountain maple is slightly more common in southern than northern aspects. Some of its locations have mean annual precipitation as low as 230 mm and as high as 1,500 mm (Anderson 2001). It tolerates competition well, usually outgrowing and overtopping young trees and most shrub species. Dull red leaf spots are caused by an unknown pathogen and bright red eriophyid mite colonies develop on the underside of leaves in some areas. The effects of these and other diseases appear to be negligible to populations of the species.

Reproduction.—Flowering occurs in early spring, depending on the elevation and latitude (Wasser 1982). Fruits mature in late summer or early autumn. Good seed crops occur every 1 to 3 years. There are about 30,000 cleaned seeds/kg (Zasada and Strong 2003). Seeds disperse by whirling sideways as they descend, often carried by the wind. Seeds sometimes lie dormant for one or two growing seasons before germinating. Germination is epigeal. Natural seedlings can be common to abundant.

Growth and Management.—Rocky Mountain maple seedlings grow about 30 cm/year (Hansen 2003). On good sites sprouts may reach 1.3 m within 2 years and 3 m in 10 years. Maximum heights are reached in 30 to 40 years (Anderson 2001). Fruits can be picked by hand from low shrubs or clipped or shaken from tall shrubs and small trees. Mechanical dewinging may be advantageous to reduce bulk and improve handling before planting. The seeds can be stored for up to 3 years (Hansen 2003). Stratification of 180 days at 20 to 30 °C followed by 180 days at 3 to 5 °C is recommended before sowing. Germination of about 40 percent can be expected in about 30 days (Zasada and Strong 2003). Alternately, seeds are sown after collection and beds are maintained for 2 years because a substantial amount of the germination will occur after the second winter. Seeds are sown 0.6 to 2.5 cm deep and mulched in shaded beds. Seedlings are produced as bare-root stock or containerized plants (Zasada and Strong 2003). The species can be propagated by layering and rooted cuttings (Hansen 2003).

Benefits.—Rocky Mountain maple is an important part of the forest understory and pioneer vegetation following fires and clearcuts. It helps protect the soil, adds beauty to the forest, and furnishes food and cover for wildlife. It is an important browse species for domestic livestock, especially sheep, and wild ungulates. Samples of summer growth contained about 8.7 percent crude protein, 3.1 percent fat, 34.0 percent crude fiber, 51.0 percent N-free extract, and 3.2 percent ash. Samples of winter browse contained 5.9 percent crude protein, 2.4 percent fat, 33.3 percent crude fiber, and 54.2 percent N-free extract (Anderson 2001). The seeds and vegetative parts are consumed by ruffed and blue grouse, grosbeaks, and small mammals (Anderson 2001). The wood is hard, close-grained, and flexible. It was used by Native Americans for arrow shafts, snowshoe frames, ceremonial equipment, hut frames, and drying and smoking racks. The inner bark furnished material for mats and ropes. Today, the wood is mainly used for firewood (Hansen 2003) and smoking meat (Johnson 1995). The young shoots may be cooked and eaten as a vegetable (Pratt and others 2003). Native Americans made infusions and decoctions of the twigs and wood to treat swelling and nausea, respectively (Moerman 1986). Rocky Mountain maple is widely used in environmental restoration projects within its native range and is an important ornamental species valued for its petite size, tolerance to shade, and bright red, yellow, and orange autumn colors (Hansen 2003).

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***Acer spicatum* Lam.** mountain maple
ACERACEAE

Synonyms: none

Paula M. Pijut

Illustration source: USDA—Forest Service collection, Hunt Institute

General Description.—Mountain maple is a tall, deciduous shrub or clumped small tree that grows 3 to 10 m tall and can spread to form dense thickets (Dirr 1998; Gleason and Cronquist 1991; van Gelderen and others 1994). In the northern part of its native range mountain maple reaches a maximum height of 6 m (Sullivan 1993). Leaves are opposite, simple, three-lobed or obscurely five-lobed, coarsely and irregularly serrate, dark yellowish-green, glabrous with impressed veins (adaxial), lighter green and pubescent (abaxial), truncate to cordate at the base, and 5 to 13 cm long and wide (Dirr 1998; Gleason and Cronquist 1991; van Gelderen and others 1994). The leaves turn yellow, orange, or most frequently brilliant red in the fall. Stems are grayish pubescent when young, developing a purplish-red color on the upper surface. Leaf scars are narrowly crescent shaped (Dirr 1998). Buds are approximately 0.6 cm long, stalked, pointed, red with minute, appressed, grayish hairs, and with two to four valvate scales (Dirr 1998; Gleason and Cronquist 1991). The flowers are small, greenish yellow, in fascicles of two to four, borne in erect 3 to 8 cm long panicles. Each flower is functionally either pistillate or staminate, although the non-functioning structures still exist in the flower, reduced to a greater or lesser extent. Staminate flowers drop soon after the pollen is shed (De Jong 1976). Each flower is borne on a slender stalk about 1.3 cm long and the panicles are found at the branchlet tips. The bark is thin, brown to reddish-brown, smooth, becoming furrowed or warty with age (Dirr 1998). The fruit is a 2.5 cm long, two-winged samara, bright red when mature, with divergent wings at an acute or right angle. The chromosome number of mountain maple is 2n = 26 (Gleason and Cronquist 1991).

Range.—Mountain maple occurs from Newfoundland to Saskatchewan, south to Connecticut, Pennsylvania, Ohio, and northeastern Iowa, and in the mountains to North Carolina and Tennessee (Gleason and Cronquist 1991).

Ecology.—Mountain maple prefers rich, moist, acid, well-drained soils with low, diffuse light (Dirr 1998; Sullivan 1993). These sites include cool woods with humid climate and year-round precipitation, rocky slopes and flats, along streams, in ravines, and on moist hillsides. Mountain maple also grows well on podzol soils, talus slopes, and in forested bogs (Sullivan 1993). Mountain maple can form a canopy on cliff faces. Mountain maple is an understory or subcanopy shrub that is tolerant of deep shade, but also grows well in full sun, has medium moisture and fertility requirements, and colonizes the understory as pioneer tree species decline (Sullivan 1993; USDA, NRCS 2002). Mountain maple is not salt tolerant, and has low drought tolerance. Release of mountain maple by canopy tree harvest allows the shrub to dominate the site within 5 to 10 years, suppressing the growth of spruce and fir seedlings for at least 35 years (Sullivan 1993). In undisturbed, mature red pine-white pine sites in northeastern Minnesota, mountain maple forms a dense, high shrub layer with beaked hazel and American hazel that inhibits reproduction of later successional species, such as balsam fir and spruce (Sullivan 1993). Eradication of mountain maple is sometimes necessary for tree regeneration. The weevil, *Phyllobius oblongus* L., is especially damaging to mountain maple (Johnson and Lyon 1991). The larvae feed on the roots, mature, and overwinter in the soil. Adults are brown weevils that defoliate mountain maple. They are found throughout the northeast into Michigan and the border provinces of Canada (Johnson and Lyon 1991). *Kabatiella apocrypta* (Ell. & Ev.) v. Arx (anthracnose pathogen) causes minor damage to mountain maple, although severe infections can led to premature defoliation (Sinclair and others 1987). Mountain maple is also susceptible to attack by *Verticillium dahilae* Kleb. (verticillium wilt), *Phyllactinia guttata* (Wallr.:Fr.) Lev. (powdery mildew), *Nectria* sp. (nectria canker), *Cristulariella depraedens* (Cooke) Hohn. (leaf spot/blight), *Pseudomonas syringae* pv. *syringae* van Hall (bacterial leaf spot and dieback), *Phyllosticta minima* (Berk. and M.A.Curtis) Underw. and Earle (leaf spot), *Rhytisma* sp. (tar spots), and *Venturia acerina* Plakidas ex Barr (leaf blotch) (Farr and others 1989, Jones and Benson 2001, Sinclair and others 1987).

Reproduction.—Mountain maple staminate flowers and pistillate flowers occur on the same plant. Some individuals may flower completely with staminate flowers. Mountain maple is predominately duodichogamous (producing flowers in three consecutive phases, male-female-male, during anthesis), with a small part of the population protogynous (stigma receptive before the pollen is shed) (van Gelderen and others 1994). Low temperatures appear to favor development of female flowers and flowers with less reduction of the non-functioning parts. (van Gelderen and others 1994). The shrub blossoms in May to June after the leaves are fully developed; fruit ripens in September to October, with seed dispersal in October to December (Zasada and Strong 2000). Mountain maple is insect pollinated (Sullivan 1983) and the seed is wind disseminated. Seeds of mountain maple need to be stratified for 90 to 120 days at 5 ºC for good germination (Dirr 1998). Mountain maple does not build up a seed-bank and seedling establishment is better on undisturbed soils (Sullivan 1993). Seedling reproduction of mountain maple does not result in dense, competitive stands, as can be the case with its vegetative reproduction. Mountain maples frequently layer, giving them the potential to develop relatively complex clones of varying size and morphology (Zasada and Strong 2000). Mountain maple can reproduce by sprouting from underground lateral stems, rarely from root suckers, and colonies usually develop following disturbances by browsing or cutting (Sullivan 1993). Propagation of mountain maple by cuttings taken early in the summer produces strong plants (van Gelderen and others 1994).

Growth and Management.—Mountain maple is a slow to medium growing shrub or small, short (crooked) trunked tree of bushy appearance (Dirr 1998). It is hardy in zones three to seven at high elevations (USDA Plant Hardiness), and starts to decline at 40 to 50 years of age (Sullivan 1993). Mountain maple is girdled at the root collar by low, surface fires, and can re-sprout from underground stems (Sullivan 1993). A severe, hot fire is necessary in order to kill the roots. Mountain maple can withstand repeated and heavy browsing, producing new growth even when 80 percent of the annual twig growth is removed each year (Sullivan 1993). Mountain maple is an understory or subcanopy component in a number of northeastern forest associations (Sullivan 1993). Cutting mountain maple near the ground level, clear-cutting, and spraying with 2,4-D in the spring will increase the availability of new growth for deer and moose browse (Sullivan 1993). Burning can be used to suppress mountain maple in order to promote reproduction of other, more desirable tree species.

Benefits.—Mountain maple is a nutritious browse species for moose, white-tailed deer, cottontails, snowshoe hares, woodland caribou, beavers, and ruffed grouse (Sullivan 1993). Mountain maple is sometimes planted as an ornamental, but has little landscape value excluding its brief fall color display and colorful samaras.

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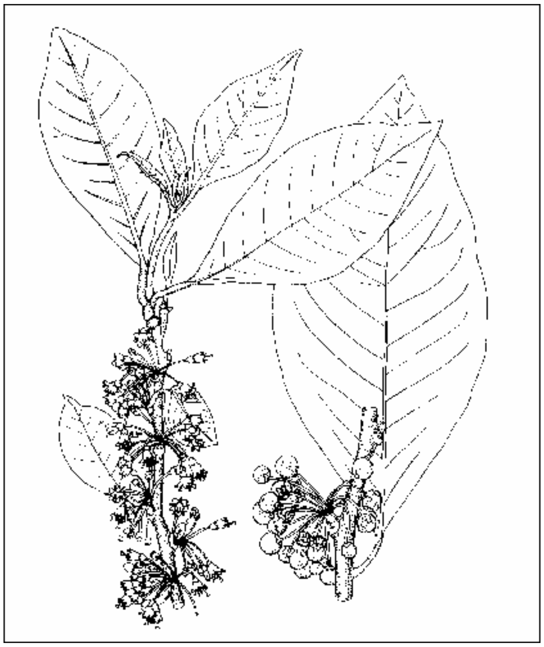
***Acnistus arborescens* (L.) Schlecht.** gallinero

SOLANACEAE

Synonyms: *Atropa arborescens* L.
Cestrum cauliflorum Jacq.
Acnistus cauliflorus (Jacq.) Schott
Acnistus frutescens Bello
Cestrum macrostemon Sassé & Moç.
Dunalia arborescens (L.) Sleumer

John K. Francis



General Description.—Gallinero is also known as hollow heart, wild tobacco, siyou, bastard sirio, galán arbóreo, mata gallina, tabaco de monte, nigüito, marieneira, and tabak djab. It is an evergreen shrub or small tree to 6 m in height and 15 cm in stem diameter. Multiple stems are usual for older plants. The trunk is supported by extensive lateral roots with "sinkers" and abundant fine roots. The roots are flexible, light tan, and have furrowed bark. Stem bark is light brown or gray and finely fissured. Stem wood is light brown and hard. Twigs of gallinero are stout, light brown or gray and finely hairy. The simple, alternate leaves are elliptical to lanciolate, 5 to 30 cm long by 3 to 14 cm broad, entire, and pointed at both ends. Gallinero bears tiny, fragrant, greenish-white flowers in clusters of 30 or more in axillary fascicles. The fruits (berries) are numerous in each cluster, yellow or orange, globose, 5 to 11 mm in diameter, and have a persistent calyx. The fruit pulp is juicy, almost tasteless or slightly bitter, and not edible to humans. Each fruit contains numerous yellow, flattened seeds 1.5 to 2 mm wide with a rolled embryo (Howard 1989, Liogier 1995, Little and others 1974, Stevens and others 2001).

Range.—Gallinero is native to the Greater Antilles, the Lesser Antilles, Trinidad and Tobago, Mexico, Central America, and South America through Brazil and Peru (Howard 1989, Little and others 1974).

Ecology.—Gallinero is widespread and rare to common on a wide range of soils over both igneous and sedimentary rocks. In Puerto Rico, it grows in areas that receive from about 1600 to 2500 mm of mean annual precipitation. The species is most common from 700 to 1,500 m in elevation in Costa Rica (Haber 2002) and from 450 to 900 m in Puerto Rico (Little and others 1974). The species is frequently found on roadsides, landslides, old pastures, and young secondary forests (Haber 2002). Disturbance is necessary for establishment. Gallinero is intolerant of shade; at least broken sunlight is necessary for long-term survival and flowering. A number of insect species feed on the leaves and parasitize the fruits (Engriser 1995, Haber 2002, Simpson and others 2002).

Reproduction.—Gallinero flowers in May and June and fruits from May to September in Costa Rica. Occasional individuals may be found in flower at any time during the year (Haber 2002). In Puerto Rico, the species flowers in spring and fruits in late spring and summer (Little and others 1974). The flowers are pollinated by bees, wasps, flies, butterflies, beetles, and occasionally hummingbirds (Haber 2002). A collection of fruits from Puerto

Rico averaged 0.2025 ± 0.0084 g/fruit. Seeds separated from them weighed an average of 0.00074 ± 0.00017 g/seed or 1,350,000 seeds/kg. Sown on commercial potting mix, 88 percent germinated between 11 and 35 days after sowing. Some of the seedlings were killed by "damping off" fungi (species unknown). A fruiting tree produces an enormous number of seeds. Birds and bats eat the fruits and disperse the seeds (Engriser 1995). Layering (rooting) occurs whenever the trunk or branches come in contact with the ground; sprouts from prostrate trunks and branches sometimes become independent plants.

Growth and Management.—Gallinero has a moderate growth rate and is relatively short-lived (10 to 20 years). Nursery and management experience has not been published.

Benefits.—Gallinero is used occasionally as an ornamental and for hedges and living fence posts. Chickens eat the fruits (Little and others 1974). The wood is burned for fuel (Espinoza 1985). Practitioners of traditional herbal medicine use extracts of leaves to treat cancerous growths. An alcoholic extract was tested and found to inhibit cancerous cells *in vitro* and *in vivo*. The active ingredients were identified as Withaferin A and Withacnistin (Kupchan and others 1969). Extracts of gallinero were the most effective against hamster lung fibroblasts of 31 Columbian plants used in herbal medicine to treat cancer (Lopez de Cerain and others 1996). The species is used in Brazil as a diuretic, to treat liver infections, as well as an antitumor agent (Mingussi and Barata 2002). Gallinero helps reforest disturbed areas, protects the soil, and furnishes food and cover for wildlife.

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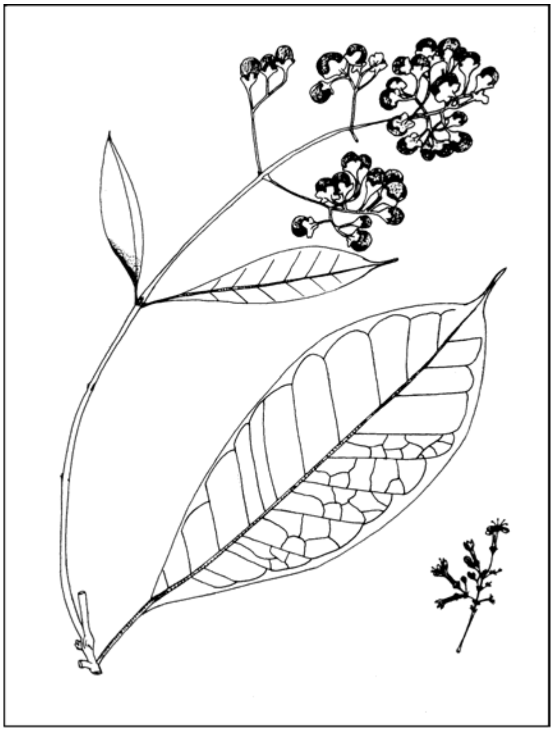
***Aegiphila martinicensis* Jacq.** Caribbean spiritweed
VERBENACEAE

Synonyms: *Aegiphila glandulifera* Moldenke
Aegiphila panamensis Moldenke

John K. Francis



General Description.—Caribbean spiritweed, also known as capaíllo, bois cabrit, bois de fer, bwa kabuit, sureau gros, and bois cabroit, is an upright to climbing, evergreen shrub or small tree up to 6 m in height and 7.5 cm in stem diameter. The older stems are gray and furrowed, branches are mostly smooth with lenticels, and twigs are four-angled. The ivory-colored wood is moderately hard and brittle, and the stems have a 2-mm pith. Roots are tan colored and flexible. The opposite, thin leaves are oblong-lanceolate to oblong with entire edges, 8 to 16 cm long by 3 to 8 cm broad, rounded or pointed at the base and long-pointed at the tip. Inflorescences are axillary or terminal, many-flowered cymes. Flowers are white or pale yellow, tubular, and 2 to 6 mm long. From these develop globose to ovoid, yellow, orange, or red, 7- to 10-mm, fleshy fruits with persistent calyxes, a grainy texture, and little flavor. Fruits have one to four brown, elliptical seeds with longitudinal striations (author's observations, Howard 1989, Liogier 1995, Little and others 1974).

Range.—Caribbean spiritweed is native to Cuba, Jamaica, Puerto Rico, the Virgin Islands, the Lesser Antilles, Trinidad, Mexico to Panama, Colombia, Venezuela, and French Guiana (Howard 1989, Liogier 1995, Little and others 1974, Missouri Botanic Garden 2003). It is not known to have been planted or naturalized elsewhere. Stevens and others (2001) treat the Central American distribution as a separate species (*A. panamensis* Moldenke) based on the shape of the calyx.

Ecology.—Caribbean spiritweed is rare in Puerto Rico (Little and others 1974) but is common in Nicaragua (Stevens and others 2001). It occurs in forests and brushy areas in foothills and lower mountains of Puerto Rico from 60 to 244 m in elevation in areas of limestone, other sedimentary, and igneous rocks (Little and others 1974). In Nicaragua, the species grows in forests and pastures in wet to dry areas from near sea level to 900 m elevation (Stevens and others 2001). Caribbean spiritweed is moderately intolerant of shade and is able to flower and fruit in partial shade.

Reproduction.—Caribbean spiritweed flowers and fruits irregularly throughout the year (Little and others 1974). The fruits ripen a few at a time in each infrutescence rather than all at once. A collection of fresh fruits from Puerto Rico weighed an average of 0.496 $\pm$ 0.026 g/fruit. Air-dried seed separated from them averaged 0.0331 $\pm$ 0.0007 g/seed or 30,000 seeds/kg. Placed on moist blotter paper without pretreatment, 61 percent germinated between 1 and 4.5 months after sowing (author's observation). Germination was hypogeal (cotyledons remain below ground). Seeds are probably dispersed by birds. Caribbean spiritweed sprouts when cut and may resprout to replace senescent stems.

Growth and Management.—Caribbean spiritweed grows relatively rapidly, about 1 m/year. Stems may live 5 years or more. No planting or management experience has been published.

Benefits.—Carabbean spiritweed helps protect the soil and furnishes food and cover for wildlife. Larva of the hawk moth, *Munduca hannibal hannibal,* apparently feed exclusively on Caribbean spiritweed (Oehlke 2003). Infusions of the leaves and twigs have been used as a diuretic and as a pleasant tonic for treating asthma (Núñez-Melédez 1982). In Costa Rica, the plant is considered an aphrodisiac (Duke 2003).

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Agave missionum Trel. corita

AGAVACEAE

Synonyms: *Agave portoricensis* Trel.

John K. Francis

General Description.—Corita, also known as maguey, is a succulent shrub with woody parts that is 1.0 to 1.5 m in height in its vegetative stage and 3 to 6 m when in flower. The plant is considered a shrub because it is of shrub size and has fibrous-woody tissue at the base of the leaf whorl, woody thorns, and a woody flower stalk. The numerous fibrous roots are about 5 mm in diameter and the fibrous-woody base of the plant extends about 15 cm below the surface. Lanciolate to broadly lanciolate, fleshy leaves are blue-green in color, contain many fine, high-quality fibers running their length, and thorns, 2 to 6 mm in length along their edges, and larger ones, 10 to 20 mm long, at the tips. The leaves die when the plant is about midway through flowering. The flower stalks (panicles) are about 10 cm in basal diameter with soft wood and a pithy center. The yellow or yellow-green perianth is six-parted and funnel shaped, 4.5 to 5.2 cm long. The capsules are elliptical or globose and 2.5 to 3.8 cm long and contains numerous seeds, 6 to 8.5 mm long and 5 to 6 mm broad. If the flowers abort, numerous bulbils are formed on the pedicels (author's observation, Britton and Wilson 1923).

Range.—Corita is native to Puerto Rico and the offshore islands of Culebra and Vieques and St. Thomas, St. Croix, St. John, Tortola, Virgin Gorda and Anegada in the U.S. and British Virgin Islands (Breckon and García 2001, Britton and Wilson 1923, University of the Virgin Islands Conservation Data Center 2002). Based on work by Trelease (1913), some sources (International Plant Name Index 2002, Missouri Botanical Garden 2002, Texas A & M University Bioinformatics Working Group 2002) separate the group into two species—*A. missionum* and *A. portoricensis* Trel. However, Britton and Wilson (1923) and Liogier and Martorell (2000) recognize just *A. missionum*. Because ecological and management differences between the two populations are probably minor, they will be treated here as a single species.

Ecology.—Corita grow naturally in well-drained to excessively drained areas that receive between 750 mm and about 1700 mm of annual precipitation. The species colonizes most soil types over both sedimentary and igneous rock formations. Corita is intolerant of shade and consequently does not grow well under a closed forest canopy and does not compete well in tall grass swards. It is often found in disturbed areas, cliffs, and rocky terrain on the coasts and inland. Corita plants are eaten by cattle when they are small but are generally avoided after the thorns harden.

Reproduction.—Flowering of corita appears to be triggered more by size and vigor than by age. Probably, reserves of starch and other nutrients are important. Flowering plants are often about 1 m or more in height (tallest leaf), 2 m in diameter, and 5 to 10 or more years old, depending on the quality of the habitat. Flowering proceeds from the bottom of the inflorescence to the top. Although honeybees and other insects visit the flowers in great numbers, most plants never produce seeds. After the flowers fall off, bulbils form at the point where the flowers were attached. Corita plants produce several hundred to several thousand bulbils each. A collection of 100 bulbils from Puerto Rico weighed (fresh) an average of 3.003 $\pm$ 0.252 g/bulbil and ranged from 0.18 to 13.63 g. Placed with their bases slightly buried in moist potting mix, all of them rooted within 1 week. They grew rapidly under partial shade and were pricked into containers in about 3 weeks from sowing. After 2 or 3 weeks they were moved to full sun and reached about 15 cm in height in 2 additional months and were dispersed to the public (author's observation). Plants originating from bulbils can be numerous under fruiting plants. It is not known what specialized means of dispersal exist. However, new plants are frequently seen with no remains of flowering corita plants nearby. Normally a plant dies after completing flowering, but many plants produce basal sprouts in the year of flowering, or before, that continue for another generation.

Growth and Management.—Corita grows at a steady, moderate rate from bulbils on well-watered soil and somewhat more slowly in poor, droughty ground. Growth and development of seedlings has not been reported. Transplanting is easy with little mortality. Because of low competition, disturbed, dry, and rocky areas are probably the best sites for planting. Corita is recommended for planting on shorelines and dunes in the Caribbean (United Nations Environment Program 1998).

Benefits.—Corita contributes to the biodiversity and helps protect the soil in the sites where it grows. Because of its hardiness in almost any well-drained soil, moderate size, and pleasing dark blue-green color, the species makes an excellent ornamental. Because exotic agaves were promoted, it was used sparingly in the past but is beginning to attract more attention. Corita appears to be an excellent honey source. The leaves contain strong fibers that probably were used for cordage in former times.

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***Allamanda cathartica* L.** allamanda

APOCYNACEAE

Synonyms: *Echites verticillata* Sessé & Moç.
Orelia grandiflora Aublet
Allamanda grandiflora (Aublet) Poiret in Lam.
Allamanda hendersonii W. Bull ex Dombrain

John K. Francis

Illustration source: Missouri Botanical Garden

General Description.—Allamanda, also known as angel's trumpet, golden trumpet, yellow bell, canario, cautiva, dabel-da-dama, orelia, and liane à lait, is an evergreen, vine-like woody shrub. It may reach a free-standing height of 2 m and an extension of 5 m or more. The species also climbs a few meters into the crowns of tall brush and low trees. Older plants often have multiple stems from the root crown and long stems with relatively few branches. Bark of lower stems is brown and furrowed. Twigs are green or yellow green. Stems and twigs exude a milky sap when cut. The leathery, yellow-green to dark green leaves grow in whorls of three or four, or are sometimes opposite. Leaves are 6 to 16 cm long, obovate to oblong-lanceolate, pointed at both ends and have entire margins and short petioles. Inflorescences are few-flowered, axillary cymes that grow near the ends of branches. The bright yellow flowers are 5 to 7.5 cm across. Flowers of cultivated varieties are often larger and may be colored white, cream, pink, or orange. Capsules, which rarely occur in cultivated varieties, are subglobose, 4 to 6 cm in diameter, and densely prickled. They contain many tan, flattened, winged seeds. There are 2n = 18 chromosomes (Howard 1989, Liogier 1995, Long and Lakela 1976).

Range.—Allamanda is apparently native to northern Brazil, Guyana, Surinam, and probably French Guiana (Liogier 1995, Pacific Island Ecosystems at Risk 2002, Tropilab Inc. 2002). The species has been planted and has become naturalized throughout the tropics (Howard 1989).

Ecology.—Wild and naturalized allamanda grows on riverbanks in Suriname (Tropilab Inc. 2002), on disturbed sites in Florida (Long and Lakela 1976), along roads (Liogier 1995), and on abandoned farms, house places, and around clandestine dumps in Puerto Rico (author's observation). The species is intolerant to intermediate in tolerance to shade. It can grow below brush and a thin forest canopy, usually without blooming, but blooms and makes its greatest growth in full sun. Allamanda grows best in well drained, moist, sandy soils rich in organic matter (Barcellos 2002). It does not tolerate salty soils, highly alkaline conditions, and is killed by temperatures of -1 °C (Floridata 2002, Tropilab Inc. 2002). In Nicaragua, the species occurs between 0 and 700 m in elevation (Stevens and others 2001). Allamanda has naturalized in Puerto Rico in areas that receive between about 1000 and 2800 mm of mean annual precipitation.

Reproduction.—Allamanda blooms all year in most habitats. Because capsules and seed are rarely produced by cultivated varieties, naturalization is usually by vegetative means. In Puerto Rico, the species has been planted widely, persists tenaciously, and spreads by layering as the vines extend. In addition, trimmings dumped in vacant lots and wildlands root readily and start new colonies. Plants coppice vigorously when cut. The species is invasive in Queensland, Australia (Pacific Island Ecosystems at Risk 2002).

Growth and Management.—Established allamanda grows rapidly, adding 1 to 3 m to extended length per year. Pruning is necessary to keep it under control in most landscaping applications. There appears to be no reason to establish it in wildlands, but the shrub could easily be planted with cuttings placed directly in the soil. Getting rid of spot infestations can be difficult. Cutting is ineffective. For grubbing to work, removal of the plant stems and roots from the site must be complete. Control with herbicides may overcome some of these difficulties but is untested.

Benefits and Detriments.—In wild stands, allamanda protects the soil and furnishes cover for wildlife. Year-long production of large, beautiful flowers endears allamanda to gardeners and landscapers throughout the tropics and subtropics. The species is particularly useful because it will grow in most areas with relatively little care. It is used as ground cover, for hedges and screens, and as upright shrubs. Because of its rapid growth, pruning is often necessary, which can expose gardeners to the toxic sap that causes dermatitis symptoms of rash, blisters, and itch. Although incidence is much less common, plant parts are also toxic if ingested. All parts contain the toxic iridoid lactone, allamandin (Ecology and Evolutionary Biology Conservatory 2002). In herbal medicine, teas prepared from leaves and roots are used as a strong purgative that must be used with caution (Liogier 1990).

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Amyris elemifera L. torchwood

RUTACEAE

Synonyms: *Amyris maritima* Jacq.
Amyris sylvatica Jacq.
Elemifera maritima (Jacq.) O. Kuntze

John K. Francis

General Description.—Torchwood, also known as candlewood, sea amyris, tea, cuabilla, bois chandelle, bois flambeau, and bois pini, is an evergreen shrub or small tree reaching maximum heights of 4 to 13 m, depending on the environment. It usually has a single stem emerging from the ground, unless damaged in the past but may begin branching near the ground when there is plenty of sunlight. The trunk is smooth and gray, becoming rough with furrows and plates when old. The plants usually have a weak taproot, strong, stiff laterals, and abundant fine roots. Torchwood has a vertical branching habit. It may have a dense, low crown in open-grown individuals. The twigs are fine and yellowish-gray, becoming gray with age. The foliage is pendulous and aromatic, pale-green or pale-green with blue-green highlights. The leaves are opposite or subopposite with three (sometimes five) leaflets on a 3-cm petiole. The blades are ovate, rhombic ovate, or lanciolate, with a pointed or long-pointed tip. The terminal or axial paniculate inflorescences contain many tiny flowers. The fruits are black globose drupes that are aromatic and contain one brown seed (Howard 1988, Liogier 1988, Little and Wadsworth 1964).

Range.—Torchwood is native to Florida, the Bahamas, the Greater Antilles, the Lesser Antilles, Trinidad, Guatemala, Belize, Honduras, and El Salvador (Liogier 1988, Little and Wadsworth 1964).

Ecology.—Torchwood is moderately intolerant of shade. Young plants compete well with shrubs and small trees, but do not survive in dense grass swards. In dry forests, understory plants linger for decades until openings in the overstory allow them to reach intermediate and codominant positions to flower and fruit. The species may be found in both remnant and secondary forests. In Puerto Rico, torchwood grows in areas receiving from 750 to over 2000 mm of mean annual precipitation. In the upper end of the rainfall range, the species is confined to excessively drained sites. Elevation ranges from near sea level to about 600 m. It tolerates a wide variety of soil textures, fertility levels, and pH’s. Torchwood may be found in areas underlain by sedimentary rocks including limestone, igneous, and metamorphic including ultramafic rocks, and coastal sands. In the Bahamas, torchwood grows in rocky and sandy coastal thickets (Britton and Millspaugh 1962); in Florida, it grows in coastal areas and on rich hammocks farther inland (4-H Youth Development 2001).

Reproduction.—In Puerto Rico, torchwood flowers irregularly through the year (Little and Wadsworth 1964). Flowers are reported to appear over several months in the fall in Florida (West and Arnold 1952). Nursery plants in pots in Puerto Rico bloomed at 2 years of age. Seeds cleaned from ripe fruits and sown without any pretreatment germinate normally. Birds are the principal seed disbursers.

Growth and Management.—Nursery plants in pots reached 1.8 m in 2 years. However, older trees in the dry forests that torchwood inhabits grow slowly and may live for 50 years or more (author's observation). A release cut or thinning should be effective if it were necessary to improve the position of torchwood in a stand.

Benefits.—The wood of torchwood is used for fence posts today but was formerly used for fuel, furniture, and torches--hence the name torchwood. In a test of untreated service life of posts, 20 of 20 posts were still sound after 13 years in the ground (Chudnoff and Goytia 1972). If the wood was more abundant and in larger pieces, it would be in demand for lumber because it is fragrant, fine-grained, strong, durable, and repellent to dry-wood termites (Little and Wadsworth 1964). Torchwood is valued as a honey plant in the Dominican Republic (Marcano Fondeur 1973). Birds eat the fruits, but there usually are many other more attractive foods present (West and Arnold 1952). In Florida, torchwood is valued as a larval food for the rare and endangered Schaus's swallowtail butterfly, *Papilio aristodemus ponceanus* (Hammer 2001). Key deer (*Odocollous virginanus clavium*) will not eat the foliage (Schaus and others 2001). However, feral goats eat at least the bark, which has caused torchwood to decrease in abundance in Mona Island, Puerto Rico (Little and Wadsworth 1964). Taxaline, an oxazole extracted from torchwood, had the most effective antibacterial activity of several bioactive chemicals from West Indian plants against *Mycobacterium tuberculosis* and two other *Mycobacterium* species (Rastogi and others 1998). Root and resin extracts from torchwood and others of the genus are used as an expectorant (Liogier 1990).

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***Aralia spinosa* L.** devil's walking stick
ARALIACEAE

Synonyms: *Aralia leroana* K. Koch.

Kristina Connor

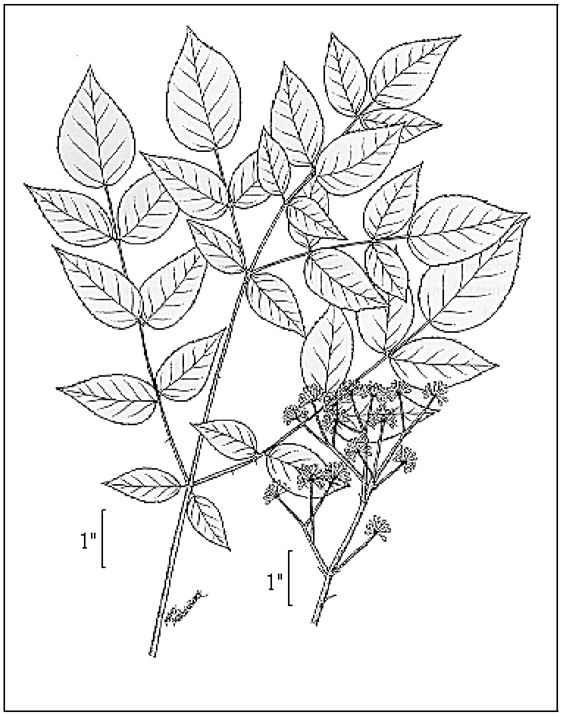

Illustration source: U.S. Department of Agriculture [not dated]

General Description.—Devil's walking stick, also known as angelica tree, American angelica-tree, Hercules' club, pigeon tree, pick tree, prickly ash, prickly elder, toothache bush, toothache tree, and shotbush, is a large, coarse-textured shrub or small tree, ranging from 6 to 10 m in height. The sturdy, ash gray to brown stems have dense, stout prickles, and diameters to 15 cm are not uncommon (U.S. Department of Agriculture [no date]). Young stems are mostly unbranched with leaves clustered near the top, producing a flat-topped, widely spreading crown. Stems tend to remain unbranched until the first terminal inflorescences are produced (Sullivan 1992). Twigs are similar in color and armament to the stems and have a large pith (Synor and Cowen [no date]). Leaf scars are distinctive, lined with spines, and can extend half way around the twigs. Leaves are alternate, bi- or tri-pinnately compound, and 0.9 to 1.8 m in length. The rachis is prickly and swollen at nodes (Bailey and Bailey 1976). The rachis and rachilla may be the functional equivalent of branches in this species (Briand and others 1998). The dark green, glaucous leaflets are sessile, 5.1 to 10.2 cms long and 3.0 to 4.1 cm wide, mostly paired, ovate, serrate, with pointed apex and rounded base (Dirr 2002, Johnson and Hoagland 1999, Krüssmann 1986). There are prickles on the veins and lower surfaces; they appear to be outgrowths of epidermal and parenchyma cells (Briand and Soros 2002). The wood is lightweight, brown but streaked with yellow (Synor and Cowen [no date]). It may be that the pithy nature of the trunk of Devil's walking stick allows for rapid growth but ultimately restricts crown architecture and maximum size attainable (Briand and others 1999). The species is deciduous and spreads by underground runners.

Range.—Devil's walking stick is found in the Eastern United States, from Pennsylvania south to Florida and west to Texas and southwestern Iowa. It has escaped from cultivation and thus can be found in New England, southern Ontario, Michigan, Wisconsin, Oregon, Washington, and western Europe (Sullivan 1992). It grows in regions where temperatures fall to –29 ^{o}C; such severe freezes can kill stems back to ground level (Godfrey 1988, Frett and MacKenzie 1999, Sullivan 1992, Scheper 2002).

Ecology.—This highly adaptable species grows best in well drained soils of low and moist woodlands but can be found growing in rocky, dry or clay soils and under a range of pH conditions (Frett and MacKenzie 1999). It grows luxuriantly on good sites, but plants may live longer and be sturdier on poorer sites (Scheper 2002). It has a fairly high heat tolerance. According to Russell (1997), it is shade tolerant, but Sullivan (1992) reports that it will decline if the overstory becomes thick, a common characteristic of moderately intolerant species. It has no serious pests, but margined blister beetles may defoliate plants early in the fall (Scheper 2002).

Reproduction.—Devil's walking stick spreads extensively by vegetative reproduction from underground rhizomes. The first terminal inflorescences usually occur when plants are, on the average, 3.5 years old (Sullivan 1992). The white to cream colored flowers are small, perfect, numerous, and occur in large clusters (umbels) in mid to late summer, depending on geographic area. Panicles of flowers may be 30 to 46 cm long. Each flower, composed of five sepals, five reflexed petals, and five stamens, is borne on a hairy stalk. The ovary is inferior, and there are usually five styles, united at the base (Brickell and Zuk 1996, U.S. Department of Agriculture [no date]). The purple-black fruits, maturing in late fall, are produced in large quantities on pink-red stems. They are juicy, ovoid drupes up to 6.4 mm long with three to five seed-like stones. The species can be propagated from seed sown outdoors in fall (Russell 1997) or from suckers taken in late winter and root cuttings taken in late fall and overwintered upside down in sand (Scheper 2002). Stored seeds require 3 to 5 months stratification, followed by 1 to 4 months at 20 ^{o}C for germination.

Growth and Management. Devil's walking stick can be maintained by mowing, cutting, and burning, and will commonly form dense thickets by resprouting after such disturbances. When the overstory becomes too dense, the species will decline. Defoliation by gypsy moth in Pennsylvania and Maryland has increased the presence of Devil's walking stick by thinning the overstory (Sullivan 1992). The species can be controlled by injecting stems larger than 2 inches in diameter with herbicide (Loftis 1978).

Benefits.—The flowers provide a pollen and nectar source to honeybees and a variety of other insects. The berries are edible to wildlife, a favorite of cedar waxwings and other birds, as well as other frugivores and omnivores, including the black bear. Deer browsing has been reported (Krüssmann 1986, Sullivan 1992). The bark, roots, and berries have also been used for medicinal purposes by both Native Americans and early settlers. While various plant parts, extracted in alcohol or water, have been used to treat boils, fever, toothache, eye problems, skin conditions, and snakebite, the raw berries can be mildly toxic to humans if ingested, contact with the bark or roots can cause a brief skin irritation, and ingesting the fresh bark will cause vomiting (Felter and Lloyd 1898, Grieve 1971). The species is cultivated as an ornamental plant, the lacy appearance of the foliage, along with the prolific flowers and fruit making it an interesting landscape plant (Dirr 2002, Odenwald and others 1996). It is also an excellent barrier plant (Frett and MacKenzie 1999, Michigan State University Extension 1999) and is good for urban use. However, it will send up shoots from its rhizomes and can be somewhat invasive.

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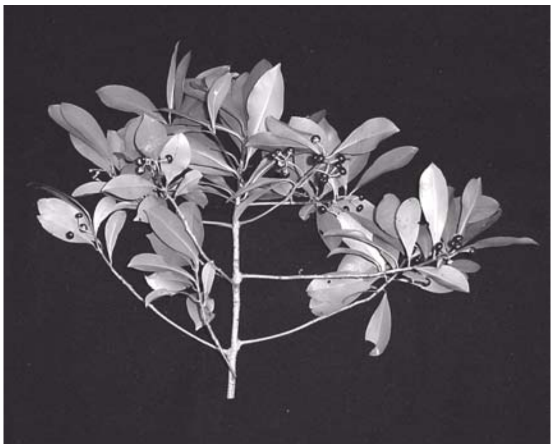
***Ardisia elliptica* Thunb.** shoebutton ardisia
MYRSINACEAE

Synonyms: *Ardisia ketoensis* Hayata
Bladhia elliptica (Thunb.) Nakai

John K. Francis



General Description.—Shoebutton ardisia, also known as sea-shore ardisia, blackberry, mameyuelo, mata pelandok, penah periah, ati popa'a, and atiu (Corner 1952, Pacific Island Ecosystems at Risk 2002), is an invasive shrub or small tree to 6 m in height and 15 cm in basal diameter. The plants produce strong stems with gray bark. The stems are usually single, but additional sprouts may arise from the rootstalk, especially if the plant is injured. Shoebutton ardisia grows a strong taproot, much-branched laterals, and fine roots with rhizomorphic tips. Leaves have a rubbery or leathery texture and are pink when young, turning dark green later. They are glabrous and alternate with petioles about 1 cm long and blades 8 to 12 cm by about 3 cm. The inflorescences are axillary, and umbellate, corymbose, or racemose with numerous five-merous, pink flowers. The drupes are globose drupes 6 to 11 mm in diameter, dark purple to dull black when ripe and contain one seed each (author's observation, Corner 1952, Howard 1989, Pacific Island Ecosystems at Risk 2002).

Range.—The taxonomy and range of shoebutton ardisia are uncertain. Native areas for *Ardisia elliptica* have been listed variously as Sri Lanka, India, China, Taiwan, Malaya, South East Asia, Indonesia, and the Philippines (Corner 1952, Tomlinson 1986, Yuen-Po 1999). Some authors unite *A. polycephala* Wall., *A. solanacea* Roxb., and *A. humilis* Vahl under *A. elliptica* (Center for Aquatic and Invasive Plants 2002, Neal 1965, Pacific Island Ecosystems at Risk 2002). These species are difficult to distinguish. Liogier (1995) erroneously cites *A. solanacea* instead of *A. elliptica* in Puerto Rico. Shoebutton ardisia is also naturalized and escaped in Hawaii (Pacific Island Ecosystems at Risk 2002), Florida (Center for Aquatic and Invasive Plants 2002), and many other areas.

Ecology.—Shoebutton ardisia principally grows and is most aggressive in areas of wet soils. It forms dense stands in low areas and intermittent stream bottoms with clay soils in Puerto Rico. It is found in wet, lowland areas in Hawaii (Pacific Island Ecosystems at Risk 2002), in hammocks, disturbed wetlands, old fields, and tree islands in marshes in Florida (Center for Aquatic and Invasive Plants 2002), and in mangroves elsewhere (Tomlinson 1986). The annual precipitation of these areas in Puerto Rico and probably elsewhere is above 1500 mm/yr. The species is shade tolerant and usually grows under forest canopies. Seedlings appear in well-established forest understories—disturbance is not required for establishment. Although significant insect herbivory does occur in Florida, it does not appear to inhibit the advance of the species into new habitats (Dominguez and others 2002).

Reproduction.—Shoebutton ardisia blooms sporadically throughout the year (Miami-Dade County 2002). The species is insect pollinated and self-fertile (Pascarella 1997). A collection of fruits from Puerto Rico weighed an average of 0.321 $\pm$ 0.005 g/fruit. Seeds separated from them weighed (air-dried) an average of 0.0463 $\pm$ 0.001 g/seed. Both the fruits and seeds are uniform in weight (coefficients of variation 15 and 17, respectively). Sown without any pretreatment in commercial potting mix, 75 percent germinated between 42 and 81 days after sowing. Germination is epigenous. Although seedlings are subject to damping-off mortality right after germination, older seedlings transplant with little mortality or loss of vigor.

Birds are the principal seed dispersers, although raccoons and opossums in Florida also eat the fruits and disperse seeds (Miami-Dade County 2002).

Growth and Management.—Although shoebutton ardisia may grow as much as 1 m the first year as a sprout, seedlings and established shrubs grow slowly, usually 0.25 to 0.5 m/year in height. No figures are known for longevity, but 10 to 25 years or more are likely. It is often desirable to control shoebutton ardisia in natural areas. Small numbers of seedlings and shrubs can be eliminated by pulling and grubbing. A broadcast spray of glyphosate is effective in killing dense stands of seedlings but will also kill native plants. Larger plants can be killed by applying a basal spray of triclopyhr mixed with an oil diluent (Pacific Island Ecosystems at Risk 2002).

Benefits and Detriments.—Shoebutton ardisia was once used heavily as an ornamental for accent and background plantings. Many plantings still remain, but the species is no longer cultivated commercially (Miami-Dade County 2002). The fruits are edible and taste slightly sour with a hint of starch but otherwise lack flavor. The species is useful for fuel and vegetable stakes. The air-dry specific gravity of stem wood in Puerto Rico was measured at 0.48 ± 0.01 g/cm^3. Biomass (dry weight) of plants from 137 cm in height to plants with a 5-cm D.B.H. may be calculated by the model: Total Dry Weight in grams = 22.020(stem length in meters) (diameter at 30 cm)^2 (Francis 2000). Shoebutton ardisia is extremely invasive. It forms dense stands under trees in wet sites in Florida, Hawaii, and Puerto Rico that suppress native understory plants (Center for Aquatic and Invasive Plants 2001).

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***Argythamnia candicans* Sw.** argythamnia
EUPHORBIACEAE

Synonyms: *Tournesol candicans* M. Gómez

John K. Francis

General Description.—No common name for A. candicans is listed in the literature. The convention among local natural resource workers, when a common name does not exist, is to use its genus or species name as a common name. Argythamnia is a common upright, low or half shrub that reaches 1.5 m in height and 2 cm of ground-line diameter. Usual heights are from 0.5 to 1.0 m. It normally has a single stem, although branches may arise near the base. It is supported by a tap and lateral root system with fine tertiary roots. The branches and twigs are thin and gray-green or whitish-green in color. The leaves are green or gray-green above and reddish- or purplish-green and pubescent below. Petioles are 1.5 to 2.5 mm long. The blades are usually narrowly elliptic, 1.3 to 8.5 cm long and 0.9 to 3.6 cm wide. Argythamnia produces tiny, inconspicuous staminate and pistilate flowers. The latter develop into round, flattened capsules 5 to 6 mm in diameter. The capsules have three chambers, each with a globose, dark brown seed 1.5 to 2 mm in diameter (Howard 1989, Liogier 1988).

Range.—Howard (1989) lists the range of agrythamnia as the Bahamas, the Greater Antilles, Anguilla, St. Martin, St. Barts, Guadeloupe, and Martinique. However, Britton and Millspaugh (1962) state that the former listings for *A. candicans* in the Bahamas should be *A. lucayana* Millsp., an endemic.

Ecology.—Argythamnia inhabits areas of Puerto Rico that receive from 750 to 1800 mm of annual precipitation at elevations from near sea level to about 450 m, usually within a few kilometers of the sea. Soils of all textures derived from all local rock types appear to be suitable, if well drained. Most of the modern habitat is rocky, steep, or disturbed. These sites include primary and secondary forests, brushy natural pastures, and roadsides. The species occurs as scattered individual plants or occasionally in thickets. Argythamnia is moderately intolerant of shade. It requires at least good filtered sunlight to survive. Argythamnia plants withstand light grazing well but tend to disappear from areas that are overgrazed. It resprouts after fires but is eliminated from large areas by repeated fires and competition from the exotic grasses, *Urochloa maximum* (Jacq.) R.O. Webster and *Bothriochloa pertusa* (L.) A. Camus. Frosts do not occur in the native range.

Reproduction.—Argythamnia flowers and fruits continuously. During the maturation and drying process, the capsules develop internal tension and eventually explode flinging seeds as much as 0.3 m away from the parent plant. A collection of capsules from Puerto Rico ranged in fresh weight from 0.0257 to 0.0381. Air-dry seeds collected from them averaged 0.0023 $\pm$ 0.0000 g/seed or 429,000 seeds/kg. On moist filter paper, 97 percent of these seeds germinated between 10 and 82 days after sowing.

Growth and Management.—Argythamnia is a relatively short-lived species. Seed-bearing plants examined by the author all had two or three growth rings in the base of the stem. Establishment of seedlings could be encouraged by soil disturbance near seed-bearing plants. No planting experience has been reported.

Benefits.—Argythamnia is eaten by livestock and contributes to ground cover and environmental diversity.

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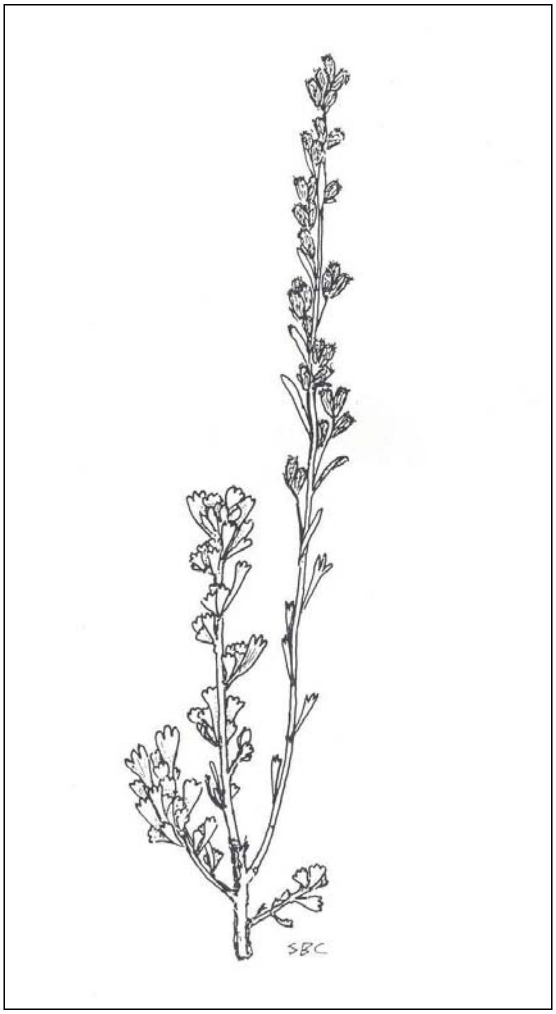
***Artemisia arbuscula* Nutt.** low sagebrush

ASTERACEAE

Synonyms: *Artemisia tridentata* var. *arbuscula* (Nutt.) McMinn
Serphidium arbusculum (Nutt.) W.A. Weber

E. Durant McArthur and J.R. Taylor



General Description.—Low sagebrush is a short, spreading, irregularly-branched shrub up to 50 cm high. Twigs are slender and densely canescent (silvery white pubescence) but may become nearly glabrous, and thus darker green, in late summer. Leaves are broadly cuneate, 0.5 to 1.5 cm long, and 0.3 cm wide. The leaf apex is usually three-toothed or cleft, although leaves on the upper part of the flowering stalks may be entire. Flower heads are arranged in elongate, narrow racemous panicles. Each head usually contains five to 11 disc flowers and is subtended by 10 to 15 canescent involucral bracts.

Taxonomy.—Three subspecies of *Artemisia arbuscula* are currently recognized by the International Plant Names Index (2003). These are *arbuscula*, *longicaulis* Winward & McArthur, and *thermopola* Beetle. Subspecies *longicaulis*, also known as Lahonton low sagebrush, is endemic to western Nevada (Winward and McArthur 1995). It is probably a hybrid between Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis* Beetle and Young) and low sagebrush (Winward and McArthur 1995). Subspecies *thermopola*, also known as hotsprings sagebrush, is a dwarf form endemic to the Stanley Basin area of Idaho, Jackson Hole area of Wyoming and east-central Oregon. Beetle (1960) speculated that it is a hybrid derived from low sagebrush and threetip sagebrush (*Artemisia tripartite* Rydberg). Low sagebrush has a base chromosome number of x = 9 and can be diploid, tetraploid, or hexaploid depending on population and subspecies (McArthur and Sanderson 1999, Winward and McArthur 1995).

Range.—The range of low sagebrush extends throughout Utah, Idaho, northern California, Nevada, Oregon, Washington, southern Colorado, and western Montana. It is usually found at elevations ranging from 700 to 3,500 m. Low sagebrush can grow well in mountains above 3,000 m, particularly in arid regions such as southwestern Utah and Nevada.

Ecology.—Low sagebrush is adapted to dry, sterile, often rocky and alkaline clay soils. Mean annual precipitation throughout its range can vary between 250 and 700 mm. Seedlings develop roots quickly to reduce the effects of soil surface drought stress. Typical low sagebrush habitat is generally drier and rockier than that of big sagebrush. It can, however, grow in mosaics with big sagebrush where each species is confined to a particular soil type. Low sagebrush rarely grows in mixed stands with black sagebrush (McArthur and others 1979), and when it does, they don't share the same chromosome number (McArthur and Sanderson 1999). In areas where the distributions of these two overlap, low sagebrush usually inhabits sites that have more moisture or are at higher elevations than black sagebrush (*A. nova* Nelson) (Tisdale and Hironaka 1981, Ward 1953, Zamora and Tueller 1973). Low sagebrush is usually associated with pinyon-juniper, mountain brush, and mountain big sagebrush communities.

Reproduction.—Flowering occurs from August to September, depending upon strain and elevation. Seeds ripen in October and November (McArthur and others 1979). Seeds are usually wind dispersed during late fall or winter, and seedlings emerge during the following spring. Seedlings emerge rapidly and grow quickly, although root growth generally outpaces stem growth during early development. Plants can be established on adapted sites by direct seeding, broadcasting, and drilling. Seeding should be conducted in the fall on a firm seedbed and seeds should remain within 2 mm of the soil surface. There are approximately 1,800 cleaned seeds per gram (Meyer 2003)

Management.—Low sagebrush is a source of browse for livestock and big game during winter months (Kufeld and others 1973, McArthur and others 1979). Some forms are browsed more heavily than others. A gray-green form in Nevada, for example, may be heavily browsed, while the green form is only lightly browsed (Brunner 1972). Stand maintenance is often crucial because shrubs provide forage and cover under conditions that are intolerable for most shrubs.

Attempts to seed low sagebrush out of its ecological range have been unsuccessful. Seedlings planted "offsite" usually establish but fail to reproduce. Stands recover quickly after burning or other disturbance. Low sagebrush spreads vigorously and can invade perennial seeded grass stands. Perennial herb and grass understory production usually decreases as stands mature. Low sagebrush is not a good candidate for mechanical control because habitat terrain is often extreme.

Benefits.—Low sagebrush is a native shrub that adds structural and biological richness to arid communities throughout the Intermountain West. Low sagebrush communities provide important habitat for a variety of domestic and wild animals (Dealy and others 1981). Its ability to grow on exposed sites is important for wintering animals and shrub cover helps reduce on-site soil erosion.

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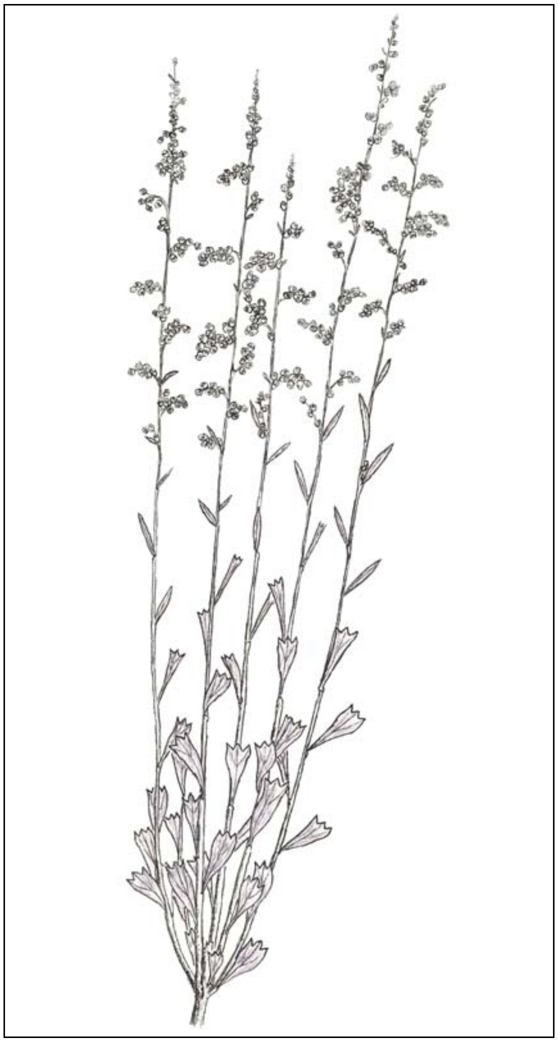
***Artemisa bigelovii* Gray** Bigelow sagebrush
ASTERACEAE

Synonyms: *Artemisia petrophila* Wooton & Standley

E. Durant McArthur and Jeffrey R. Taylor



General Description.—Bigelow sagebrush, also known as flat sagebrush (Hall and Clements 1923), is a low shrub 20 to 40 cm high with numerous spreading branches. Leaves are narrowly cuneate, 1 to 2 cm long, 0.2 to 0.5 cm wide, and normally tridentate, although tips may be variously shaped. The leaves on vegetative branches are similar to those of big sagebrush (*Artemisia tridentata* Nutt.), although the lobes of Bigelow sagebrush are shallower and more sharply dentate (McArthur and others 1979). The odor of crushed leaves is mild and pleasant. New growth is covered with a silvery-canescent pubescence. Flower stems are slender and erect and inflorescences form long narrow panicles with short, recurved branches. Flower heads normally bear one ray flower and two disc flowers. Occasionally, however, heads may include zero or two ray flowers and one or three disc flowers. The turbinate involucre consists of eight to 12 short, densely tomentose bracts 2 to 4 mm long and 1.5 to 2.4 mm wide.

Taxonomy.—This taxon is undivided, and ecotype variation has not been documented. Chromosome races from 2x to 8x, however, have been documented (McArthur and others 1981; McArthur and Sanderson 1999). Bigelow sagebrush occupies a taxonomic position between the true sagebrushes (subgenus *Tridentatae*) and other *Artemisia* species (subgenus *Artemisia*). We have chosen to treat Bigelow sagebrush as a member of subgenus *Tridentatae* because of its growth habit, wood anatomy, leaf form, chromosomal karyotype, RAPD molecular genetic markers, and ITS sequences in nuclear ribosomal DNA (Kornkven and others 1998, McArthur and others 1981, McArthur and others 1998). The confusion exists because flower heads may include one or two ray flowers in addition to the characteristic disc flowers of the *Tridentatae*.

Range.—The distribution of Bigelow sagebrush is more southern than other sagebrushes. It covers approximately 88,000 km^2 through western Texas, southern Colorado, New Mexico, Arizona, Utah, Nevada, and California between 900 and 2,400 m elevation (Beetle 1960, Kearney and Peebles 1960, Ward 1953).

Ecology.—Bigelow sagebrush is one of the most drought-tolerant sagebrushes. It typically grows in canyons, gravelly draws, and dry flats. It also grows on rocky soils of the southern portion of the pinyon-juniper woodlands (Hall and Clements 1923). It is often found in mixed stands with big sagebrush, black sagebrush (*Artemisia nova* Nelson), leafless green rabbitbrush [*Chrysothamnus nauseosus* Pallas ex Pursh ssp. *junceus* (Greene) Hall & Clements], shadscale [*Artriplex confertifolia* (Torr. & Frem.) Wats.], and especially broom snakeweed [*Gutierrezia sarothrae* (Pursh) Britt. & Rusby]. Bigelow sagebrush is usually resistant to the common rust diseases and insect galls common to other *Tridentatae* taxa (Beetle 1960). It is, however, susceptible to wilt disease (Nelson and Krebill 1981). It grows in areas that usually receive 250 to 400 mm of annual precipitation.

Reproduction.—Flowering occurs from August to October and seeds mature during the following months. Seeds are wind dispersed in the fall and winter, and seedlings emerge in spring. Seeds are among the smallest of sagebrush seeds, about 5.5 million cleaned seeds per kg (Meyer 2003). Seedlings grow rapidly, and young shrubs are robust and vigorous. Plants appear to have good drought tolerance, even as seedlings.

Direct seeding has been limited to experimental plantings. Seeded shrubs grow well and natural spread normally occurs around the parental plant, suggesting that Bigelow sagebrush can be successfully seeded.

Management.—Bigelow sagebrush is palatable to livestock and game throughout its distribution. Its twigs are less woody, aromatic, and bitter than most species within the big sagebrush complex (Hall and Clements 1923). In addition, Bigelow sagebrush is more grazing tolerant than most other sagebrushes. These shrubs, however, are generally scattered, and extensive stands are found only near the Four Corners area of Utah, Arizona, New Mexico, and Colorado.

Benefits.—Bigelow sagebrush adds biological diversity to shrub communities throughout the Southwestern United States. This species improves soil stability and reduces erosion. It also provides palatable forage for livestock and wildlife and adds structural diversity to the landscape.

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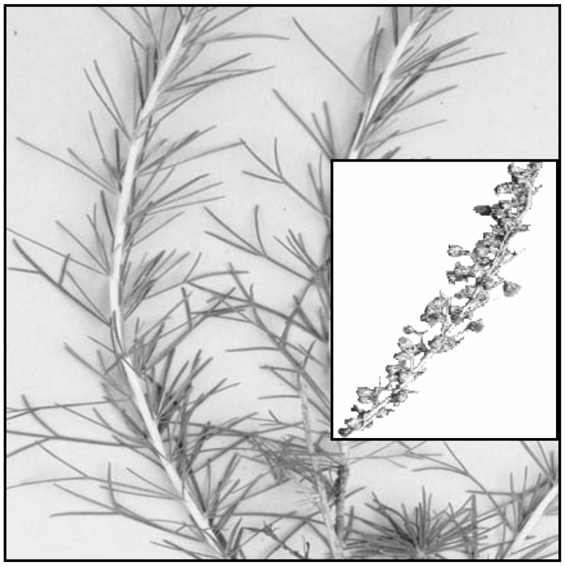
***Artemisia californica* Less.**

ASTERACEAE

Synonyms: None

Arlee M. Montalvo and Catherine E. Koehler



General Description.—Mature California sagebrush are 0.6 to 2.5 m tall and abundantly branched from the base (Munz and Keck 1968, Hickman 1993). The common name refers to its strong, sage-like aroma and being endemic to California and Baja California. The stems are whitish with appressed hairs, long, slender, leafy, and flexible. The somewhat hairy gray-green leaves are soft, entire to divided into narrow linear segments, giving the entire shrub a wispy appearance. The many small flower heads are less than 5 mm wide, arranged in racemes, and have 15 to 30 disk florets per flower head. Plants are diploid with n = 9 chromosomes (Hickman 1993).

Range.—California sagebrush occurs in California from Contra Costa Co. south into Baja California, including the Channel Islands, at elevations of less than 800 m (Munz and Keck 1968, Hickman 1993). Historically, it was the dominant shrub on north-facing slopes in coastal sage scrub but has declined to about a third of its past abundance in many areas of southern California, especially inland on north-facing slopes where it is being replaced by exotic annual grasses (Minnich and Dezzani 1998).

Ecology.—California sagebrush is common in sage scrub and coastal strand on dry slopes and fans (Munz and Keck 1968, Hickman 1993). It is an indicator species of sage scrub (Kirkpatrick and Hutchinson 1977), occurs on virtually all soil types except serpentine (Westman 1981a), and its range is limited primarily by cold winter temperatures (Malanson and O'Leary 1995). Leaves are drought-deciduous and seasonally dimorphic (Westman 1981b, Gray 1982). In California, shoot and new leaf production begins with the winter rains, usually in December, and continues throughout winter and spring. Leaf drop and production of smaller leaves occurs during the summer drought (Westman 1981b). The shallow, branched roots (Harrison and others 1971) allow for rapid water absorption and growth response to shallow rains (Gray 1982). The thin leaf cuticle and numerous stomata allow a high photosynthetic rate in response to water availability (Poole and Miller 1975, Gray 1983). Consequently, there is a higher transpiration rate and longer period of water stress compared to species with thick leaves and deep roots (Poole and Miller 1975, Gray 1982). Roots form associations with arbuscular mycorrhizal (AM) fungi, but the beneficial nature of the interaction may be facultative and is potentially affected adversely by nitrogen deposition (Sigüenza 2000, Yoshida and Allen 2001).

Studies on chemistry of leaves, litter, and soil below shrubs documented the presence of both soluble compounds and volatile monoterpenes and sesquiterpenes that inhibit germination or growth of some plants (Halligan 1973, 1975, 1976). Small mammalian herbivores and seed eaters often restrict foraging to beneath shrub canopies and to within a short distance of protective cover (Halligan 1973, 1974) and may contribute to conspicuous bare zones on the edge of shrub stands and under canopies.

Reproduction.—Flowering of California sagebrush tends to peak in late fall, but in Baja California, summer rains may trigger flowering during summer (Minnich 1985). The reduced flowers are typical of other wind-pollinated species of *Artemisia*. The single-seeded fruits (achenes) ripen in December and January, with some variation among years and habitats, and are primarily wind-dispersed (Eliason and Allen 1997, DeSimone and Zedler 1999). Achenes are tiny (about 60 micrograms) and in bulk amount to about 14,300,000 seeds/kg. (personal communication with S&S Seeds, Carpenteria, California). Seeds germinate in canopy openings or in small grassland clearings generated by gophers (*Thomomys* spp.), but seedlings suffer high mortality from gopher activity (Eliason and Allen 1997, DeSimone and Zedler 1999, 2001). Seedlings emerge in the rainy season, and most growth occurs by May.

Seed Germination.—Seeds will germinate when fresh, but stored seeds may need cold stratification to enhance germination (De Hart 1994). While testing the combined effects of light and fire components on germination, 73 percent of seeds exposed to light germinated on soil, but seeds in the dark did not germinate (Keeley 1987). These results are consistent with field data that show germination may be limited by reduced light (Elliason and Allen 1997, Montalvo and others 2002). Certain components of fire also influence germination. In light, treatment with leachate from charred wood (charrate) alone or with heat increases germination by 5 to 14 percent, but germination is about a third lower when seeds are subjected to high temperatures (70 to 120 ^{o}C). In contrast, in darkness both heat and charrate alone stimulate germination, although heat and charrate together generally decrease germination. Thus buried seeds may require some exposure to fire in order to germinate, but such exposure yields inferior germination compared to light alone (Keeley 1987).

Genetics and Geographic Variation.—Near the coast, plants vary in pubescence, color, chemistry, and physiology (O'Brien 1980). Shrubs vary between a green form with sparse hairs on the leaves to a form with dense hairs that give the plants a gray hue. Populations differ in the distinctness of forms and in their relative frequency. Seedlings raised together generally retain the grayness of their parents but can become grayer with age (O'Brien 1980). Differences in pubescence also correspond to differences in water content, rate and timing of shoot elongation, leaf retention, and chemistry. The lower leaf-water content of gray plants negatively impacts larval growth and fecundity of the beetle, *Trirhabda sericotrachyla* (O'Brien 1980).

Fire Effects.—California sagebrush resprouts after fire about 25 percent of the time (Keeley 1998). Resprouting appears to be lower in burns through dense vegetation, where plants are older, or if fire intensity is high (Malanson and O'Leary 1982, Keeley 1998, Minnich and Dezzani 1998). Seedling emergence after fire is variable and low (Zedler and others 1983, Keeley 1998). Seedlings tend to appear the second year from seeds of resprouts or seeds blown in from adjacent areas. Under high fire intensities or frequency, California sagebrush will likely be extirpated because of its poor resprouting ability and poor competitive ability of seedlings (Malanson and O'Leary 1982, Malanson and Westman 1991). Development, increased fire frequency, competition with exotic grasses, poor growth in grasslands, and air pollution are each detrimental to this shrub's survival (Eliason and Allen 1997, Allen and others 1998, Minnich and Dezzani 1998, Keeley 1998).

Horticulture.—California sagebrush can be compact if kept pruned and subjected to occasional pinching. These aromatic plants remain attractive in the dry season with occasional water (Schmidt 1980, Keator 1994). It prefers well-drained soils and a low organic matter content (Wasowski and Wasowski 1995). Naturally occurring prostrate or low-mounding varieties are in cultivation (Browse 1987, Perry 1992, Wasowski and Wasowski 1995) and look good in dry borders or as a foreground to contrasting taller shrubs (Keator 1994).

Benefits.—California sagebrush provides habitat for many plant and animal species and is an important component of critical habitat for the rare California gnatcatcher, *Polioptila californica* (Weaver 1998). The bird forages preferentially in California sagebrush and the often co-dominant shrub *Eriogonum fasciculatum* Benth. (Beyers and Wirtz 1997), in part because they house a high number and diversity of arthropods. Osborne (1998) found high diversity and abundance of arthropods in both species and concluded that *A. californica,* together with other sage scrub shrub species, is important to the maintenance of high arthropod species richness and abundance in coastal sage scrub. California sagebrush is also involved in species-specific interactions. For example, it is the host for *Trirhabda sericotrachyla*, an herbivorous beetle whose developmental cycle is closely associated with the seasonal growth of its only known host plant (O'Brien 1980).

Historical Uses.—Leaves of California sagebrush have been used by Native Americans for smoking, in sweat-houses, and various other purposes (Bean and Saubel 1972). The Cahuilla used the plant to ensure proper maturation of girls into women. It is said to stimulate the uterine mucosa, ensuring rapid childbirth and, if regularly consumed as a decoction prior to the onset of each menstruation, to prevent menstrual cramps and alleviate menopausal trauma. Fresh or dried leaves were chewed to alleviate colds (Bean and Saubel 1972). Costanoan Indians applied leaves to wounds or aching teeth for pain reduction, and as a decoction to bathe patients with colds, coughs, rheumatism, or to be consumed and used as a poultice for treatment of asthma (Bocek 1984).

Growth and Management.—California sagebrush should be planted using shallow seeding methods such as hydroseeding or dry broadcasting followed by seed imprinting. Shallow methods are superior to planting with a range drill because the seeds need light for germination (Montalvo and others 2002). Attempts to use annual legumes as nurse plants can result in reduced seedling growth and survival (Marquez and Allen 1996), but seedling survival may be unaffected when sown with other native species at low density (Montalvo and others 2002). Clearing weeds before planting is critical. California sagebrush can return vigorously to areas where all vegetation has first been removed, even when sown with a variety of other species. Spring rains or artificial late fall and spring irrigation may enhance survival of seedlings (Williams and Hobbs 1989, Elliason and Allen 1997, Padgett and others 2000). However, survival is not enhanced by late-season watering in wet years (DeSimone and Zedler 2001).

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***Artemisia cana* Pursh** silver sagebrush
ASTERACEAE

Synonyms: *Seriphidium canum* (Pursh) W.A. Weber

E. Durant McArthur and Jeffrey R. Taylor

General Description.—Silver sagebrush, also known as white sagebrush or hoary sagebrush, is an erect, freely branched, rounded shrub up to 1.5 m tall. Older stems have a dark brown, fibrous bark while younger stems are covered with a dense white to yellowish-green tomentum. Branches often layer when in contact with the soil. Leaves on vegetative branches are 1 to 10 mm wide and 2 to 8 mm long. Leaf shape is linear to linear-oblanceolate, entire, or occasionally with one or two irregular lobes. Leaves are covered with a silvery-white pubescence that becomes slightly viscid with age. On flowering stalks, leaves are similar to those on vegetative branches but may be smaller, especially toward the distal end. The foliage emits a mild to pungent odor when crushed. Flower heads are arranged into dense, narrow, leafy panicles, sometimes reduced to a raceme or spike-like inflorescence. Each head contains from four to 20 disc flowers that are subtended by ovate involucral bracts. Silver sagebrush exhibits several levels of polyploidy based on x = 9, varying by subspecies and population. Diploid, tetraploid, and octaploid, populations have been documented (McArthur and others 1981, McArthur and Sanderson 1999, Ward 1953).

Taxonomy.—Silver sagebrush comprises three subspecies: *A. cana* ssp. *cana*, *A. cana* ssp. *viscidula*, and *A. cana* ssp. *bolanderi*. Ploidy levels are octaploid, diploid or tetraploid, and diploid, respectively (McArthur and others 1981, McArthur and Sanderson 1999, Ward 1953). Plains silver sagebrush (*A. cana* ssp. *cana*) and mountain silver sagebrush (*A. cana* ssp. *viscidula*) have a strong tendency to layer. Plains silver sagebrush is an erect, round, canescent, freely branched shrub up to 1.5 m tall. It has a more eastern distribution than the other subspecies. Putative natural hybrids have been found between plains silver sagebrush and big sagebrushes (Beetle 1960, Ward 1953). Plains silver sagebrush has the ability to spread rapidly after burning by resprouting and by rhizomes (Beetle 1960).

Mountain silver sagebrush (*A. cana* ssp. *viscidula*) is an erect shrub usually not more than 1.0 m tall. It is distinguished from plains silver sagebrush by its smaller, darker leaves, and more western distribution. Leaves on vegetative stems are 1 to 5 mm wide and up to 7 cm long. They are typically simple, entire, and grow in dark green clusters. This subspecies varies in appearance but is always darker than mountain big sagebrush, with which it is often growing (Beetle 1960). Bolander silver sagebrush (*A. cana* ssp. *bolanderi*) has narrow leaves like mountain silver sagebrush, but leaves are canescent like plains silver sagebrush.

Range.—Aside from big sagebrush, silver sagebrush is the most widely distributed member of the genus. It occurs over approximately 140,000 km^2, from British Columbia and Saskatchewan in the north, to Arizona and New Mexico in the south, and west to Oregon and California (Beetle

1960). Ranges for each subspecies, however, are smaller. Plains silver sagebrush is found mostly east of the Continental Divide, through Montana, the Dakotas, Wyoming, western Nebraska, and northern Colorado. Mountain silver sagebrush inhabits mountainous regions (around 1,800 m or higher) of Montana, south along the Continental Divide, and west to Arizona, Nevada, and Oregon. The range of Bolander silver sagebrush is restricted, generally to enclosed basins, in central Oregon and eastern California.

Ecology.—Silver sagebrush grows on soils that are less mature, with less phosphorous, potassium, nitrogen, organic matter, and lower cation exchange capacity than soils supporting big sagebrush (Hazlett and Hoffman 1975). It inhabits various environments, each subspecies adapting to different soil conditions. Plains silver sagebrush grows particularly well on well-watered, deep soils of the northern Great Plains, especially along stream bottoms and drainageways (McArthur and others 1979, Walton and others 1986). Mountain silver sagebrush, on the other hand, grows in areas with a heavy, lingering snow pack (Beetle 1960, McArthur and others 1979, Tisdale and Hironaka 1981, Winward 1980). Bolander silver sagebrush grows on poorly drained, alkaline soils (Beetle 1960, McArthur and others 1979, Tisdale and Hironaka 1981, Winward 1980). Silver sagebrush usually grows in areas with precipitation between 350 and 600 mm but it occurs in areas of water accumulation, such as near streams or in enclosed basins.

Reproduction.—Flowers bloom between August and September and seed ripens in October and November. Seeds are wind dispersed during the winter months. Establishment by direct seeding has been successful (Kelsey 1986), especially when sown in the fall on the soil surface or at shallow depths (Wasser 1982). Seedlings emerge in spring and grow rapidly. Seeding silver sagebrush is best done in the late autumn or early spring to maintain high viability and high germination of seeds (Hou and Romo 1998, Romo and Grilz 2002, Romo and Young 2002). Seedlings are best established in lightly tilled soils so that stands of existing perennial grasses are maintained (Romo and Grilz 2002).

Plants respond dramatically to moist conditions and may reach 35 to 50 cm in 1 year. Silver sagebrush can also spread asexually. Harvey (1981) successfully propagated plants through hardwood cuttings, and plants can also spread by rhizomes. There are approximately 2,900 cleaned seeds per gram (Meyer 2003).

Management.—Silver sagebrush can provide an important source of browse and is used quite extensively by livestock and big game, especially when other food sources are scarce (Kufeld and others 1973, Wasser 1982). In the western Great Plains area, silver sagebrush is an important survival food for antelope. Domestic sheep and mule deer found Bolander silver sagebrush among the most preferable sagebrushes during winter and fall feeding trials (Sheehy and Winward 1981). Sheep often browse silver sagebrush in the fall after forbs and grasses are dry.

Silver sagebrush can occupy areas at high densities, and therefore is a candidate for plant control. It can be difficult to control because of its tendency to resprout from the crown and to spread by rhizomes. It is not as susceptible to fire as other species of sagebrush (Wright and others 1979, White and Currie 1983). White and Currie (1983) reported that silver sagebrush mortality after prescribed fall and spring burns was directly related to fire intensity. In general, fall burns are more effective at reducing silver sagebrush than spring burns.

Benefits.—Silver sagebrush is an abundant native shrub that provides additional diversity to shrubland ecosystems. It is an important winter forage source for domestic sheep and game animals and adds structural variety to the landscape. Native Americans traditionally used a decoction from silver sagebrush to stop coughing (Stubbendieck and others 1997). In addition, Euro-American settlers and Native Americans used it for fuel (McArthur and others 1979).

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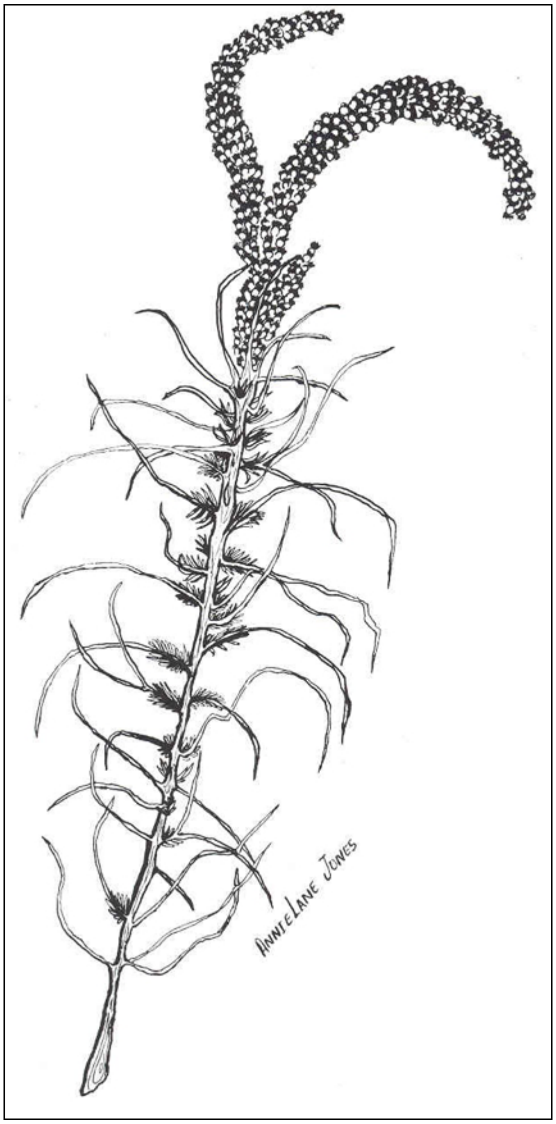
***Artemisia filifolia* Torr.** sandsage
ASTERACEAE

Synonyms: *Oligosporus filifolius* (Torr.) W.A.Weber

E.Durant McArthur and Jeffrey R. Taylor



General Description.—Sandsage, also known as sand sagebrush and oldman sage or oldman sagebrush, is a freely branched, rounded shrub that grows up to 1.5 m tall. Young branches are covered with a canescent pubescence while the older stems are covered by a dark gray-green or blackish bark. Leaves are filiform, and covered with a canescent pubescence. Leaf length can range from 3 to 8 cm, and leaf width is less than 0.5 cm. Leaves are entire or alternately divided into filiform divisions and are often fascicled. Flower heads are arranged into leafy narrow panicles. Each head usually contains two or three fertile, pistilate, ray flowers and one to six perfect, sterile, disc flowers. Five to nine canescent involucral bracts subtend each head. The receptacles and achenes are both glabrous.

Taxonomy.—Sandsage does not have subspecific divisons. It has traditionally been assigned to the subgenus *Drancunlus* based on floral characteristics (McArthur 1979). Beetle (1979) suggested that it might have an affinity with true sagebrushes (subgenus *Tridentatae*). It does have some cytological, chloroplast DNA, and chemical similarities with *Tridentatae* (Kelsey and Shafizadeh 1979, Korkven and others 1998, 1999, McArthur and Pope 1979) although it differs from *Tridentatae* in floral characteristics, wood anatomy, and nuclear ribosomal DNA sequences (Korkven and others 1998, Moss 1940). The chromosome number for *A. filifolia* is 2n = 18; its karyotype is similar to that of the true sagebrushes (subgenus *Tridentatae*) (McArthur and Pope 1979).

Range.—Sandsage is common on sandy substrates from the southern Black Hills in South Dakota south to Texas and Chihuahua and west to Arizona and Nevada (Hall and Clements 1923, McArthur and others 1979, Rasmussen and Brotherson 1986). It is particularly important in the central and southern Great Plains in bands along the sandy mantles that parallel stream drainages (Berg 1994)

Ecology.—Sandsage grows almost exclusively on sand. It is probably the most widespread shrub on dunes and sandhills. In a study in southwestern Utah, Rasmussen and Brotherson (1986) found that sandsage communities were less diverse than adjacent communities, but plant densities were higher. They also reported that sandsage nutrient quality was not affected by the relative poor soil nutrient profile characteristic of some sandsage communities. Its accumulation of mineral nutrients above that of the soil is apparently an adaptation to sand habitats with inherently low soil fertility. It grows in areas with an annual precipitation range of 220 to 600 mm.

Reproduction.—Blooming occurs during August and September, and seed ripens between October and December (McArthur and others 1979). Seeds are smaller than those of most sagebrushes, but seedlings grow well once established. There are approximately 3.2 million cleaned seeds per kg (Meyer 2003). Seedlings emerge in the spring and grow and mature quickly. Survival is reduced, however, if it is planted in habitats that extend beyond its natural range (Nelson and Krebill 1981). Sandsage has been seeded alone in most plantings but can be seeded with herbs adapted to arid sandy soils. It is easy to grow as bareroot stock and survives well when field planted. Wildings can be transplanted in the spring or fall, and plants can be easily reared from seed.

Management.—The value of sandsage as a source of browse varies with community type. It is seldom eaten in grasslands where other forage is adequate but is consumed by cattle, domestic sheep, and big game in arid desert regions. It can be particularly important during dry years (Hall and Clements 1923, McArthur and others 1979). It is important in the vegetation cover of harsh sandy sites, although limited water often reduces natural seed production. It is particularly useful in blackbrush and pinyon-juniper communities where sandy outcrops occur.

Sandsage resprouts vigorously after fire; fire may be useful in reducing canopy height and volume, thus allowing associated herbaceous species to express more vigor (Vermeire and others 2001.

Benefits.—Sandsage can be an important, locally abundant, native shrub that provides habitat and forage for wildlife, including some small nongame birds. This species helps reduce wind erosion by stabilizing light sandy soils. People in Mexico have used a decoction of leaves to reduce the effects of intestinal worms and other stomach problems (Stubbendieck and others 1997).

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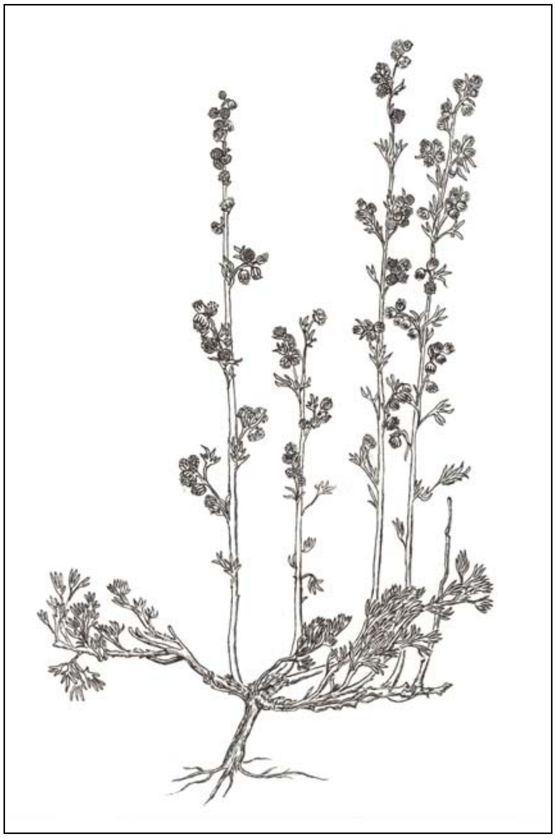
Artemisia frigida Willd. fringed sage
ASTERACEAE

Synonyms: *Artemisia virgata* Richardson

E. Durant McArthur and Jeffrey R. Taylor



General Description.—Fringed sage, known also as prairie sagewort, fringed sagewort and fringed sagebrush, is an aromatic, mat-forming, perennial shrub 20 to 60 cm tall (McArthur and others 1979, Stubbendieck and others 1997). The lower woody stems are spreading and often branched, while upper herbaceous stems are erect and leafy. Adventitous roots may occur when stems come in contact with soil. The entire plant is densely silver-canescent. Leaves are abundant, 6 to 12 mm long, and two or three times ternately (sub-pinnately) divided. Flowerheads are arranged into nodding racemes or open panicles. Small, densely hairy involucral bracts occur in series around each flowerhead. Each head contains 10 to 17 outer, seed-producing, pistillate, ray flowers and numerous (25 to 50) tubular, funnelform, perfect seed-producing disc flowers (McArthur and others 1979, Stubbendieck and others 1997). This species has a deep perennial taproot with numerous extensive lateral roots as adaptations to withstand drought.

Taxonomy.—Undoubtedly, fringed sage, with its broad geographical and altitudinal distribution, has considerable genetic variation. The taxon has three varieties: the typical variety, *Artemisia frigida* Willd. var. *frigida*, *Artemisia frigida* var. *gmelinianum* Besser, and *Artemisia frigida* var. *williamsae* S.L. Welsh (International Plant Names Index 2003). Unlike several other widespread *Artemisia* species, fringed sage is known only at the diploid (2n = 2x = 18) chromosome level (McArthur and Pope 1979). Fringed sage is a member of the subgenus *Artemisia* (McArthur and Pope 1979).

Range.—Fringed sage is probably the most widely distributed and abundant species of *Artemisia* L. Its range extends from Mexico in the south, through most of the Western United States, Western Canada, and Alaska in the north, and into Siberia, Mongolia, and Kazakhstan (Harvey 1981; USDA 1937). In the United States, it is most abundant in the eastern and northern parts of its range on the high plains along the eastern slope of the Rocky Mountains. The altitudinal gradient of fringed sage in the Intermountain area extends from 900 to 3,500 m; in other parts of its range (Great Plains and Asian Steppes) the lower elevational limits are somewhat less.

Ecology.—Mean annual precipitation throughout the native range of fringed sage varies between 210 and 550 mm. It inhabits a wide variety of sites but typically grows in full sunlight on dry, coarse, shallow soils. On winter livestock and game ranges in western Utah and eastern Nevada, fringed sagebrush may grow in dense stands along shallow depressions that collect moisture from summer rains. In such areas, it is frequently associated with winterfat [*Ceratoides lanata* (Pursh) J. T. Howell], shadscale [*Atriplex confertifolia* (Torr. & Frem.) Wats.], and rabbitbrushes (*Chrysothamnus* Nutt. species). On plains, foothills, and mountain slopes, fringed sage may grow in association with a variety of grasses and forbs as well as with various shrubs, including big sagebrush (*Artemisia tridentata* Nutt.), Bigelow sagebrush (*Artemisia bigelovii* Gray), sandsage (*Artemisia filifolia* Torr.), and especially in overgrazed areas, with broom snakeweed [*Gutierrezia sarothrae* (Pursh) Britt. & Rushby]. It is also a common understory shrub in ponderosa pine communities in several Western States (McArthur and others 1979).

Reproduction.—Blooming occurs from June at high elevations and latitudes, to November at lower elevations and latitudes. Fringed sage is a prolific seed producer; each 2.5 cm length of inflorescence contains approximately 1,000 seeds (Harvey 1981). There are about 10 million cleaned seed per kg (Plummer and others 1968). Seed matures between September and December (McArthur and others 1979) and are wind dispersed in winter. Seedlings emerge in spring. Fringed sage can be established by seed, transplanting young plants, or from rooted segments of mature plants. Surface seeding on disturbed soils is recommended (Wasser 1982).

Management.—The forage value of fringed sage varies considerably with location and season (Dietz 1972). On Western ranges, it is most valuable to big game and livestock in late fall, winter, and early spring (Cooperrider and Bailey 1986, Kufeld 1973, USDA 1937, Wasser 1982). Nutritive quality is highest in the spring but remains adequate throughout much of the year (Cooperrider and Bailey 1986, Rauzi 1982). Individual plants are susceptible to overgrazing, but populations tend to increase under heavy grazing pressure (Cooperrider and Bailey 1986). In the northwestern Great Plains, fringed sage may be less palatable than other available forages and occasionally invades deteriorated grasslands. Pronghorn (*Antilocapra Americana* Ord) utilize fringed sage extensively during winter, and to a lesser extent, year round (McArthur and others 1979).

Fringed sage is well suited to grass and broad-leafed herb communities. Seedlings are competitive and can establish in areas with herbaceous competition. It is adapted to mine spoils, perhaps better than any other species of *Artemisia*. It can be used as a biological control to reduce rapid weed expansion on large disturbed sites but can be controlled when it is too abundant (Alley 1972).

Benefits.—Fringed sage is a good pioneer shrub for stabilizing disturbed sites. It is often used in seeding Western strip mines, especially coal areas. Its strong taproot and numerous lateral roots help stabilize gullies and reduce soil erosion. These rooting characteristics enable the shrub to resist considerable grazing and trampling. It also provides forage for livestock and forage and habitat for wildlife in both North America and Asia (Li and others 2002, USDA 1937). It is an important food for sage grouse (Wallestad and others 1975). Fringed sage has some value as a medicinal plant (Hall and Clements 1923). Native Americans traditionally used fringed sagebrush as toilet paper, to eliminate unpleasant odors from dried meat, as a chewed application for wounds prior to bandaging, and to make mats and fans (Stubbendieck and others 1997).

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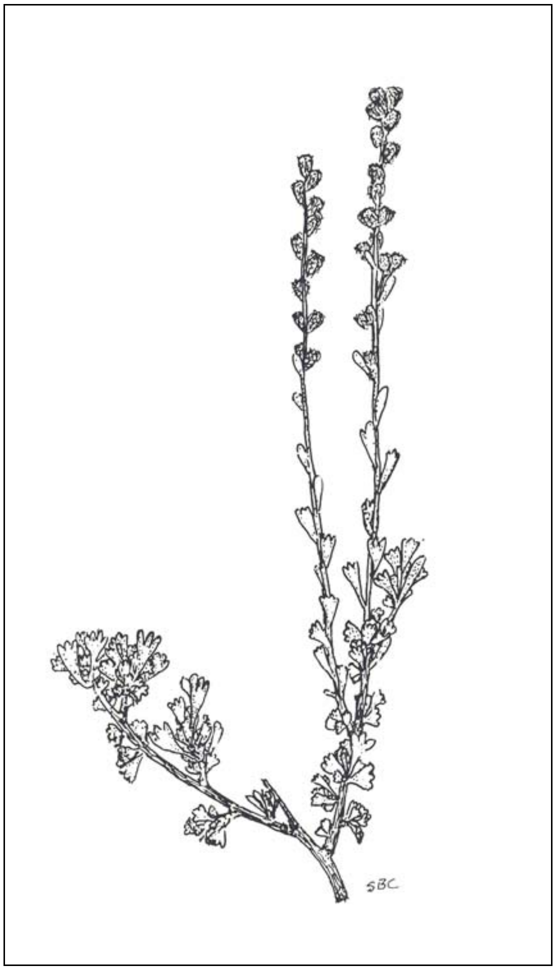
***Artemisia longiloba* (Osterhout) Beetle** alkali sagebrush
ASTERACEAE

Synonyms: *Artemisia spiciformis* Osterhout var. *longiloba* Osterhout
Artemisia arbuscula Nutt. ssp. *longiloba* (Osterhout) L. Shultz

E. Durant McArthur and Jeffrey R. Taylor



General Description.—Alkali sagebrush, also known as early sagebrush and low sagebrush, is a small shrub up to 45 cm tall. It has lax, spreading stems that frequently layer. The bark is dark brown to black on older stems. The whole plant has a dark gray-green appearance (Beetle 1960). Leaves on vegetative stems are broadly cuneate, up to 2 cm long, and deeply three-lobed. Leaves on flowering stems are similar in shape but smaller. Its large heads and early blooming readily distinguishes alkali sagebrush from other small sagebrushes (Beetle 1959). Heads contain six to 11 disc flowers that are 3 to 5 mm wide. Disc flowers of similarly sized sagebrushes, such as low sagebrush (*Artemisia arbuscula* Nutt.) and black sagebrush (*Artemisia nova* A. Nelson), are 3 mm wide or less. Beetle (1960) points out that this species has been confused with silver sagebrush (*Artemisia cana* Pursh) because of its large heads; with big sagebrush (*Artemisia tridentata* Nutt.) because of its broadly cuneate, three-lobed leaves; and with low sagebrush because of its diminutive size.

Taxonomy.—The taxon includes no recognized subspecies or varieties. Although relegated to subspecific status by some, e. g., the U. S. Department of Agriculture, Natural Resource Conservation Service plant data base 2003, we prefer to maintain its specific status. Zamora and Tueller (1974) differentiated it from typical low sagebrush (*Artemisia arbuscula* Nutt.) in ecological habitat preference. Its large, scattered, distribution and its differential use by animals suggest that it harbors considerable genetic variation. Beetle (1960) suspected that it is a parent to the narrowly endemic coaltown sagebrush (*Artemisia argillosa* Beetle). Alkali sagebrush has both diploid (2n = 18) and tetraploid (2n = 36) populations (McArthur and others 1981).

Range.—Alkali sagebrush is found along foothills and basins of the ranges that form the Continental Divide in southwestern Montana, south through Wyoming to northwestern Colorado, and scattered westward through northern Utah and Idaho to Nevada and Oregon (Beetle 1960, Winward 1980).

Ecology.—Despite the common name of alkali sagebrush, the species also often grows well on neutral soils (Passey and Hugie 1962, Tisdale and Hironaka 1981). It is well adapted to xeric conditions (Robertson and others 1966, Zamora and Tueller 1973). Mean annual precipitation throughout its range can vary between 220 and 500 mm. Alkali sagebrush typically grows in heavy, highly impermeable soils with dense "B" horizons (Passey and Hugie 1962, Tisdale and Hironaka 1981). It does, however, grow on lighter soils as well (McArthur and others 1979).

Reproduction.—Shrubs usually bloom in mid-June to early August and seed ripens in August and September. Seeds are wind dispersed during late fall and winter, and seedlings emerge during the following spring. Seeds are about the size of low sagebrush seeds so we expect there would be about 2 million cleaned seeds per kg (Meyer 2003). Natural seeding occurs rapidly following fires and other disturbances, yet mechanical tillage can limit establishment if seeds are sown too deep or if the seedbed is disrupted (Monsen and Shaw 1986).

Management.—Alkali sagebrush, depending on location and ecotype, can be a source of palatable browse for domestic sheep and provide habitat and forage for other animals (Dealy and others 1981, McArthur and others 1979). Stands of alkali sagebrush in good condition can support a diverse understory of perennial grasses and annual and perennial forbs. Such stands provide forage and cover for sage grouse, antelope, other wildlife, and domestic livestock (Dealy and others 1981, Monsen and Shaw 1986). Some stands, however, are much less diverse and provide little forage or habitat. Sites that lack a satisfactory understory remain closed unless shrubs are reduced by fire or other disturbance. Monsen and Shaw (1986) reported that decadent stands can be rejuvenated by mechanical means.

This shrub has the potential to be a useful plant in rehabilitation, especially on heavy, seasonally dry soils. It has been observed invading roadcuts in Echo Canyon, Utah, and along roadsides near Kemmerer, Wyoming (McArthur and others 1979).

Benefits.—Alkali sagebrush is a native shrub that provides habitat and forage for wildlife and livestock. In addition, it has characteristics that could make it useful in ecological restoration, rehabilitation, or soil conservation. It spreads well through natural seeding and tolerates disturbance. It also grows on argillic soils that may be too heavily textured for most other shrubs.

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***Artemisia ludoviciana* Nutt.** Lousiana sagewort
ASTERACEAE

Synonyms: *Artemisia albula* Wooton
Artemisia candicans Rydb.
Artemisia gnaphalodes Nutt.
Artemisia incompta Nutt.
Artemisia mexicana Willd. ex Spreng.
Artemisia redolens A.Gray
Artemisia sulcata Rydb.
Artemisia vulgaris var. *americana* Besser
Artemisia vulgaris ssp. *ludoviciana* H.M. Hall & Clem.
Artemisia vulgaris var. *ludoviciana* Kuntze

Jeffrey R. Taylor and E. Durant McArthur

Illustration credit: USDA—Forest Service collection, Hunt Institute

General Description.—Louisana sagewort, also known as cudweed sagewort, Louisiana sagebrush, Louisiana wormwood, western mugwort, white sage, sage-weed, estafiate, and iztafiate, is an aromatic, morphologically variable, herbaceous forb or sub-shrub 0.3 to 1 m tall. Stems are erect, single to numerous, and woody near the base. Stems can be grayish-green, greenish-yellow, or green and are typically covered with a white to gray tomentum. Leaves may be entire, tridentate, variously-lobed oblanceolate, or linear. Lower leaves are grayish green, oblanceolate, lobed, or entire, 3 to 9 cm long and 0.5 to 2.5 cm long, while upper leaves are mostly entire, gray to green floccose to glabrous above, and white tomentose beneath (Hall and Clements 1923). The leaf apex is acute. Flower heads bear six to 12 pistilate ray flowers and five to 12 perfect disc flowers, arranged in elongate, leafy panicles 20 to 50 cm long (Stubbendieck and others 1997). Louisana sagewort has a strong tendency to spread through rhizomes.

Taxonomy.—*Artemisia ludoviciana* is a highly polymorphic species. Hall and Clements (1923) chose to classify it within the *Artemisia vulgaris* L. complex. This system of classification consolidated 54 previously recognized species into one species and 15 subspecies. Keck (1946) suggested that the complex arose from one cenospecies, and subsequently revised the taxonomy. Keck's revision classified *A. ludoviciana* on the specific, rather than subspecific level, with seven subspecies of its own. These subspecies include: *typica*, *sulcata* (Rydb.) Keck, *albula* (Woot.) Keck, *candicans* (Rydb.) Keck, *incompta* (Nutt.) Keck, *mexicana* (Wild.) Keck, and *redolens* (Gray) Keck. Cytogenetic studies show that the New World members within the *vulgaris* complex have a base chromosome number x = 9, as opposed to the Old World members, with a base chromosome number of x = 8. Lousiana sagewort and its close relatives (*A. ludoviciana* species complex) can be diploid, tetraploid, or hexaploid (Estes 1969, Welsh and others 1993). Estes (1969) suggested that autopolyploidy has been the driving evolutionary force within the complex. Molecular genetic studies have also shown New World and Old World members of the complex to be different from one another (Vallès and McArthur 2001).

Range.—Lousiana sagewort is widely distributed throughout Western North America. Its range spans from Ontario and Michigan in the east, to British Columbia in the west, and south through Texas, Louisiana, California, and Mexico (USDA Forest Service 1937). Lousiana sagewort grows at various elevations from 250 to 3,050 m.

Ecology.—Lousiana sagewort grows on rocky, sandy, or gravelly loams on open ridges, slopes, and mesas (USDA Forest Service 1937). It is also common on plains and prairies and is usually a late seral species that grows after grasses have declined (Hall and Clements 1923). Lousiana sagewort grows rapidly, is long lived, and is cold and drought tolerant (Shaw and Monsen 1982). It grows well in sunny sites even though it is shade tolerant. It is can be found in grasslands, sagebrush, ponderosa pine, and alpine communities (Shaw and Monsen 1982). Lousiana sagewort often associates with asters (*Aster* L.), goldenrods (*Solidago* L.), sunflowers (*Helianthus* L.), fringed sagebrush (*Artemisia frigida* Wild.), big sagebrush (*Artemisia tridentata* Nutt.), tarragon (*Artemisia dracunculus* L.), needlegrass (*Stipa* L.), blue grama [*Bouteloua gracilis* (H.B.K.) Lag. ex Steudel], muhly grasses (*Muhlenbergia* Schreber), wheatgrasses (*Agropyron* Gaertner), mountain dandelions [*Agoseris glauca* (Pursh) Raf.], and western yarrow (*Achillea millefolium* L.) (USDA Forest Service 1937, Hall and Clements 1923). Mean annual precipitation within its range varies between 400 and 1200 mm.

Reproduction.—Blooming begins in August and ends in September (Stubbendieck and others 1997). Seed matures in the fall and is dispersed by wind during late fall or winter. Seeds are relatively small, numbering about 8,360,000/kg (personal communication with S. Stranathan, Upper Colorado Environmental Plant Center, Meeker, CO). Seed viability decreases after 2 or 3 years of storage (personal communication with K.R. Jorgensen, Great Basin Experimental Area Ephraim, UT). Seeding aerially, by drill, or broadcasting are all effective methods of planting and should be conducted during fall or winter (Shaw and Monsen 1982). In addition to seeds, Lousiana sagewort spreads asexually through rhizomes.

Management.—Lousiana sagewort is used differentially by livestock and wildlife throughout its distribution. Populations in the southern portions of its range, such as in southern Utah, New Mexico, and southern Colorado, are more palatable than those in the north (USDA Forest Service 1937, Stubbendieck and others 1997). In these southern areas, it can provide valuable forage, especially on spring-fall and winter ranges. In more northern areas, it has a pungent taste and is generally not eaten until after the first frost (Hall and Clements 1923). Lousiana sagewort is generally considered poor forage, although it is utilized by domestic sheep, deer, and elk to some degree, and may be seasonally important (Shaw and Monsen 1982, Hall and Clements 1923, USDA Forest Service 1937). Lousiana sagewort has also been used to revegetate road, logging, and other disturbances (Shaw and Monsen 1982). In a revegetation experiment at Mesa Verde National Park, CO, it survived well when transplanted in roadcut sites (Paschke and others 1999).

Benefits.—Lousiana sagewort is an extensive and genetically diverse native plant that is widespread throughout Western North America. It provides quick and excellent cover, reduces erosion, and serves as a nurse plant for other species (Shaw and Monsen 1982). It also has pharmaceutical potential. Zavala-Sanchez and others (2002) found that an essential oil found in Lousiana sagewort, nonanal, inhibited diarrhea in mice. In addition, Lousiana sagewort extracts inhibited reproduction in malarial parasites (Malagon and others 1997). The ssp. *mexicana* (estafiate) is used for gastrointestinal pain, as a verimfuge, and as a bitter stimulant (Heinrich 2002). It has also been used by Native Americans in ceremonial and purification rituals, to deodorize feet, as pillows, saddle pads, and to treat headaches, stomach ailments, and coughs (Stubbendieck and others 1997).

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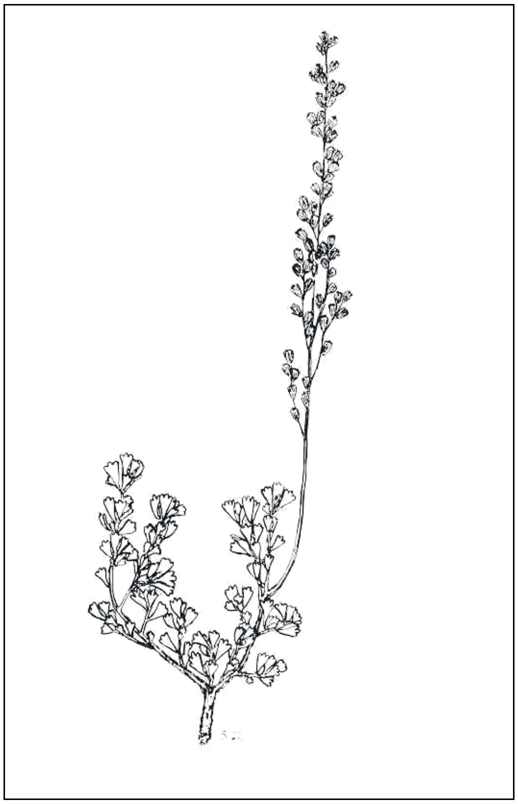
***Artemisia nova* A. Nels.** black sagebrush
ASTERACEAE

Synonyms: *Artemisia tridentata* ssp. *nova* (A. Nels.) H.&C.
Artemisia arbuscula ssp. *nova* (A. Nels.) McMinn
Artemisia arbuscula var. *nova* (A. Nels.) G. Ward
Serphidium novum (A. Nels.) W.A. Weber

E. Durant McArthur and Jeffrey R. Taylor



General Description.—Black sagebrush is a small aromatic shrub generally 15 to 20 cm tall, although it may occasionally exceed 75 cm. A dull grayish-tomentose layer causes most populations of black sagebrush to appear darker than those of big sagebrush or low sagebrush. Branches are numerous and erect and arise from a spreading base. Leaf base is typically cuneate, and the leaf surface is covered with a viscid glandular pubescence. The leaf apex is three-toothed, although the uppermost leaves, particularly on flowering stems, may be entire. Leaf dimensions can vary between 0.5 to 2 cm long and 0.2 to 0.8 cm wide. Flowering heads are grouped in narrow spike-like panicles that commonly extend above the foliage. Heads contain three to five disc flowers subtended by eight to 12 greenish-yellow involucral bracts. Leaf hairs, visible at 10x magnification, can be useful diagnostic clues to distinguish black sagebrush from other sagebrushes.

Taxonomy.—Black sagebrush taxonomy is relatively simple. It includes one species and two varieties, *A. nova* var. *duchesnicola* and *A. nova* var. *nova* (Welsh and Goodrich 1995). Beetle and Johnson (1982) have found forms of black sagebrush that are similar in appearance to Wyoming big sagebrush. This, in addition to other factors, has led some to suspect that black sagebrush may have been involved in the parentage of Wyoming big sagebrush (McArthur 1983, Winward 1976). Glandular trichomes are a taxonomic feature that helps separate black sagebrush from big sagebrush (*A. tridentata* Nutt.) and low sagebrush (*A. arbuscula* Nutt.) (Kelsey 1984). Black sagebrush has a base chromosome number of x = 9; both diploid (2n = 18) and tetraploid populations are known. About two-thirds of the cytologically known populations are tetraploid (McArthur and Sanderson 1999).

Range.—Black sagebrush is one of the most common shrubs in the Western United States. Populations can be found from California and Oregon in the west, to Colorado in the east, and from Montana in the north to northern Arizona and New Mexico in the south. Black sagebrush is most common at elevations ranging between 1,500 to 2,400 m (McArthur and others 1979)

Ecology.—Black sagebrush is well adapted to dry stony soils that are relatively shallow. Zamora and Tueller (1973) found root restricting layers 28 to 69 cm deep in half of their black sagebrush study sites. Gravelly or sandy loam strata are also common subsurface soil profile characteristics in areas with black sagebrush. In addition, most soils supporting black sagebrush are calcareous. Black sagebrush is not restricted to adverse environments, however. If seeded, it can grow well on sites normally occupied by big sagebrush. Mean annual precipitation throughout the natural range of black sagebrush ordinarily is between 180 and 320 mm.

Most stands of black sagebrush do not burn because populations are relatively sparse (Tisdale and Hironaka 1981). Exceptions to this rule, however, have been observed in central Utah, where large stands of black sagebrush burned. In a comparative study, Nelson and Krebill (1981) found that black sagebrush is less susceptible to a wilt disease than other species of *Artemisia* grown under similar conditions.

Reproduction.—Mature shrubs flower in late summer (usually August), and seed matures in September and October. Black sagebrush seed tends to be larger than those of other sagebrushes. There are about 2,000 seeds/g (Deitschman 1974). Seeds are wind dispersed in late fall or early winter. Seedlings emerge in the spring and often grow rapidly. Once established, young plants can persist well even under adverse conditions. With favorable moisture conditions, mature plants produce abundant seed, and natural spreading occurs quickly.

Management.—Black sagebrush is usually considered a valuable browse species for wildlife and livestock, especially for deer, domestic sheep, and pronghorn (Clary 1986; McArthur and Plummer 1978, USDA Forest Service 1937). Black sagebrush has good winter nutritive value, but not as good as big sagebrush (Welch 1983). Palatability, however, can vary significantly between populations (Welch and others 1981). Deer and elk preference studies for black and big sagebrushes have yielded inconsistent results (Scholl and others 1977, Nagy and Regelin 1977, Smith 1950, Wambolt 1996). Welch and others have shown that some accessions are not eaten while others are highly preferred (Behan and Welch 1985, Welch and others 1981), which may partially explain differences in preference studies.

Black sagebrush can also be a valuable conservation species for dry, shallow, stony soils because it produces abundant seed and seedlings establish readily. Due to its habitat, it is not usually a candidate for plant control. Black sagebrush can successfully be seeded in fall or early winter. Seeds should be covered with soil, but remain within 6 mm of the surface. It grows well with seeded herbs, but understory production tends to decrease as the stand matures.

Benefits.—Black sagebrush is an important native shrub in many areas of the Western United States. It provides structural diversity within native plant communities and provides an important browse source for native and introduced ungulates. It can also reduce soil erosion on steep shallow slopes. 'Gordon Creek' is a tested germplasm from Carbon County, Utah, that has been demonstrated to be high in nutritive quality and palatability to wildlife (Welch and others 1994).

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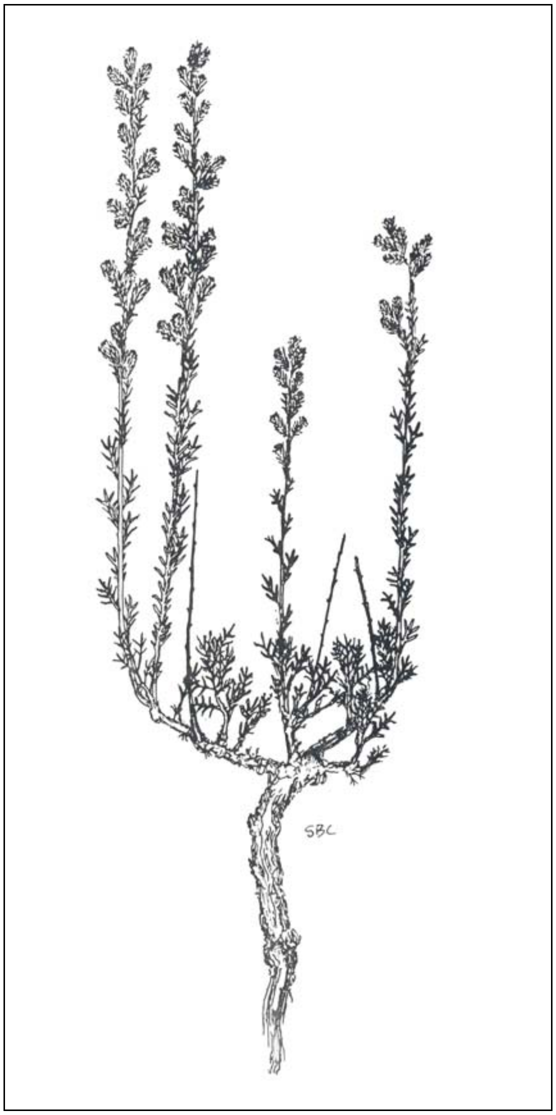
Artemisia pygmaea Gray pygmy sagebrush
ASTERACEAE

Synonyms: *Seriphidium pygmaeum* (Gray) W.A.Weber

E. Durant McArthur and Jeffrey R. Taylor



General Description.—Pygmy sagebrush is a dwarf, depressed, evergreen, cushion-like shrub less than 20 cm tall. Bark on older stems becomes dark brown and fibrous with age. Bark on younger branches is nearly white to straw-colored and somewhat puberulent. Leaves on vegetative stems are green, nearly glabrous, viscidulous, and are pinnatified with three to 11 lobes, or sometimes may be toothed. Leaf dimensions range between 2 to 4 mm wide and 2 to 8 mm long. Leaves on flowering branches are usually reduced and may be entire. Flower heads contain three to five disc flowers and are arranged into spike-like inflorescences. Ray flowers are lacking. Twelve to 18 greenish-yellow involucral bracts subtend each head (Cronquist 1994, McArthur and others 1979).

Taxonomy.—No subspecific entities have been described for pygmy sagebrush. Pygmy sagebrush is known only at the diploid, 2n = 18, chromosome level (McArthur and Sanderson 1999).

Range.—The distribution of pygmy sagebrush is limited to approximately 54 km^2 in eastern Utah, western Nevada, and northern Arizona (Beetle 1960; McArthur and Plummer 1978; Ward 1953).

Ecology.—Pygmy sagebrush grows on calcareous desert soils. Mean annual precipitation within its range is approximately 200 to 300 mm. In Nevada, this species is often associated with halophytic threadleaf rubber rabbitbrush [*Chrysothamnus nauseosus* (Pallas ex Pursh) Britton ssp. *consimilis* (Greene) Hall & Clements]. In Utah, some relatively large stands are mixed with black sagebrush (*Artemisia nova* A. Nelson).

Reproduction.—Blooming occurs between August and September. Seed matures in October. Seeds are relatively large compared to those of other subgenus *Artemisia* subgenus *Tridentatae* species (McArthur and others 1979). Seeds are wind dispersed during late fall or winter. Seedlings emerge during spring. Shrubs in research plantings have spread naturally. It also establishes well by transplanting divided plants. Although it spreads through naturally dispersed seed, artificial seedings have been unsuccessful.

Management.—Pygmy sagebrush provides little browse because of its scarcity and size. It is readily eaten, however, when available. It is a good candidate to plant in clay soils and may be of considerable value for revegetating mine spoils and roadway disturbances.

Benefits.—Although it is not abundant, pygmy sagebrush does provide important soil cover in dry, alkaline habitats where little else grows. It also adds to the overall biological diversity to the shrub communities where it is found.

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Ward, G.H. 1953. *Artemisia*, section *Seriphicum*, in North America. A cytotaxonomic study. Contributions from the Dudley Herbarium 4: 155-205.

Artemisia rigida (Nutt.) Gray stiff sagebrush
ASTERACEAE

Synonyms: *Artemisia trifida* var. *rigida* Nutt.
Seriphidium rigidum W.A. Weber

E. Durant McArthur and Jeffrey R. Taylor

General Description.—Stiff sagebrush, also known as scabland sagebrush, is a low, pungently aromatic shrub with thick, rigid, somewhat brittle branches. The bush grows up to 40 cm tall. Leaves, mostly 1 to 4 cm long, are deciduous, silvery-canescent, spatulate, and usually deeply divided into three to five narrowly linear lobes. Occasionally, leaves are linear and entire (Cronquist 1994, McArthur and others 1979). Each head is composed of five to 16 perfect disc flowers. The campanulate involucre is 4 to 5 mm long with numerous canescent bracts. The inflorescence is a leafy spike with heads sessile or in small clusters in the axils of their subtending leaves, which are generally longer than the heads. This species somewhat resembles threetip sagebrush (*Artemisia tripartita* Rydb.) in size, silvery pubescence, and the deeply, narrowly lobed leaves, but is distinguishable by the spike-like inflorescence, large leafy bracts that subtend the heads, and the deciduous leaves (Cronquist 1994, McArthur and others 1979).

Taxonomy.—Stiff sagebrush does not include subspecific taxa. However, both diploid, 2n = 18, and tetraploid, 2n = 36 populations are known (McArthur and others 1981, McArthur and Sanderson 1999, Ward 1953).

Range.—Stiff sagebrush is found in the Columbia and Snake River basins and the northern end of the Great Basin between 910 to 1,500 m elevation. Its range includes portions of Idaho, central and eastern Oregon, and eastern Washington. The report that its range extends into Montana is apparently an error (Morris and others 1976; McArthur and others 1979).

Ecology.—This shrub grows primarily, if not exclusively, on sites with rocky, basaltic parent material (Daubenmire 1982, Tisdale and Hironaka 1981). Otherwise, its ecological niche is similar to that of low sagebrush (*Artemisia arbuscula* Nutt.). Stiff sagebrush grows in sites with annual precipitation between 250 and 350 mm. Stiff sagebrush is able to survive wildfires even though it is not known to resprout or layer, probably because it grows in scattered patches that carry fires poorly. Plants grow slowly and require 2 to 4 years to attain a mature size (> 15 cm in height). It appears to have broader ecological amplitude than its present range suggests (McArthur and others 1979).

Reproduction.—Blooming begins in late August and ends in early October, and seeds ripen in October and November. Seed is wind dispersed in late fall or winter, and seedlings emerge during the ensuing spring. Seed production and seed quality are low in comparison to other sagebrush species (McArthur and others 1979). Attempts to seed and transplant this species in arid sagebrush ranges near Boise, Idaho, have been unsuccessful. In such instances, plantings were made where cheatgrass (*Bromus tectorum* L.) and other annuals have invaded, and stiff sagebrush seedlings were unable to compete. Plantings have successfully established on prepared seedbeds, however.

Management.—Due to scant foliage and stiff branches, few animals except domestic sheep browse stiff sagebrush (Hall and Clements 1923). It provides forage on dry sites for domestic sheep during midsummer when herbaceous plants are dry.

Benefits.—Stiff sagebrush is a native shrub that adds biological diversity to Western ecosystems. It is an important plant that provides cover and reduces erosion on rocky sites. Its ecology suggests that it could be used in reclaiming harsh, disturbed sites.

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***Artemisia rothrockii* Gray.** rothrock sagebrush
ASTERACEAE

Synonyms: *Artemisia tridentata* ssp. *rothrockii* Hall & Clements
Artemisia tridentata var. *rothrockii* McMinn

Sally A. Reynolds and Eric L. Berlow

General Description.—Rothrock sagebrush, also known as timberline sagebrush, is a low, aromatic, evergreen shrub, spreading to ascending from a narrow trunk, 20 to 60 cm tall. Bark is gray to dark grayish brown, becoming fibrous with age. Young twigs are densely tomentose. Leaves are dark green, narrowly cuneate, ranging from 0.5 to 2 cm long and 0.2 to 1.5 cm wide. Vegetative leaves are three-toothed but, leaves on flowering stalks are generally entire. Young leaves are canescent, becoming glabrous with age (Shultz 1993).

Range.—Rothrock sagebrush is native and endemic to California. It occurs at high elevations in the Sierra Nevada and the White and San Bernardino Mountains. This species is commonly found in the southern Sierra Nevada on the Kern Plateau, at Monache Meadows, Big Meadows, Ramshaw Meadows, Templeton Meadows, and Mulkey Meadow. It is also found at Mono Pass, Tuolumne Pass and Mount Dana in Tuolumne County, Angora Peak, and near Fallen Leaf Lake in El Dorado County (McMinn 1951). Its northernmost extent is Placer County (Sawyer and Keeler-Wolf 1995).

Ecology. –Rothrock sagebrush generally vegetates well-drained, gravelly soils on the margins of montane meadows from 2,000 to 3,500 m. In the southern Sierra Nevada, evidence suggests rothrock sagebrush was historically limited to dry soils in the areas between the meadows and surrounding slopes of lodgepole or red fir forest but has expanded into mesic meadows since the onset of livestock grazing in the 1850's (Ratliff 1985, Odion and others 1988, Dull 1995). Grazing and trampling along stream banks are proposed to have caused channel incision and an associated lowering of the water table in the adjacent meadow (Kattelmann and Embury 1996, Kirchner and others 1998, Knapp and Mathews 1996, USDA Forest Service 1998, 2000). While more often found on drier soils, rothrock sagebrush appears to be tolerant of very high soil moisture as individuals survive periods of standing water following spring snowmelt (Berlow and others 2002). Additionally, in a pot experiment, rothrock sagebrush seedlings showed 100 percent survival after 2 weeks and over 60 percent survival after 4 weeks of complete immersion in flowing water (Swartz, Berlow and D'Antonio unpublished data). The highest potential germination and seedling growth rates were observed in mesic, rather than xeric, meadow habitat. However, in these areas micro-site availability and seed dispersal limit establishment, with seedlings preferentially associated with small soil disturbances within 0.5 m of a seed source (Berlow and others 2002).

Reproduction.—Flowers develop on narrow inflorescences. Heads are sessile to short-peduncled, 3 to 5 mm in diameter. Phyllaries (involucre bracts) occur in two series. Both series are shiny with wide margins. The outer phyllaries are canescent with acute tips, whereas the inner phyllaries are elliptic and only sparsely tomentose. Discoid flowers (ray florets are absent) have between eight and 20 fertile florets. Seeds are small and resinous, ranging from 0.8 to 2 mm, with pappus present on outer seeds (Shultz 1993). Inflorescences begin development in late spring. Flowering takes place at the end of the growing season in early to late fall, and seed dispersal begins soon after. Seeds are primarily wind dispersed and do not appear to travel far, as seedlings tend to be aggregated within 0.5 m of adult shrubs (Berlow and others 2002). Germination occurs immediately following spring snow-melt. Rothrock sagebrush does not form a large soil seedbank (Reynolds unpublished data). An average sized adult plant can produce over 5000 seeds (Reynolds unpublished data). However, field germination rates are low (< 1 percent), and seed viability appears to decline rapidly after 1 year (Berlow and others 2002, and unpublished data).

Growth and Management.—The growing season for rothrock sagebrush in montane habitats is relatively short, beginning in early spring and continuing until the soil moisture is depleted in late summer. Under mesic conditions, rothrock sagebrush can begin flowering within 5 years of establishment (Berlow and others 2002). While age to senescence is unknown, individuals up to 40 years old have been documented by counting growth rings (Bauer and others 2002). Rates of increase in stem diameter have been observed to vary between 0.10 to 0.14 mm/year. Faster growth rates were found in microhabitats characterized by moist surface soil and a shallow water table, suggesting that this woody species can use similar water sources as herbaceous species (Bauer and others 2002, Berlow and others 2003). Rothrock sagebrush seedlings are not palatable to livestock or native grazers, which may contribute to their encroachment into intensively grazed meadows. While large areas of sagebrush expansion are associated with stream incision, rothrock sagebrush also has the demonstrated potential to invade un-incised, mesic meadow habitat given the presence of exposed soil and a nearby seed supply (Berlow and others 2002). Thus, on a large scale, preventing further stream incision is critical to slowing sagebrush invasion. Within mesic meadow habitat, removal of scattered individual shrubs that serve as local seed sources may be the most effective way to prevent rapid expansion into un-incised areas.

Benefits.—Rothrock sagebrush contributes to the diversity of California's montane plant communities. It stabilizes sandy soil on the slopes of meadow fringes and provides habitat for a variety of birds and small mammals.

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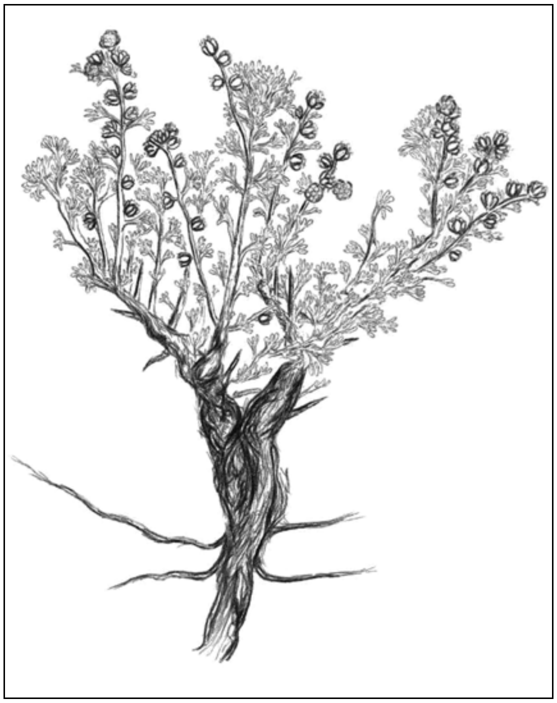
Artemisia spinescens Eaton budsage
ASTERACEAE

Syononyms: *Picrothamnus desertorum* Nutt.

E. Durant McArthur and Jeffrey R. Taylor



General Description.—Budsage, also known as spring sage and bud sagebrush, is a low, spinescent, pungently aromatic, rounded shrub 10 to 50 cm high and profusely branched at the base. Young branches and leaves are covered with a white-tomentose pubescence that becomes stiff and gray with age. Leaves are small and normally 2 cm or less in length. Leaves are three- to five-palmately parted, again divided into three linear-spatulate lobes. Leaves are crowded on short stems, with those near the apex being smaller and more entire. Unlike most members of the genus, budsage is deciduous, losing most leaves by midsummer. Flowerheads are small and arranged in glomerate racemes of one to three heads in leaf axils on flower branches. Each head contains two to six fertile, pistilate ray flowers and five to 13 perfect, but sterile, disc flowers. Four to eight rounded involucral bracts subtend each flowerhead (Cronquist 1994, McArthur and others 1979).

Taxonomy.—Budsage is distinct from closely related *Artemisia* species and is sometimes considered a separate monotypic genus although (Cronquist 1994) states that “despite this proposed segregation, its affinity with *Artemisia* is not in question”. The inclusion or exclusion of segregate genera from *Artemisia* including *Picrothamnus* has not been confirmed by molecular genetic studies as of yet (Vallès and McArthur 2001). Polyploidy within the budsage has been documented; both diploid, 2n = 18, and tetraploid, 2n = 36, populations occur (McArthur and Pope 1979).

Range.—The range of budsage extends from Wyoming to western Montana, southern Idaho, and easten Oregon south to northwestern New Mexico, northern Arizona, and southeastern California (Cronquist 1994, McArthur and others 1979).

Ecology.—Budsage is well adapted to xeric conditions. It is quite common in semiarid valley bottoms, benches, and foothills throughout the Interior Western United States (Hall and Clements 1923, Wood and Brotherson 1986). Mean annual precipitation throughout its habitat varies between 150 and 250 mm. It has an extensive root system that grows primarily within the top 15 to 56 cm of the soil. Interxylary cork is formed over the previous year’s wood that restricts the upward movement of water to the narrow zone of wood formed by the current year’s growth. The corky tissue develops during the early summer and reduces water loss during dormancy (Wood 1966).

Summer dormancy is an adaptation that reduces the effects of drought stress. Early in the spring, when budsage first shows signs of breaking dormancy and prior to bud elongation, the previous season’s bark growth can be removed easily. This condition is known as “slipping” and is used as a sign to tell when the plant is palatable to sheep (Wood and Brotherson 1986). Shrubs subsequently produce new, bright-green leaves as soon as February or March. Terminal and lateral buds generally expand and begin to elongate in late March and early April. Although budsage ordinarily begins to grow in early spring and becomes dormant by midsummer, it occasionally may break summer dormancy after late summer storms.

Reproduction.—Blooming normally begins during the last week in April and continues through the last week in May. Exceptions, however, have been documented where blooming began as early as late March or has extended as late as mid-June (Wood 1966). Seeds normally mature in early June. There are about 3 million cleaned seeds per kg (Meyer 2003). Freezing temperatures in early spring frequently kill developing embryos. Intact heads regularly fall from the plant without breaking apart to release seeds, although some seeds are usually dispersed independently. Abundant natural reproduction occurs in years when seed production is plentiful and moisture conditions are favorable.

Management.—Budsage is a palatable, nutritious winter forage for upland birds, small game, big game, and domestic sheep. It is particularly preferred just after dormancy. Budsage is high in calcium, magnesium, phosphorous, and protein (Wood and Brotherson 1986). It is usually more palatable in late winter than early winter (Holmgren and Hutchings 1972). Palatability again decreases once twigs have elongated and volatile oil content increases (Cook and others 1954). Budsage is especially important to grazing animals during late winter in areas where there is an abundance of dry grass. Unfortunately, it does not tolerate grazing well, and continual heavy grazing may eliminate it from certain areas (Holmgren and Hutchings 1972). In order to maintain the species in plant communities, periodic rest from grazing is needed. This allows seed and seedlings to develop.

Benefits.—Budsage is an important native shrub because of its forage value to various species of wildlife and domestic livestock. Wildlife species that utilize budsage include mule deer (*Odocoileus heminonus* Rafinesque), pronghorn (*Antilocapra Americana* Ord), mountain sheep (*Ovis canadensis* Shaw), black-tailed jackrabbits (*Lepus californicus* Gray), and chucker partridge (*Alectoris graeca* Meisner) (Wood and Brotherson 1986). In areas of local abundance, budsage can be an important source of protein during late winter months.

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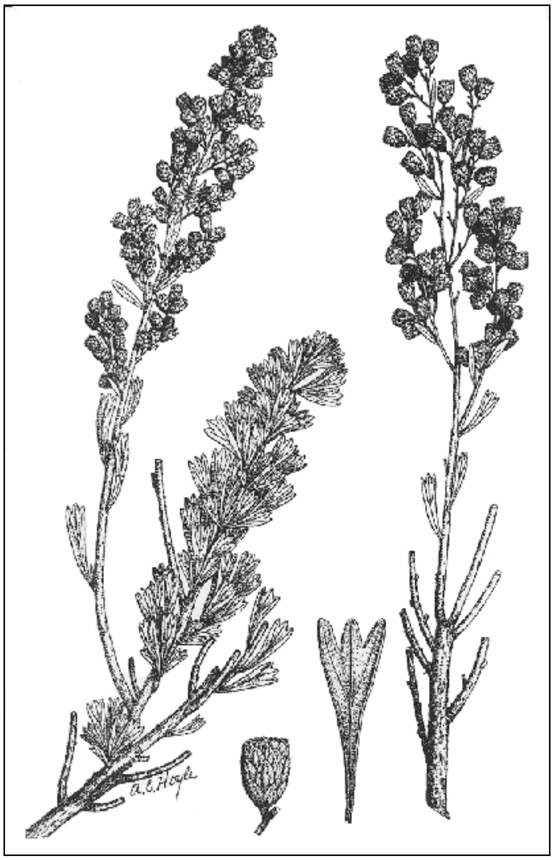
***Artemisia tridentata* Nutt.** big sagebrush
COMPOSITAE

Synonyms: *Artemisia tridentata* var. *angustifolia* Gray
Artemisia angusta Rydb.
Artemisia tridentata ssp. *typica* Hall & Clements

Bruce L. Welch



General Description.—Big sagebrush is an erect, aromatic, evergreen species, that lacks winter buds. It has numerous ecotypes that range in size from 0.4 to 4.5 m tall (Beetle 1960, Beetle and Young 1965, Diettert 1938, McArthur and others 1979). Growth forms are of two types; multistemmed and single trunks and are correlated with subspecific taxonomy. This species produces two types of branches, vegetative and flowering (Diettert 1938). The bark on older vegetative branches is stringy and black or dark brown in color. Bark on younger vegetative and inflorescences is heavily covered with trichomes that give the branches a silvery green to gray color. The leaves are also silvery green or gray. Principal leaves are narrowly cuneate or oblanceolate, 1.0 to 6.5 cm long and 2 mm to 2 cm wide, and usually are three-toothed at the apex (McArthur and others 1979). Leaf arrangement is spiral with a 2/5 divergence (Diettert 1938). Internodes are often so short that the leaves form dense, rosette-like clusters at the shoot tips (Diettert 1938). The haploid chromosome number of big sagebrush is nine (Diettert 1938, McArthur and Sanderson 1999). Two levels of ploidy have been reported among the three subspecies of big sagebrush–diploid ($2n = 2x = 18$) and tetraploid ($2n = 4x = 36$) (Diettert 1938, McArthur and Sanderson 1999). All three subspecies of big sagebrush contain polyploid populations (McArthur and Sanderson 1999).

Taxonomy.—There are three widely recognized subspecies of big sagebrush (Beetle 1960, Beetle and Young 1965). These are Wyoming big sagebrush (*A. t.* ssp. *wyomingensis*), basin big sagebrush (*A. t.* ssp. *tridentata*), and mountain big sagebrush (*A. t.* ssp. *vaseyana*). Subspecies can be separated on morphological, chemical, and ecological characteristics (McArthur and others 1979, Welch 2002). Wyoming big sagebrush occupies the drier sites that range from 20 to 32 cm of precipitation, 31 to 149 cm for mountain big sagebrush with basin big sagebrush somewhat between the other two subspecies (Welch 2002). Some authorities have divided mountain big sagebrush into three forms, varieties, or subspecies depending on the authority being quoted. One is called subalpine big sagebrush, *A. t.* ssp. *spiciformis*, (McArthur and Goodrich 1986) or *A. t.* ssp. *vaseyana* f. *spiciformis* (Beetle and Johnson 1982). The second is referred to as "X" big sagebrush, or xeric big sagebrush or *A. t.* ssp. *xericensis* (Welch 2002). Lastly, a variety of mountain big sagebrush is called *A. t.* ssp. *vaseyana* var. *pauciflora* (Welch 2002).

Range.—Beetle (1960) describes the range or distribution of big sagebrush in these terms: "occupying a great variety of sites at scattered localities in southern Montana and central to western Wyoming; southern-central British Columbia, south through central Washington, to the Columbia River; from the south side of the Blue Mountains in northeastern Oregon, throughout central and southeastern Oregon, southwestern and central Idaho to northern Utah, Nevada, and northwestern California; from the northern great basin areas of California, Nevada, and Utah, extending southward at elevations from 5,000 to 7,000 feet and extending into western Colorado, northwestern New Mexico, northern Arizona; at much lower elevations in southern California and northern Lower California, Mexico." It also occupies areas of the northern Great Plains in the States of North and South Dakota, Montana, Wyoming, and Nebraska (Welch 2002).

Ecology.—Big sagebrush grows in a variety of soils throughout its range from arid plains, valleys, foothills, to mountain slopes, from 500 to 3,400 m elevation (McArthur and others 1979, Welch 2002). It has been found growing on five soil order: Alfisols, Aridisols, Entisols, Inceptisols, and Mollisols. It can be found growing on all 12 soil textural classes, but it is most often found on loams or sandy loams (Welch 2002). Chemical properties of big sagebrush soils are highly variable (pH 5.9 to 10.0 and organic carbon 0.62 to 4.14 percent) but two characteristics are common: they are well-drained and contained low concentrations of salts (Welch 2002). Depending on subspecies, as many as 40 plant species (grasses and forbs) can grow with big sagebrush (Welch 2002). Big sagebrush is not fire tolerant and can be killed by a number of pathogenic fungi, insects, and environmental conditions such as winter kill or winter induced drought (Welch 2002).

Reproduction.—The growth of inflorescence starts in late spring and is complete by late summer to early fall (Welch 2002). Flowering occurs during early to late fall with fruit development commencing almost simultaneously with flowering. Thus reproductive growth occurs when water supplies and temperatures are not particularly favorable; in fact, during this period big sagebrush plants have started shedding ephemeral leaves and neighboring plants species are largely dormant (Welch 2002). However, inflorescences do generate positive net photosynthesis at a time when whole plant is in a water conservation mode (Welch 2002). Big sagebrush achenes or seeds are small, weighing from 0.00018 to 0.00025 g (Welch 2002). Time of seed dispersal is highly variable among stands and somewhat dependent on elevation; some starting in mid-fall other not until early winter. Most seeds germinate immediately after snow melt or after late-winter or early spring storms (Welch 2002). The seeds possess no special adaptations for wind dispersal, but are wind dispersed to a maximum distance of 30 m from the mother plant. Hence seedlings placement is heavily depended on wind direction (Welch 2002). Big sagebrush forms a weak soil seed bank (Welch 2002). A single mature big sagebrush plant can produced upward of 500,000 seeds, although, excessive browsing can reduce inflorescences production by a factor of 20 (Welch 2002). The seeds must lie on the soil surface or be buried not more than 5 mm for successful emergence (Welch 2002).

Growth and Management.—Vegetative growth starts in early spring and declines when soil moisture becomes deficient. In general, Wyoming big sagebrush, the smallest of the subspecies, has the slowest vegetative growth rate and produces the least amount of biomass. Basin big sagebrush has the fastest growth rate and is the largest of the subspecies (McArthur and others 1979, Welch 2002). In the past 50 years or more, management has erroneously perceived big sagebrush to be a highly competitive, dominating, and suppressive species of grasses and forbs (Welch 2002). Thus a variety of techniques have been developed to kill big sagebrush (Welch 2002). As more studies show the importance of big sagebrush in maintaining it's ecosystem, techniques have been and continue to be developed to restore big sagebrush to its native sites (Welch 2002).

Benefits.—Big sagebrush is the keystone species of a large and highly variable ecosystem of Western United States (Welch 2002). It is literally a "nursing mother" to a host of organisms ranging from microscopic to large mammals and is what supports life in Bailey's (1896) description: "One never recovers from his surprise that there should be so much life where apparently there is so little to support it." Species that depend directly or indirectly on big sagebrush are many: 31 species of fungi, 52 species of aphids, 10 species of insects that feed on aphids, 42 species of midges and fruit flies that induce galls, 20 species of insects that parasitize the gall inducers, 6 species of insects that hibernate in big sagebrush galls, 18 species of beetles, 13 species of grasshoppers, 13 species of shield-back katydids, 16 species of thrips, 74 species of spiders, 24 species of lichens, 16 species of paintbrushes, 7 species of owl-clovers, 5 species of bird's beaks, 3 species of broom rapes, and a host of large and small mammals, birds, and reptiles (Welch 2002). Soil fertility is higher under big sagebrush canopy cover than outside the canopy (Welch 2002). Roots of other plants can tap into these islands of fertility (Krannitz and Caldwell 1995). Also, by a process known as "hydraulic lift or hydraulic redistribution" associated plants receive part of their needs from water pumped by big sagebrush to the soil surface from greater soil depths (Welch 2002). Lastly, big sagebrush provides a safe haven for grasses and forbs growing under its canopy from grazing domestic livestock (Welch 2002).

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Artemisia tripartita Rydb. threetip sagebrush
ASTERACEAE

Synonyms: *Artemisia trifida* Nutt.
Seriphidium tripartitum (Rydb.) W.A.Weber

E. Durant McArthur and Jeffrey R. Taylor

General Description.—Threetip sagebrush is a round, evergreen shrub up to 1.8 m tall. It may have a simple, trunk-like stem or several, lesser stems arising from the base. The bark on young branches is canescent but becomes shredded and grayish, light brown to dark brown or black, on older stems. This species can layer and resprout after fire or herbicide treatment (Beetle 1960, Pechanec and others 1965, Schlatterer 1973, Winward 1980). Leaves on vegetative branches are canescent, 0.5 to 4 cm long, and typically deeply divided into three linear or narrowly linear-lanceolate lobes, which in turn may be three-cleft. Upper leaves are often entire. Crushed foliage emits a pungent odor. Flowerheads contain three to 11 disc flowers typically arranged into panicles. Ray flowers are lacking. Eight to 12 canescent involucral bracts subtend each head. Achenes are resinous-granuliferous (Cronquist 1994, McArthur and others 1979).

Taxonomy.—The taxon includes two subspecies: *Artemisia tripartita* ssp. *tripartita* and *Artemisia tripartita* ssp. *rubicola* Beetle. This species, as is quite common for other species in the subgenus *Tridentatae*, includes populations that are diploid, 2n = 18 and tetraploid, 2n = 36 (McArthur and Sanderson 1999).

Subspecies *tripartita*, also known as tall threetip sagebrush, is a freely-branching shrub up to 1.8 m high. It can layer when conditions are conducive, but it is seldom found layering in the field. It can stump-sprout after fire (Beetle 1960). Leaves on vegetative branches are 1.5 to 4 cm long and deeply divided into three linear lobes, each less than 1 mm wide, that may be further divided (Beetle 1960). Flower heads bear four to eight disc flowers arranged into panicles that may be reduced to a spicate form.

Subspecies *rubicola*, also known as Wyoming threetip sagebrush, is a dwarf shrub usually less than 15 cm tall with decumbent branches. It layers frequently and may have a crown diameter of 30 to 50 cm (Beetle 1960). Leaves on vegetative branches are often 3 cm long and deeply divided into linear lobes, each at least 1 mm wide (Beetle 1959, 1960). Flower heads bear three to 11 disc flowers arranged in leafy, narrowly racemose panicles.

Range.—Threetip sagebrush covers approximately 34,000 km^2 in the Northern Rocky Mountains and Great Basin States. It usually grows at elevations between 910 to 2,700 m. It extends from British Columbia south through Montana and Wyoming to Colorado, and west to Washington, Oregon, northern Nevada, and northern Utah (Beetle 1960). Subspecies *rubicola*, however, is limited to areas of central and southeastern Wyoming and southern Oregon (Brunner 1972).

Ecology.—Threetip sagebrush grows well on moderate to deep, well-drained, loamy and sandy loam soils (Winward 1980). In some places, particularly in Idaho, this species grows between the lower, hot, dry sites dominated by Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *wyomingensis* Beetle & Young) and the higher, cooler sites dominated by mountain big sagebrush [*Artemisia tridentata* ssp. *vaseyana* (Rydb) Beetle] (Schlatterer 1973). It often grows intermixed, but as separate stands, with mountain big sagebrush, Wyoming big sagebrush, or alkali sagebrush [*Artemisia longiloba* ([Osterh.) Beetle] in areas with 300 to 600 mm of annual precipitation. Wyoming threetip sagebrush grows on rocky knolls at high elevations (2,100 to 2,700 m) adjacent to mountain big sagebrush sites.

Reproduction.—Flowers bloom between July and September and seed matures in October. Seeds are wind dispersed and seedlings emerge during the ensuing spring. Plants grow quickly and attain maturity in 3 to 5 years. The seeds are smaller than many *Artemisia* species; there are approximately 5 million cleaned seeds/kg (Meyer 2003).

Management.—This species is a vigorous seeder. Some forms are more palatable than others. Threetip sagebrush establishes well by direct seeding, rearing, or transplanting. Seedlings are able to persist with both a dense perennial and annual understory, although it is no more effective at excluding invasive annuals than other sagebrushes. It frequently grows with a number of other shrubs and herbs. It is compatible with many introduced and native grasses including mountain brome (*Bromus carinatus* H. & A.), slender wheatgrass [*Elymus trachycaulus* (Link) Gould ex Shinn], intermediate wheatgrass [*Elymus hispidus* (Opiz) Meld], and orchard grass (*Dactylis glomerata* L.).

Attempts to establish threetip sagebrush on arid sites dominated by Wyoming big sagebrush have been unsuccessful. Some ecotypes, however, can extend into drier sites. Threetip sagebrush generally recovers well after disturbance, but hot summer fires can kill large stands, inhibit resprouting, and significantly delay natural seedling recovery.

Benefits.—Three-tip sagebrush adds structural and biological diversity to the landscape and reduces the effects of wind and soil erosion. Although Beetle (1960) reported it was not palatable to livestock or game, Kufeld (1973) reported that elk used it, and Kufeld and others (1973) also reported that deer use it. A form near Salmon, Idaho, is palatable to deer and may have introgressed into a nearby population of Wyoming big sagebrush (McArthur and others 1979).

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***Arundinaria gigantea* (Walt.) Muhl.** giant cane
POACEAE

Synonyms: *Arundinaria macrosperma* Michx.
Arundinaria tecta (Walter) Muhl.
Arundinaria tecta var. *decidua* Beadle
Arundo gigantea Walter
Arundo tecta Walter

Kristina Connor

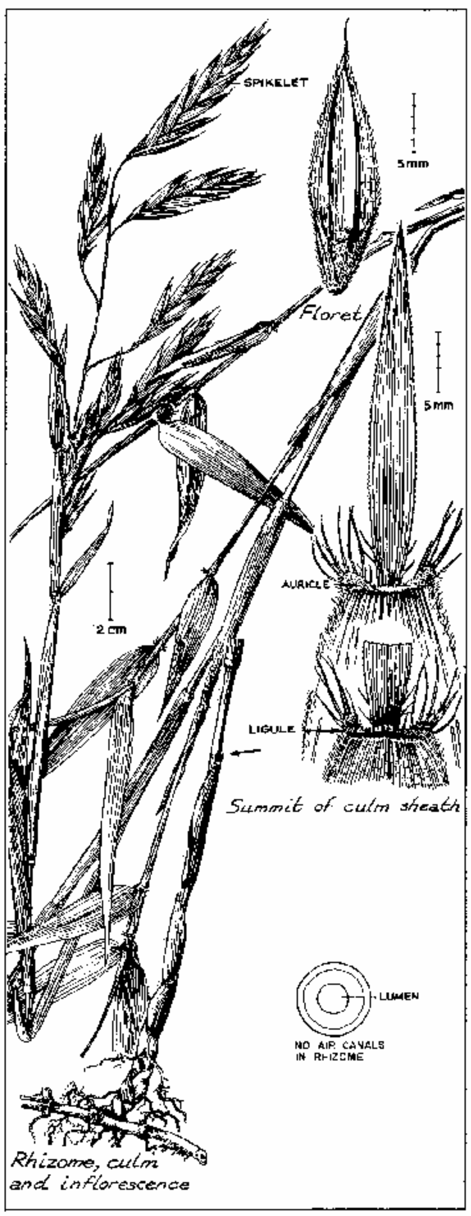

Illustration source: Grelen and Duvall 1966

General Description.—Giant cane, also known as cane or switchcane, is a perennial monocot, a woody grass, and one of only two native bamboos. With its stem-like rhizomes and hard, 'woody' stems, giant cane can grow to a height of 8 to 9 m but is typically less. Lower sheaths are about half as long as the culm internodes, while the upper six to 10 sheaths culminate in 10 to 12 bristles that are 5 to 9 mm long (Hitchcock 1971). Leaves range from 10 to 30 cm in length and from 2 to 3 cm wide. They have rounded base, are lance shaped, and have finely toothed margins (Bailey and Bailey 1976). Leaves are typically pubescent underneath and are either pubescent or glabrous above. Leaves on stems 2 years and older grow on side branches. Branches are short, less than 30 cm, also with loose papery sheaths.

Range.—Giant cane is found at elevations ranging from sea level in southern floodplains to 610 m elevation in the Appalachian Mountains. It can grow in dense thickets in the Mississippi Delta and in other southern swamplands. Its range extends from southern Maryland west into Ohio, Indiana, and Illinois, south to the Gulf Coast and west to Texas, Oklahoma, and Arkansas (Bailey and Bailey 1976, Brickell and Zuk 1996, Walkup 1991). A recognized variety is *A. gigantea* subsp. *tecta* (Walter) McClure.

Ecology.—Giant cane formerly occupied large areas (canebrakes) in floodplains of southern rivers; now these thickets are usually found only in the Mississippi Delta where they form in low-lying, shady moist areas. Elsewhere, giant cane is usually intermixed with shrubs. It is fire dependent and resprouts from rhizomes (Walkup 1991). It has a broad tolerance for weather and can withstand temperatures ranging from -23 to 41 °C. It grows in a variety of soil types (muck lands to mountain slopes and rich alluvial soils) and is rugged, cold-hardy and adaptable.

Reproduction.—Giant cane primarily spreads by rapid vegetative reproduction from large rhizomes. It flowers infrequently, and at irregular intervals, in early spring, forming simple panicles on the branches. The panicles consist of a few racemes of five to 15 large, stalked spikelets, which may be purple (Bailey and Bailey 1976, Brickell and Zuk 1996). The inflorescence may be a single axis or have branches. Seed production from these flowers is sparse and unpredictable.

Growth and Management.—Giant cane is a short-lived, evergreen monocot. Individual stems survive less than 10 years, but the species sprouts prolifically from its rhizomes. In the presence of fire and on the best-suited sites, it forms dense thickets called canebrakes. While it can withstand flooding, drought, and intense surface fires, giant cane is sensitive to overgrazing (Grelen and Duvall 1966, Hitchcock 1971). One source reports rapid growth (Brickell and Zuk 1996), especially after a fire. Fuel accumulates rapidly in a canebrake, and, to eliminate the hazard, a short burning cycle is advised (Hughes 1966, Walkup 1991).

Benefits.—The dense thickets of giant cane provide cover for nesting birds and small mammals. In addition, the young shoots are edible, sometimes used as a potherb (Hitchcock 1971), and of good nutritional quality. The leaves are a preferred food for southern pearly eye butterfly caterpillars (University of Florida 2001). The leaves extend well above the ground, plants can be completely defoliated by cattle and are also uprooted by swine (Hitchcock 1971, Walkup 1991). Thus, while grazing capacity of cane is high, careful management is required to prevent deterioration of the plants (Grelen and Duvall 1966).

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***Atriplex canescens* (Pursh) Nutt.** fourwing saltbush
CHENOPODIACEAE

Synonyms: *Calligonum canescens* Pursh

E. Durant McArthur, Stewart C. Sanderson, and Jeffrey R. Taylor

Illustration source: USDA—Forest Service collection, Hunt Institute

General Description.—Fourwing saltbush, also known as costilla de vaca and chamizo, is an upright shrub between 10 and 200 cm tall. Stature varies with site conditions and genotype. Branches arise freely from the base and are brittle and hard at maturity. Young branches and leaves are covered with inflated or collapsed bladder hairs that create a scurfy, grey-green appearance. Leaves are evergreen, linear to oblanceolate or spatutulate, usually 1 to 4 cm long and 0.1 to 1.0 cm wide. The species is usually dioecious, although some are monoecious or trioecious. Pistillate (female) flowers are small and inconspicuous. A pair of small bracts united along their edges encloses each pistil. Each of these bracts has two ridges down the face that expand into "wings," giving the utricle (fruit) four "wings" at maturity. Staminate (male) flowers are small, yellow to red to brown, and borne in glomerules 2 to 3 mm wide (Blauer and others 1976). Sexual expression varies between populations and with ploidy level. Diploids are usually monoecious, with a few exceptions. At higher ploidy levels (tetraploids and hexaploids), fourwing saltbush is trioecious (three sexual states). In the trioecious condition, some plants are consistently female and others are consistently male and some are able to switch during stressful conditions from the less physiologically taxing female state to the male state (McArthur 1977, McArthur and others 1992). Gender differences appear to be adaptive and allow for greater species radiation (Freeman and others 1993).

Taxonomy.—Fourwing saltbush is composed of a number of polyploid races with a base chromosome number of x = 9 (Sanderson and Stutz 1994, 2001). Many have been named as varieties. It appears that many of these are autopolyploids (Stutz 1978). The common form of fourwing saltbush in the Intermountain region (race *Occidentalis)* is tetraploid (Sanderson and Stutz 2001). Of the several distinct diploids the most widespread are race *Angustifolia* of the Chihuahuan Desert and race *Linearis* of the Sonoran Desert. Hexaploids are also generally southern in distribution (Nevada, New Mexico and Mexico) (Sanderson and Stutz 2001). Polyploids higher than 6x (up to 20x) are usually restricted endemics (Sanderson and Stutz 2001).

The North American perennial saltbushes form a group of related species. Fourwing saltbush apparently hybridizes, at least to some extent, with all of these species (Blauer and others 1976, Stutz 1978).

Range.—Fourwing saltbush is a widespread shrub throughout much of Western North America. It grows from the Great Plains to the Pacific Coast and from Canada to Mexico at elevations ranging from below sea level to 2,400 m. Fourwing saltbush has been planted in various parts of Eurasia and Australia but naturalization has not been documented.

Ecology.—Fourwing saltbush is adapted to desert climates. Mean annual precipitation within its distribution usually ranges between 150 and 400 mm. It grows on deep, usually halophytic, well-drained sandy soils, gravelly washes, mesas, ridges, and slopes. Soil salts enhance growth of fourwing saltbush by increasing days to wilting, organic matter production, water use efficiency, and ability to extract water by means of osmotic adjustments (Glenn and Brown 1998). It often grows intermixed with a wide variety of shrubs, grasses and forbs.

Reproduction.—Flowering generally occurs between May and September (Blauer and others 1976). This period can vary, however, with genotype and location. Flowers are wind pollinated, and seed matures in October. Most wildland stands of fourwing saltbush produce abundant seed 3 out of every 5 years.

Seed fill in high quality lots may only reach 50 percent, although rates of 40 percent or lower are generally considered substandard (Meyer 2003). Like many species of saltbush, *Atriplex canescens* exhibits high levels of dormancy controlled by multiple and complex mechanisms (Meyer 2003). Woody bracts inhibit germination mechanically and also contain water-soluble substances, salt and perhaps saponin, which inhibit germination (Clor and others 1989). Seed normally requires 20 to 30 days of stratification to assure uniform germination. There are about 120,000 cleaned, dewinged seeds (utricles)/kg (Blauer and others 1976).

Artificial seeding should take place during the fall or winter unless spring frosts threaten seedling survival. Fall and winter seeding promotes seed stratification and overall germinability. When sown, seeds should remain within the top 1.25 cm of soil. Broadcast seeding followed by chaining has produced excellent stands. Shrubs can also be established using drills alone or in separate rows among other species. Care should be taken to keep herbs from displacing fourwing saltbush seedlings. Seedlings grow vigorously and quickly produce a dense canopy although interspecific competition can reduce stand densities.

Shrubs can also be grown from nursery stock, container stock, or by stem cuttings (Shaw and Monsen 1984). Rooted stem cuttings have been used successfully to establish shrub seed orchards with desirable traits (McArthur and others 1978, 1992). Some populations reproduce asexually through root sprouting (Barrow 1997).

Management.—Fourwing saltbush is a valuable forage shrub because it is abundant, palatable, provides large quantities of forage, is nutritious, and grows rapidly (Cibils 1998, McArthur and others 1983, Peterson and others 1987). Leaves, stems, and fruits provide browse throughout the year. Winter protein content has been shown to vary between accessions (Welch and Monsen 1981). Relative saponin concentrations may affect palatability. In mixed species communities, herbage production of fourwing saltbush and forbs remains quite high. Fourwing saltbush is a facultative selenium absorber, making it mildly poisonous to browsing animals in selenium-rich soils (Davis 1972).

When propagating fourwing saltbush, it is important to select ecotypes that are adapted to the site. If possible, seed should be from a source with a similar climate unless the strain being planted is known to have a broad ecological range. Climatic and biological factors may affect plant persistence. Plants established from southern seed sources have not persisted in colder northern areas. However, seed collected from colder areas have done well at warmer sites (McArthur and others 1983, Plummer and others 1966).

Benefits.—Fourwing saltbush is a valuable plant that provides livestock and wildlife habitat and food. It has been widely and successfully used in revegetation and restoration projects including soil stabilization (Blauer and others 1976, Plummer and others 1966). Its ability to adapt and to hybridize with other woody *Atriplex* can facilitate *in situ* selection during revegetation (Stutz 1982).

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***Atriplex confertifolia* (Torr. & Frém.) S. Wats.** shadscale
CHENOPODIACEAE

Synonyms: *Obione confertifolia* Torr. & Fremont
Atriplex collina Woot. & Standl.

Stewart C. Sanderson, E. Durant McArthur, and Jeffrey R. Taylor

Illustration source: USDA—Forest Service collection, Hunt Institute

General Description.—Shadscale is a compact spinescent shrub that is typically 15 to 120 cm tall and 30 to 170 cm wide. Branches are scruffy when young but become rigid, brittle, and spiny with age. Leaves are nearly circular to elliptic, oval, or oblong, 9 to 25 mm long and 4 to 20 mm wide (Blauer and others 1976). Flowers are imperfect. Staminate (male) flowers are arranged in glomerate inflorescences borne in leaf axils. Pistilate (female) flowers are enclosed by foliose bracts, 5 to 12 mm long, broadly ovate to almost round, united at the base, and have entire, free, somewhat spreading margins. Staminate flowers are small and inconspicuous. Populations may have biased sex ratios and can include monocieous as well as dioecious individuals (Freeman and McArthur 1984).

Taxonomy.—Shadscale includes several chromosome races ranging from diploid (2n = 2x = 18) to decaploid (2n = 10x = 90). Plant similarities and the paucity of close relatives suggest that these races are largely autoploid (Stutz and Sanderson 1983). Of all the races, tetraploids are most common (Sanderson and others 1990). Generally, polyploid populations occur in uniform stands at lower elevations and on valley floors while diploid forms occur on uplands in more diverse communities and are usually larger in stature (Sanderson and others 1990, Stutz and Sanderson 1983).

Range.—Shadscale is present throughout much of Western North America, from Montana in the north to Texas and Chihuahua in the south, and from North Dakota in the east to California and Oregon in the west (Stutz and Sanderson 1983). It usually grows at elevations from 460 to 2,100 m. Among the woody chenopods, it ranks next to fourwing saltbush [*Atriplex canescens* (Pursh) Nutt.] and winterfat [*Ceratoides lantata* (Pursh) J. T. Howell] in frequency and distribution.

Ecology.—Shadscale usually grows on fine-textured alkaline soils, although it can be found on coarser, sandier soils (Blaisdell and Holmgren 1984, McArthur and others 1978). It can occur in nearly pure stands, but also grows intermixed with many other shrubs, especially of the chenopod and sunflower families, and with junipers (*Juniperus* L.) and grasses. It tolerates alkali soils better than most of these associates (McArthur and others 1978). Relationships between microhabitat, synecology, and physiology have explained differences in distribution patterns within intermixed stands of shadscale and winterfat (Caldwell and others 1977, West and Gasto 1978). Shadscale grows slowly, has a relatively short life span and can be killed by drought or high water (Blaisdell and Holmgren 1984, McArthur and others 1978). High water can kill plants directly, lead to anaerobiosis, induce abiotic disease, or predispose plants to biotic pathogens, all of which may have contributed to die-offs over the past decades (Wallace and Nelson 1990). Shadscale typically grows in arid climates where mean annual precipitation can range between 180 and 360 mm.

Reproduction.—Shadscale usually blooms during April and May. In isolated locations populations may bloom as early as January and as late as June. Utricles mature, in general about mid-October. Shadscale seeds are largely dormant after maturation but respond to cold treatment (chilling) through dry after-ripening (Meyer and others 1998). Chilling and leaching soluble inhibitors from seeds has been shown to increase germination (Garvin and others 1996). Interestingly, seeds from warm desert populations responded to chilling more and after-ripened quicker than those from cold deserts (Meyer and others 1998). Ecotypic germination variation is common in shadscale.

Shadscale spreads naturally through seed but is difficult to establish by artificial seeding (McArthur and others 1978, Monsen and Richardson 1984). Low seed fill often compounds seed dormancy and germination problems. Fall seeding is recommended because it reduces the effects of dormancy, and utricles are more likely to break down before spring. Seeds should remain between 6 and 13 mm of the soil surface to improve the likelihood of germination and establishment. Soil type and seedbed preparations should be considered prior to seeding. Seed should be planted at rates of 2.2 to 4.5 kg of pure live seed/ha and in separate rows from other seeded species. Seedlings grow slowly and compete poorly with herbs and aggressive grasses, particularly within the first 2 years. Diploid races from pinyon-juniper woodlands and big sagebrush communities establish more readily in biologically diverse communities than other races.

Shadscale has also been successfully transplanted when moisture conditions are right during spring or fall (Luke and Monsen 1984). Transplants can be from container or bare-root stock. Survival is usually poor unless care is taken during handling and planting. Young shrubs are particularly susceptible to overwatering. Transplanting is most successful if plants are dormant at the time of planting.

Management.—Despite its spiny nature, shadscale is grazed by livestock and game. Forage value is directly related to leaf persistence, which is a characteristic that varies by habitat. Many species prefer the nutritious seeds (USDA 1937). Livestock and wildlife tend to seek seed and leaf accumulations under parent shrubs after leaves and fruits have fallen in autumn. Grazing pressure can reduce more palatable shrub species, such as budsage and blacksage, resulting in increased shadscale populations (Blaisdell and Holmgren 1984). Shadscale may be more effective in restoring and stabilizing salty areas than fourwing saltbush or other saltbushes because it is more salt tolerant (McArthur and others 1978). In large stands, shadscale should be managed rather than mechanically controlled. Managing for shadscale is easier than reducing shrub densities and seeding in new species because limited soil moisture and precipitation make it difficult to manipulate these plant communities (Bleak and others 1965). Aggressive annuals, such as cheatgrass, usually invade such areas if they are disturbed.

Benefits.—Shadscale is a genetically and morphologically diverse native shrub that occupies a considerable range throughout the West. It provides soil cover, habitat for birds, and forage for domestic livestock and wildlife. Some small passerine birds, such as horned lark (*Eremophila alpestris*), Brewer's sparrow (*Spizella breweri*), and sage thrashers (*Oreoscoptes montanus*) nest in shadscale stands (Medin 1990). Healthy stands also reduce the proliferation of exotic, undesirable annuals. In addition, seeds were historically ground into flour by Native-Americans for bread (Stubbendieck and others 1997).

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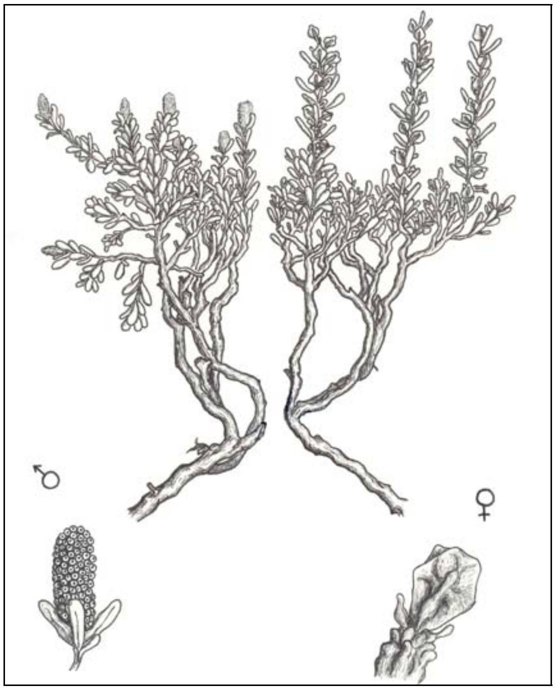
***Atriplex corrugata* S. Wats.** mat saltbush
CHENOPODIACEAE

Synonyms: *Atriplex nuttallii* var. *corrugata* A. Nelson
Obione corrugata Ulbr.

E. Durant McArthur, Stewart C. Sanderson, and Jeffrey R. Taylor



General Description.—Mat saltbush, also known as matscale, is a low shrub that forms dense, prostrate (15 cm tall) and nearly white mats five to 20 times wider than they are tall. Prostrate branches often form adventitious roots when in contact with the soil. The bark is soft, spongy, and white. Leaves are sessile, evergreen, oblong, linear-oblancelate, or spatulate, rounded at the apex, opposite on the lower portions of stems, and alternate above. Leaf blades are densely scurfy and 7 to 18 mm wide (Blauer and others 1976, McArthur and others 1978, Welsh and others 1993). Individual shrubs are commonly dioecious but may be monoecious. Staminate (male) flowers are yellow to light-brown, 3 to 6 mm wide, and borne in glomerulate spikes. Pistilate (female) flowers are enclosed by sessile or subsessile fruiting bracts. Fruiting bracts are 3 to 5 mm long, 4 to 6 mm wide, and united along two-thirds of their length and densely tuberculate on the lower one-third (Blauer and others 1976, McArthur and others 1978, Welsh and others 1993).

Taxonomy.—This species will hybridize with other saltbushes (Blauer and others 1976, Stutz 1978, 1984). Mat saltbush forms intermediates with *Atriplex confertifolia* Torr. & Fremont and *Atriplex cuneata* A. Nelson (Welsh and others 1993). Plants can be either diploid (2n = 18) or tetraploid (2n = 36) (Sanderson and Stutz, unpublished data).

Range.—Mat saltbush is an endemic of the Colorado Plateau and Uintah Basin, found mainly on Mancos shale formations in eastern Utah, western Colorado, and northwestern New Mexico between 1,200 and 2,100 m (Hall and Clements 1923; Hanson 1962).

Ecology.—Mat saltbrush grows on fine textured, often saline, soils. It tolerates up to 13,000 ppm soluble salts and is often the only perennial plant present in such high-saline environments (Hanson 1962). Although it is probably the most halophytic member of the genus, in less saline habitats, patches of mat saltbush may alternate with patches of winterfat [*Ceratoides lanata* (Pursh) J.T.Howell], cuneate saltbush (*Atriplex cuneata* A. Nelson), shadscale (*Atriplex confertifolia* Torr. & Fremont), black greasewood (*Sarcobatus vermiculatus* Torr.), budsage (*Artemisia spinescens* Eaton), and greenmolly summercypress (*Kochia americana* S. Wats.). It grows in areas with 150 to 280 mm of annual precipitation.

Reproduction.—Blooming occurs between March and May and fruits (utricles) ripen 6 to 10 weeks later. Seed production is usually modest, although some seed is usually produced even during drought.

Because germination is near zero without cold treatment, fall is normally the recommended season for artificial seeding. Where possible, midwinter planting is also successful. Preparatory measures are usually unnecessary if the site previously supported mat saltbush and is not infested with weeds. Recommended seeding rates range between 2.2 and 4.5 kg of pure live seed/ha. Seed should be sown in separate rows and covered with a drag or harrow. Seeds should be planted near the soil surface and no more than 1.3 cm deep. Seedlings emerge rapidly and grow vigorously during the first year. Growth continues until soil moisture becomes limiting (usually by mid-summer). There are about 220,000 cleaned seed per kg (Blauer and others 1976).

Transplants from bare root stock, wildings, or containers have all established successfully. Wildings and bare root stock tolerate considerable distress. Transplants survive surprisingly well, even when planted on seemingly infertile soils. Young plants have been successfully transplanted into former black greasewood communities in the Great Basin (Blauer and others 1976).

Management.—Mat saltbush is valuable winter forage for wildlife and domestic livestock. It often grows interspersed among other plant communities on shale outcrops at medium elevations. Shrubs often grow on windblown slopes and provide important, accessible winter forage. Big game have been known to congregate on these areas during periods of deep snow accumulation. Shrubs tolerate grazing and trampling and maintain vigor even after serious abuse.

Mat saltbush has been seeded with selected grasses including Russian wildrye (*Elymus junceus* Fisch.), tall wheatgrass [*Agropyron elongatum* (Host) P.Beauv.], and crested wheatgrass [*Agropyron cristatum* (L.) Gaertn.]. Although these species may increase forage production, they do not usually persist in dense stands. Grasses and forbs will suppress shrub establishment, but grasses interseeded into established shrub stands do not reduce shrub density or vigor.

This species is useful in revegetation and restoration projects and can help reclaim disturbed areas with heavy textured soils such as road construction sites or mine disturbances.

Benefits.—Mat saltbush is a native shrub that occupies a specialized niche in Western ecosystems. Its ability to grow on fine textured, often saline soils helps reduce soil erosion on sites that are inhospitable to many shrubs. It also provides important forage for wildlife during winter when other sources of forage may be inaccessible.

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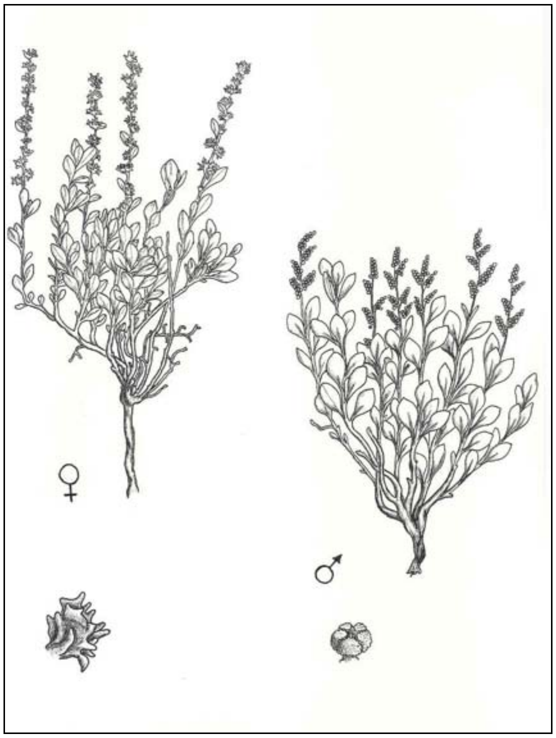
***Atriplex cuneata* A. Nels.** Castle Valley clover saltbush

CHENOPODIACEAE

Synonyms: *Atriplex gardneri* var. *cuneata* (A. Nels.) S.L.Welsh
Atriplex acanthocarpa var. *cuneata* Jones
Atriplex nuttalli subsp. *cuneata* H.M. Hall & Clem.

E. Durant McArthur, Stewart C. Sanderson, and Jeffrey R. Taylor



General Description.—Castle Valley clover saltbush, also known as Castle Valley saltbush and cuneate saltbush, is a low shrub 10 to 45 cm tall with a more or less prostrate, woody, much-branched base with erect branches. Leaves are evergreen, light-grey green, spatulate to broadly elliptic, 2 to 6 cm long and 0.5 to 2.5 cm wide (Hall and Clements 1923). Staminate (male) flowers are dark, almost black, and are borne in glomerules arranged in panicles. Pistilate (female) flowers are borne in axillary clusters and consist of pistils enclosed by wingless bracts. At maturity, bracts are 5 to 9 mm wide, irregularly toothed along their margins, and have numerous, crest-like tubercles on their side. Sex expression in Castle Valley clover saltbush is trioecious (Freeman and McArthur 1984). In this system, some individuals are consistently male, some are consistently female, and others can switch between the less energistically expensive male state, and the more taxing female state, depending on climatic conditions.

Taxonomy.—Castle Valley clover saltbush is one of several related saltbush species. It hybridizes with a number of other saltbushes, particularly with fourwing saltbush (*Atriplex canescens* (Pursh) Nutt.). *Atriplex cuneata* is tetraploid (2n = 36). Some taxonomists consider it to be a variety or subspecies of other woody saltbush species. Its exact taxonomic distinction remains somewhat unclear. Hanson (1962) described one subspecies for *Atriplex cuneata*, ssp. *introgressa,* found to be diploid (2n = 18) (Sanderson and Stutz, unpublished data). It is now considered to be a variant of *A. welshii* Hanson, also diploid. *Atriplex cuneata* hybridizes with other perennial *Atriplex*, especially with *A. confertifolia* Torr. & Freemont, a hybrid that has been named as *A.* X *neomexicana*. Populations of this hybrid and its derivatives may expand enormously during favorable years but are eradicated during drought (Sanderson and Stutz, unpublished data).

Range.—The distribution of Castle Valley clover saltbush includes portions of eastern Utah, southwestern Colorado, and northern New Mexico. It usually grows at elevations between 1,220 and 2,170 m (Welsh and others 1993).

Ecology.—This species often grows on fine textured soils, typically clay or soils derived from shale, that are moderately to highly alkaline. It grows on variably saline soils and may be associated with many other shrubby chenopod species and several of the sagebrush (*Artemisia* L.) species. It is often the dominant or codominant shrub with shadscale (*Atriplex confertifolia* Torr. & Frem.) or mat saltbush (*Atriplex corrugata* S. Wats.). It grows in areas with 160 to 310 mm of precipitation.

Reproduction.—Castle Valley clover saltbush blooms in April and May, or sometimes later depending upon rainfall. Fruits (utricles) ripen about 7 weeks after blooming (Hanson 1962). Annual seed production is often erratic and only about 50 percent of utricles contain viable seed. Germination rates are also erratic and vary among ecotypes. Fruits are small and generally number about 180,000/kg (Blauer and others 1976).

This species should not be seeded in areas beyond its natural distribution. It is poorly adapted to big sagebrush (*Artemisia tridentata* Nutt.) and other upland habitats but can be seeded into most salt desert shrublands. Young plants grow vigorously and are competitive but can be suppressed by perennial grasses and annual weeds. It should not be seeded directly with herbaceous species but competes well when seeded with fourwing saltbush [*Atriplex canescens* (Pursh) Nutt.], green ephedra (*Ephedra viridis* Coville), and spiny hopsage [*Grayia spinosa* (Hook.) Moq.].

Management.—Castle Valley clover saltbush is preferred by livestock throughout the year. It remains green and succulent, even through winter. It is an important source of protein in winter months for both livestock and game when most other forages are dry (McArthur and others 1978). A stabilized hybrid between fourwing saltbush and Castle Valley clover saltbush has great potential to improve the forage quality on winter ranges. Such a hybrid would be taller than Castle Valley clover saltbush and retain more green foliage than fourwing saltbush.

This species shows particular promise in winter game range restoration and on disturbed alkaline soils. Like other woody saltbushes, it grows on freshly disturbed soils, such as exposed substrata created by mining or road construction activities (Blauer and others 1976, McArthur and others 1978).

Benefits.—Castle valley clover saltbush is a native shrub that is adapted to fine textured soils that are inhospitable to many other shrubs. It adds biological and structural diversity to the plant communities on these otherwise difficult sites. It helps stabilize the soil, can be useful in wildland restoration projects, and provides valuable and nutritious forage for wildlife and livestock on Western shrublands.

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***Baccharis pilularis* DC.** coyote brush
ASTERACEAE

Synonyms: None

Christopher Ross

General Description—Coyote brush, also known as chaparral broom, is a shrub to 3 m tall, with glabrous, sticky, oblanceolate to obovate leaves 8 to 55 mm long, with toothed or entire margins. It may either be spreading or ascending in form (Sundberg 1993).

Range.—Coyote brush occurs from Oregon to northern Mexico. In California it ranges from the northwestern coast south, including the peninsular and transverse ranges and the Channel Islands, and eastward to the Sierra Nevada foothills (Sundberg 1993).

Ecology.—Coyote brush is found on coastal bluffs and oak woodlands from sea level to 1500 m. It sometimes occurs on serpentine soils (Sundberg 1993). Coyote brush may invade stabilized dunes in northern California, especially after yellow bush lupine has established (Pickart and Sawyer 1998). It has been very invasive in grassland areas near Oakland, California, apparently as a result of decreased grazing and fire, and appears to favor areas of bare soil (McBride and Heady 1968). It may be a seral stage leading to oak and bay woodlands in the San Francisco Bay area (McBride 1974). The annual grass *Bromus mollis* L. has been found to interfere competitively with *Baccharis* seedlings, especially in dry conditions (Da Silva and Bartolome 1984). In coastal regions of central California, a cecidomyiid midge, *Rhopalomyia californica* Felt forms terminal galls on coyote brush, and the midges are in turn preyed upon by various parasites (Latto and Briggs 1995).

Reproduction.—Flowers are headed in leafy panicles, with staminate heads 3.2 to 5 mm long, and pistallate heads 3.5 to 5 mm long. Phyllaries (involucre bracts) are in five to six series, linear-lanceolate, hairy, and glandular, with convex receptacle. Staminate flowers are 19 to 26, with 4 to 7 mm corollas and 3.5 to 4.5 mm pappus. Pistillate flowers number 19 to 43, with 2.5 to 3.5 mm corollas. Seeds are glabrous, 1 to 2 mm long with 8 to 10 ribs and a 5.5 to 9 mm pappus (Sundberg 1993). Seed dispersal begins in November, with germination in winter and early spring (McBride and Heady 1968). Coyote brush is sometimes propagated horticulturally from tip cuttings.

Fire Effects.—Coyote brush has been observed to burn readily in coastal California, despite the fact that it is sometimes marketed as a fire-resistant species. Coyote brush seedlings and young plants are susceptible to fire damage, but older plants quickly resprout from their base after fire (McBride and Heady 1968).

Growth and Management.—Coyote brush seedlings are adversely affected by grazing and trampling by livestock, although grazing animals may also foster its spread by decreasing grass cover (McBride and Heady 1968). However, Williams and others (1987) found no proximal link between decreased grazing and fire and coyote brush invasion. Mowing of specimens used as ground cover is effective in controlling height without long-term detrimental effects (Hodel and Pittenger 1994). Coyote brush may be removed by burning and then pulling out the roots.

Benefits.—Although several cultivated varieties are often sold as a landscaping shrub or ground cover, some growers caution that it is neither an especially attractive plant, nor as fire-proof as sometimes stated. It is of low value as livestock forage (McBride and Heady 1968). Coyote brush was used by Native Americans as a tea for use on poison oak rash (Timbrook 1987). It is considered problematic in recreation areas due to its impenetrability and frequent association with poison oak (*Rhus diversiloba* T. & G.) (McBride and Heady 1968).

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***Barleria prionitis* L.** porcupine flower
ACANTHACEAE

Synonyms: none

John K. Francis

General Description.—Porcupine flower, also called espinosa amarilla, and picanier jaune, is a flowering, spiny invader that reaches 1.5 m in height and 2.5 cm in basal diameter. It has a tap and lateral root system. Plants commonly have a single stem but may have multiple stems or branches from near the ground. The stems and branches are stiff, round, and light tan or light gray. The shrub is armed with 5- to 20-mm long spines in the leaf axils. Leaves are elliptic to oblong, 3 to 10 cm long and 1.5 to 4 cm broad. The yellow, tubular flowers, 3 to 4 cm long and broad, are sessile in the leaf axils or in terminal branched spikes. The two-celled capsule is ovate-lanceolate and 1.3 to 2 cm long, with a sharp-pointed beak about 6 mm long. The seeds are 8 by 5 mm, flattened and covered with matted hairs (Howard 1989, Liogier 1997).

Range.—Porcupine flower is a native of Tropical East Africa and Asia (Burkill 1985). It is widely cultivated as an ornamental and has escaped in many tropical countries including Hawaii (Neal 1965) and Puerto Rico (Liogier 1997).

Ecology.—Porcupine flower grows in a wide variety of well-drained soils derived from igneous, metamorphic (including ultramafics) and sedimentary (including limestone) rocks. In the Puerto Rican naturalized range, it grows in areas receiving from about 750 to 900 mm of mean annual precipitation (author's observation). Within the native range, it probably tolerates both higher and lower precipitation, but no data are available. Porcupine flower is found throughout the hotter parts of India and defoliates annually during the dry season (Parrotta 2001). The species is moderately intolerant of shade, growing in both full sunlight and under light forest canopies. Porcupine flower may grow as single plants or in large, tangled thickets. Dense stands eliminate most other ground vegetation. However, the species does not compete well in dense stands of tall grass. It is most often found on roadsides, bluffs and bars above streams, overgrazed range, disturbed areas, and farmsteads.

Reproduction.—In the deciduous tropical forest zone of central India, these shrubs flower from September to December and fruit from January to April (Parrotta 2001). The flowering and fruiting seasons are about the same in Puerto Rico. Sixty fruits collected in Puerto Rico averaged 0.0998 $\pm$ 0.0044 g/fruit. Air-dried seeds separated from the same collection averaged 0.0305 $\pm$ 0.0005 g/seed or 33,000 seeds/kg. Forty-four percent of the seeds sown on commercial potting mix germinated between 13 and 77 days following sowing. Natural regeneration generally occurs within 1 or 2 m of the parent plant in Puerto Rico, perhaps because animal vectors for seed dispersal are lacking. Seedlings can be abundant near fruiting plants.

Growth and Management.—Seedlings of porcupine flower grow slowly at first. However, established plants add up to 0.5 m per year to their height and nursery seedlings reach 0.6 m in 6 months. In Puerto Rico, these shrubs live about 4 years. Because it is spiny and generally ignored by cattle, the species is considered a weed in much of its range. Mowing, followed by spraying of the sprouts with broadleaf herbicide, is a general control measure for low shrubs and would probably be effective against porcupine flower.

Benefits.—Porcupine flower furnishes cover for wildlife and protects the soil against erosion. It is widely planted as an ornamental and cultivated in Asia as a hedge plant (Burkill 1985). Whole-plant extracts of porcupine flower contain iridoid glycosides, barlerin, and verbascoside, which have shown potent activity against respiratory syncytial virus *in vitro* and may account for the plant's use in treating fever and several respiratory diseases in herbal medicine (Balick and others 1998). Extracts of the plant have also been shown to effectively suppress the fungi *Trichophyton mentagrophytes in vitro* (Panwar and others 1979). A mouthwash made from root tissue is used to relieve toothache and treat bleeding gums (Burkill 1985). The whole plant, leaves, and roots are used for a variety of purposes in traditional Indian medicine. For example, the leaves are used to promote healing of wounds and to relieve joint pains and toothache (Parrotta 2001). Because of its antiseptic properties, extracts of the plant are incorporated into herbal cosmetics and hair products to promote skin and scalp health (Prakruti 2002, Probiotics New Zealand 2002, Vaipani 2002).

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***Batis maritima* L.** saltwort
BATACEAE

Synonyms: none

John K. Francis

General Description.—Saltwort, also known as turtleweed, pickleweed, barilla, planta de sal, camphire, herbe-à-crâbes, and akulikuli-kai, is a low, yellow-green shrub with succulent leaves. It is prostrate or upright and occasionally reaches 1 m in height, 2 m in lateral extent, and 5 cm in basal diameter. Stems are usually multiple as sprouts from the root crown, and as they become tall and heavy, lie down and root along the stems forming loose mats. Weak roots with light-tan, corky bark form tap and lateral root systems. The bark is grayish white; stem wood is weak and brittle. The glabrous leaves are succulent, linear or narrowly oblanceolate and round or three- to four-angled in cross section. Tiny, white male and female flowers occur on different plants. Fruits are axillary drupaceous, yellow-green syncarps 1 to 2 cm long (Liogier 1985, Stevens and others 2001, Wiggins and Porter 1971).

Range.—Saltwort is native to coastal areas of southern United States including California, Mexico, Central America, South America to Brazil and Peru, the West Indies, and the Galapagos Islands (Howard 1988, Wiggins and Porter 1971). It has been planted in a number of areas in the tropics and has naturalized in at least Hawaii (Neal 1965).

Ecology.—Saltwort is uncommon to abundant in low-laying areas near seashores. It grows in salt marshes, at the upper edge of tidal flats, at the edge of mangrove stands, and between scattered mangroves. It is recognized as a major colonizer after mangroves are destroyed by hurricanes. Although it is not a water plant, it can endure brief flooding and long periods of waterlogged soils (Nelson 1996). Saltwort grows slowly in soils with high salt concentrations and areas with seawater overwash where it suffers little competition from other plants. The species manages salts by sequestering them in cell vacuoles and eventually shedding the leaves (Barbuda Turf Company 2002). It also grows in soils without salt but is vulnerable to competition from nonhalophytes. The soils are usually sandy, marly, or gravely. Deposits of wrack (dead plant material) by high tides have been shown to be beneficial to the species (Pennings and Richards 1998). Saltwort is intolerant of shade. The species is not seriously affected by insects, disease, or grazing.

Reproduction.—In Florida, saltwort flowers in the spring and fruits in the summer (Long and Lakela 1976). Flowering and fruiting occurs year-round in Puerto Rico. Little is known about seed production or germination. Most effective reproduction of the species appears to be vegetative. Sprouting from the root crown occurs with and without disturbance. Layering is a constant process of prostrate stems. New plants can be started by cuttings and probably broken pieces of plants are carried to new habitat by water and machinery. It is speculated that whole plants washed to sea during torrential rains in South

America were carried by currents to establish the species in the Galapagos Islands (Trillmich 2002).

Growth and Management.—Saltwart plants established in experiments from cuttings and irrigated with fresh and brackish water grew 65 cm and reached plant dry weights of 120 g in 13 weeks. Plants receiving saltier water grew much less but still added height and weight with water almost twice as salty as sea water. Tissue ash concentrations did not differ significantly between treatments (Miyamoto and others 1996). Wild plants in stands in Puerto Rico appear to extend their stems about 1 m/year. Leaf succulence increases as much as 1.5 times during the dry season to maintain a near static solute (chiefly Na^+, Cl^-, and $S0_4^{--}$) concentration (Lüttge and others 1989). Probably all planting for landscaping and environmental restoration is by rooted cuttings or uprooted wild plants. Except in Hawaii, where it is being suppressed as an exotic plant (Big Island Invasive Species Committee 2002), there is little reason to control stands of saltwort. It grows in disturbed areas where few other plants can survive.

Benefits.—The principal benefit of saltwort is that it grows in, covers, and protects salty low-laying areas where few other species will grow. It is used as an ornamental and ground cover on similar sites. Salt tolerance of the species allows it to be irrigated with brackish and sea water, as well as fresh water (Miyamoto and others 1996). Ashes of the plant were once used in the manufacture of glass and soap. The leaves are sometimes eaten as a salad (Neal 1965). However, it is toxic in large quantities (Austin 1998). Saltwort serves as the larval and adult hosts for the great Southern white and Eastern pigmy blue butterflies (Florida Cooperative Extension Service 2002) and is an important food source for the Galapagos marine iguana (*Amblyrhynchus cristatus*) (Wrege 2002). The species has applications in herbal medicine to treat eczema, psoriasis, and other skin conditions, rheumatism, gout, blood and vein disorders (Liogier 1990).

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Bidens menziesii **(Gray) Sherff** ko'oko'olau
ASTERACEAE

Synonymns: *Coreopsis menziesii* A. Gray
Bidens menziesii subsp. *filiformis* (Sherff) Ganders & Nagata
Bidens m. var. *filiformis* Sherff
Bidens lepida Degener & Sherff

Sarah A. Taylor and Randy S. Senock

General Description.—*Bidens menziesii*, known as ko'oko'olau, is a sparingly branched shrub with erect stems reaching 1 to 4 m in height. Leaves are 4 to 26 cm long, including petiole, bipinnately divided into long linear divisions and may be glaborous or pubescent. Margins are entire. Densely branched compound cymes terminate the main stem and lateral branches. Flowers measure 5 to 7 cm in diameter. Ray florets are 4 to 5 per head, disk florets 6 to 8 per head. Corollas are yellow. Fruits are indehiscent, dry, grayish black, straight, wingless or very rarely winged, barbless and 9 to 12 mm long (Wagner 1990).

Range.—Ko'oko'olau can be found on Molokai and West Maui scattered on arid, leeward slopes and cliffs in shrubland vegetation, generally between the elevations of 200 to 750 m. On leeward sides of Mauna Loa and Mauna Kea of Hawaii, this species is common on slopes of cinder cones in montane a'ali'i shrublands, and in subalpine forest, from elevations of 750 to 2,200 m. The species is one of 19 *Bidens* unique to the Hawaiian islands (Wagner 1990).

Ecology.—Ko'oko'olau is an important dryland shrub and forest plant of ecosystems seriously under threat by agriculture and development. On the island of Hawaii, the species is a minor component of the Ohi'a forest. In montane dry shrublands of leeward Mauna Kea and Mauna Loa, ko'oko'olau becomes structurally codominant with a'alii. Due to its tall growth habitat, it appears dominant over other species when it is in flower. Ko'oko'olau appears intollerant of wildfire and is conspicuously absent from burned areas on leeward Hawaii. Ko'oko'olau does not resprout following fire (Sherry and others. 1999). The plant is worth preserving because, like the honeycreepers, *Loxops spp*. and *Hemignathus spp*., ko'oko'olau serves as an example of the adaptive radiation that occurred in Hawaii, with all 19 species of *Bidens* having a single ancestor.

Reproduction.—Seed production is fairly prolific as the inflorescence is a large terminal panicle composed of 8 to 100 disc florets. Fruits are achenes. Chromosome number has been identified as 2n = 72 (Wagner 1990). Interestingly, the species hybridizes readily and for this reason individuals unique to a particular local should not be introduced to a different zone, in order to protect the integrity of endemic species.

Growth and Management.—Reasonably fast growing, ko'oko'olau may not be long-lived. Ko'oko'olau can be grown easily from seeds or from terminal cuttings using a root hormone. It prefers light to moderate watering and full sun (Krauss 1998).

Benefits.—Ko'oko'olau was widely used by Hawaiians prior to European arrival and is still sold as tea, although the introduced pantropical *B. pilosa* is usually the species incorrectly labeled and sold as the traditional Hawaiian tea.

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Bixa orellana L. annatto

BIXACEAE

Synonym: _Bixa katagensis_ Delpierre

John K. Francis

General Description.—Annatto, which grows as a shrub or a small tree, is known by many other common names including lipstick plant, roucou, achiote, bija, urucú, and shambu (Little and others 1974). Its single or multiple stems are light brown. The bark is more or less smooth with many warty lenticels, but may become fissured in old individuals. If given ample space, annatto generally branches several times near the ground and develops a dense, spreading crown. The plant roots firmly with a thick taproot and finer laterals. The alternate leaves have long petioles, thin ovate blades with long-pointed tips. Panicles at the branch tips have few to many pink or white flowers. The fruits are spiny capsules that dry and split open in two parts to expose red seeds on their inner surfaces (Howard 1989, Liogier 1995).

Range.—Although annatto is native to continental tropical America, it is unclear where the original native stands of the species were located because the shrub has been cultivated since ancient times. It now grows in cultivation and naturalized from Mexico to Argentina and throughout the Caribbean Islands. The plant is also widely cultivated and naturalized in tropical and subtropical regions throughout the rest of the world.

Ecology.—Annatto is shade-intolerant and must have disturbance or a broken forest canopy to become established. All the naturally growing annatto shrubs in Puerto Rico are found on neglected or abandoned farmland, some of which has grown up to early secondary forest. Rainfall ranges from 1000 mm to 3000 mm per year in areas where the species grows naturally or under cultivation. Soils with textures from sands to clays are colonized. The species tolerates relatively low base saturation and moderate compaction. Anatto is vulnerable to overtopping and smothering by trees, shrubs, vines, and grass. Plants that have become overtopped and shaded cease to flower and bear fruit. The species is frost sensitive (von Carlowitz 1991).

Reproduction.—Annatto plants flower and fruit heavily and almost continuously in favorable habitat. Cuttings taken from flowering plants will produce flowers and fruits and a smaller shrub than plants of seed origin (Bailey 1941). Belfort and others (1992) report that seeds dried to moisture contents of 10 to 15 percent germinated at from 8 to 58 percent compared to fresh seeds (65 percent moisture) that gave 96 percent germination. Scarification was reported to improve germination of fresh seeds in another study. Mechanical scarification proved superior to acid or hot water treatments (Amaral and others 1995). Air-dry fruits collected in Puerto Rico weighed an average of 1.701 $\pm$ 0.078 g. Seeds from that collection averaged 0.029 $\pm$ 0.008 g/seed or 35,000 seeds/kg. Of these seeds that received no pregermination treatment, 60 percent germinated between 11 and 110 days after sowing. The resulting plants were ready to prick out (10 cm in height) about 3 months after germination. Success in air layering of shoots ranged from 93 to 100 percent except when sawdust was used as substrate (7 percent) (Barbosa e Silva and others 1993). Stem cuttings rooted (up to 60 percent) when treated with IAA or IBA. Untreated cuttings did not root (Thirunavoukkarasu and Saxena 1997). Annatto can be grafted by several techniques. The best method is budding (70 percent success in tests) (Bruckner and others 1991).

Growth and Management.—Annatto shrubs will bear fruit when 2 years old in Hawaii (Neal 1965).

Under good management, plants will fruit within 1 year of planting (Nepstad and others 1991). An Indian plantation yielded 529 kg/ha of seed at 2 years old and 2,483 kg/ha of seed at 3 years old (Kanjilal and Singh 1995). Annatto seldom reaches more than 5 m in height and 10 cm in stem diameter (Little and others 1974). Pruning of ornamentals is recommended to shape and thicken the crowns (Warren 1997).

Benefits.—Annatto, obtained from the oily arils of the seeds is the world's second most important (after caramel) natural colorant (Mercadante and Pfander 1998), yielding yellow to red colors. The colors are produced by several apocarotenoides and may reach up to 7 percent of the seed's dry mass (Katzer 1999). World production of annatto seed, both for commercial and home use, was estimated in 1990 at 10,000 tons per year (Arkcoll 1990). Brazil is the world's largest exporter (Katzer 1999). Not only was the dye used anciently to color food, but also to dye cloth and paint the skin (which is still done today). The species is also planted as an ornamental, particularly the varieties with bright pink pods. Branches with the dry pods are used in dry floral arrangements (Warren 1997). Bees collect nectar from its flowers to make honey. The wood is light-weight (specific gravity 0.4), weak, and not durable. It was used in former times to start fires by friction. Ropes and twine were made from the fibrous bark (Little and others 1974). The pulp surrounding the seeds is widely used in herbal medicine to treat burns, bleeding, dysentery, gonorrhea, constipation, and fever (Parrotta 2001). Extracts of leaves, bark, and roots are reported to be antidotes for poisoning from *Manihot esculenta* Crantz, *Jatropha curcas* L., and *Hura crepitans* L. (Liogier 1990).

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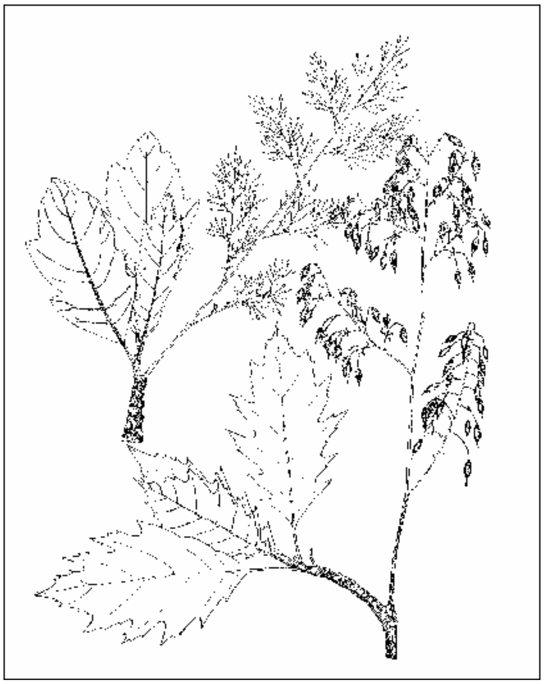
***Bocconia frutescens* L.** pan cimarrón

PAPAVERACEAE

Synonyms: *Bocconia frutescens* var. *cernua* Moc. & Sessé *ex* DC.
Bocconia glauca Salisb.
Bocconia pearcei Hutch.
Bocconia quercifolia Moench
Bocconia sinuatifolia Stokes
Bocconia subtomentosa L'Hér. *ex* Stahl

John K. Francis



General Description.—Pan cimarrón is also known as parrot weed, celadonia, plume-poppy, palo de toro, panilla, llorasangre, curarador, palo amarillo, saúco, yagrumito, chocolate blanco, gordolobo, guacamayo, trompeto, tabaquillo, grande chelidoine, and bois codine. It is a shrub or small tree, usually 2 to 3 m in height and 2 to 3 cm in stem diameter. Branching near the ground normally results in multiple stems. The plant is supported by a tap and lateral system of orange-red roots that are fleshy outside and fibrous within. There are relatively few branches. The outer bark is light brown, smooth to lightly fissured; the inner bark is orange-red and bitter. An orange or yellow sap exudes from wounds. The deeply lobed and toothed leaves are alternate but usually clustered at the ends of older branches. Petioles are stout, 1.5 to 3 cm long, and blades are 14 to 50 cm long. Panicles up to 50 cm long have lax branches. The numerous small flowers are yellow-cream in color. The fruits are ellipsoidal capsules each containing a black seed with a red, fleshy aril running along one side (Howard 1988, Liogier 1985, Little and others 1974).

Range.—Pan cimarrón is reported to be native from the middle of Mexico through Central America to Argentina and Bolivia in South America, and throughout the Caribbean (Howard 1988, Liogier 1985, Stevens and others 2001, New York Botanical Garden 2002). It has naturalized in forests in the islands of Maui and Hawaii in the State of Hawaii (University of Hawaii Botany 2002).

Ecology.—Pan cimarrón grows in a wide variety of soil types at middle elevations up to 2,150 m in Mexico (Secretaría de Madio Ambiente y Recursos Naturales 2002). In Puerto Rico, it grows in subtropical dry forest along streams (750 to 1000 mm/year precipitation), in subtropical moist forest (1000 to 2000 mm/year precipitation), and in subtropical wet forests (2000 to 3000 mm/year precipitation). In Nicaragua, the species grows even in the cloud forests (Stevens and others 2001). In Puerto Rico, pan cimarrón is most common along streams, road cuts, and landslides. The species also grows widely scattered in brush lands, which develop from abandoned fields and pastures, and in secondary forest. Pan cimarrón is intolerant of shade. It competes vigorously with herbs and brush after establishment. The shrub does not form continuous stands in Puerto Rico, but occurs as scattered individuals or small patches. However, as an invader in Hawaii, it does form large, dense stands in dry and mesic habitat (University of Hawaii Botany 2002).

Reproduction.—Pan cimarrón flowers and fruits throughout the year (Little and others 1974, Stevens and others 2001). The infrutescences may contain tens to hundreds of fruits. Fruits in the infrutescences mature a few at a time beginning at the top and proceeding downward. A collection of seeds from Puerto Rico weighed (air-dried) an average of 0.0146 $\pm$ 0.0002 g/seed (author's observation). Germination begins in 25 to 55 days with 40 percent germinating. Germination is epigeal (Ricardi and others 1977). The seeds are dispersed by birds (Environmental Protection Agency 2002). Damaged plants usually resprout.

Growth and Management.—Once established, pan cimarrón has relatively rapid growth (Jardín Botánico de Bogotá José Mutis 2002). Only in Hawaii is the species mentioned as a nuisance where it displaces native vegetation and threatens the endangered Blackburn's sphinx moth (Environmental Protection Agency 2002). In the absence of tests of control measures, such standard practices as grubbing and spraying with broadleaf herbicides are recommended.

Benefits.—Pan cimarrón contributes to biodiversity, helps protect the soil, and furnishes food and cover for wildlife. The sap has been used as a dye (Little and others 1974). The orange wood is soft and brittle with a thick pith, and is of little use. Extracts of various tissues of pan cimarrón are employed in herbal medicine to control mange, lice, and intestinal worms, to treat ulcers of the eyes, to treat wounds, and to treat edema and jaundice (Pérez-Arbelaez 1978). A dose of 15 drops of the sap causes a strong purgative effect (Guzmán 1975). The sap will cure warts and if injected under the skin acts as a local anesthetic although the injection itself causes considerable pain. The bark contains the alkaloids, bocconietrine, cocconichlorine, bocconiyoidine, and bocconixatine (Secretaría de Madio Ambiente y Recursos Naturales 2002). Pan cimarrón is being evaluated as a species for restoration of disturbed sites (Jardín Botánico de Bogotá José Mutis 2002).

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***Bontia daphnoides* L.** white alling
MYOPORACEAE

Synonyms: *Bontia daphnifolia* Salisb.
Bontia daphnoides var. *menor* (Gaertn. f.) A. DC.
Bontia menor Gaertn. f.

John K. Francis

General Description.—White alling, also known as wild olive, mangle bobo, aceituna Americana, olivier bard, and oliba, is a shrub or small tree usually 3 or 4 m in height, occasionally reaching 9 m and 15 cm in stem diameter. Although seedlings have a tap and lateral root system, older plants rely on shallow lateral roots that are stiff and brittle with a brown, corky bark. Trunks of white alling are usually covered with a thick, light brown, furrowed bark. The heartwood is light gray-brown, hard, heavy, and somewhat brittle; the sapwood is tan in color. Multiple stems commonly diverge from the base of the principal stem. The crowns are vertical and narrow with a thin complement of foliage. Leaves are oblong to linear-lanceolate, 3 to 11 cm long by 1 to 2 cm broad, and pointed at both ends. The usually solitary, axillary tubular flowers are yellow blotched with purple and 2 cm long. Drupes are ovoid, tapering to a point with a permanently attached style. Their corky-textured flesh is yellowish-green to yellow at maturity, has a slightly bitter taste, and contains a single hard-shelled stone (Howard 1989, Liogier 1997, Little and others 1974).

Range.—White alling is native to the Bahamas, the Greater and Lesser Antilles, Trinidad, Venezuela, and Guyana (Howard 1989, Little and others 1974). It is cultivated as an ornamental in Hawaii (Hawaiian Ecosystems at Risk 2001) and Spain (Sánchez 2001) and has naturalized in Florida (Nelson 1996).

Ecology.—White alling is most common in coastal thickets between the tidal mangroves and the upland forests. These areas are flooded during storm surges and receive a moderate amount of salt spray. The soils vary from sandy to clayey, are usually high in organic matter, and range in pH from 7.0 to 8.5. The water table is usually within 2 m of the surface. In Puerto Rico, the species grows in areas that receive from 750 to 1800 mm of mean annual precipitation. White alling plants are moderately intolerant of shade, generally starting in openings. Seedlings and saplings survive in relatively sunny understories. Adults flower and fruit in intermediate crown positions. The species is rare in uplands, probably because of competition. It has been cultivated successfully at elevations up to 1,500 m (Little and others 1974). White alling grows as rare to common components of stands but does not form pure or nearly pure stands.

Reproduction.—White alling flowers and fruits throughout the year (Little and others 1974). Fruits collected in Puerto Rico averaged 0.311 $\pm$ 0.015 g/fruit. Air-dried seeds cleaned from the above collection averaged 0.0898 $\pm$ 0.0033 g/seed or 11,000 seeds/kg. Sown in commercial potting mix, 44 percent of the seeds germinated between 12 and 68 days after sowing (author's observation). Seeds are dispersed by water and presumably by birds and mammals that eat the fruits. Fruit production is usually good and seedlings are common in small openings near seed sources. Although white alling are often tipped in hurricanes, they sprout from the trunks and reform vertical crowns.

Growth and Management.—A small group of white alling seedlings grown in the nursery in Puerto Rico ranged in height from 21 to 86 cm, 8 months after being pricked into containers. Sapling and sprout growth rate is moderate (about 0.5 m/year) and individual plants live 10 to 30 years. Although no management experience has been published, the species can probably be established with nursery seedlings and be managed like other short-statured species.

Benefits.—White alling helps protect the soil and provides food and cover for wildlife. The wood is useful for fuel and stakes. Ethanol extracts of white alling showed promising insecticidal activity against *Boophilus microplus, Cylas formicarius,* and *Tribolium confusum* (Mansingh and Williams 1998, Williams and Caleb-Williams 1997, Williams and Mansingh 1993). White alling is frequently used to control diabetes in Trinidad (Mahabir and Gullifor 1997). Extracts of the plant are used to control intestinal worms, treat herpes, treat inflammation, insect bites, scarring, ulcers, and wounds (Liogier 1990).

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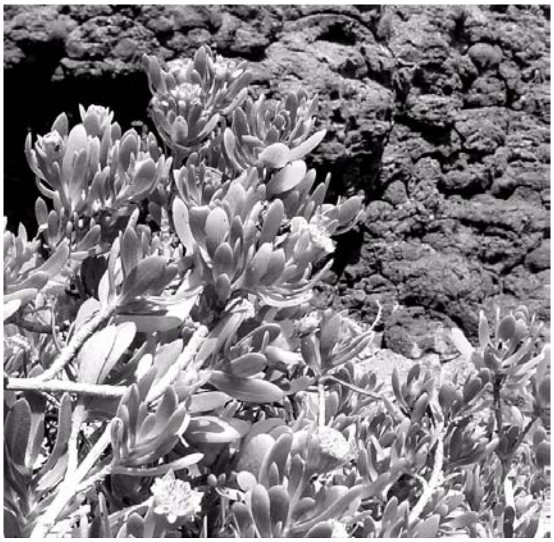
***Borrichia arborescens* (L.) DC.** sea ox-eye

ASTERACEAE

Synonyms: *Buphthalmum arborescens* L.
Borrichia argentea DC.
Borrichia glabrata Small.

John K. Francis



General Description.—Sea ox-eye, also known as tree oxeye, silver sea ox-eye, oxeye daisy, sea daisy, seaside tansy, gull feed, clavelón de playa, and fleur-sorleil bord de mar, is an evergreen, low shrub usually 1 m or less in height with stem diameters of 1 cm, which forms mounds and mats. Older plants have numerous stems. The plants are supported by short rhizomes and a moderate number of lateral roots. The stems are gray with a white, brittle wood and a 3-mm pith. Twigs bear deep leaf scars. The foliage tends to be crowded at ends of twigs. The simple, opposite, sessile leaves are fleshy and yellow-green, light-green, or gray-green, oblanceolate to spatulate, entire, and 3 to 8 cm long. The foliage is resinous and aromatic. Sea ox-eye flowers are usually solitary, terminal heads about 2.5 cm across on peduncles 2 to 5 cm long. The corolla and the ray florets are bright yellow and the disk florets are orange-yellow. The black achenes are 3 to 4 mm long with a pappus in the form of a dentate cup less than 1 mm long. The chromosome number is 2n = 28 (Howard 1989, Liogier 1997, Long and Lakela 1976, Nelson 1996)

Range.—Sea ox-eye is native to southern Florida, the Bahamas, Bermuda, the West Indies, Mexico and Guatemala (Liogier 1997). Although it is planted as an ornamental, it is not known to have naturalized outside the native range. *Borrichia* x *cubana* of southern Florida is believed to be a natural hybrid of sea ox-eye and *Borrichia frutescens* (L.) DC. (Nelson 1996).

Ecology.—Natural sea ox-eye grows near the seashore, usually within the influence of salt spray. Because the species is low in stature, grows slowly, and is intolerant of shade, it must occupy areas with low competition from other vegetation. It finds these conditions on headlands, seaside rocks, dunes, beach strands, low hammocks, and the edges of mangroves and brackish marshes. Sea ox-eye will grow in more favorable conditions if artificially protected from competition. Almost any soil will do, including both acid and alkaline soils. Sea ox-eye tolerates both excessively drained and poorly drained conditions. Mean annual rainfall may range from 900 to 1500 mm. It is drought resistant (Gillman 1999).

Reproduction.—Sea ox-eye blooms in spring and summer in Florida (Long and Lakela 1976) and throughout the year in Puerto Rico (author's observation). It is pollinated by insects. Seeds collected in Puerto Rico averaged 0.00115 g/seed or 870,000 seeds/kg. Only 16 percent of this collection germinated when placed in moist potting mix. Workman (1980) recommends propagating sea ox-eye by sowing in pots. Also, the plant can be propagated by cuttings (Gillman 1999). Seed dispersal appears to be by water (storm surges) and strong winds. Once established, plants widen by constant layering of the semiprostrate stems. New clumps probably are established by the rooting of broken stems moved by storms.

Growth and Management.—Growth of sea ox-eye is slow. Branch extension is about 10 to 30 cm/year. Although, stems and branches die, as long as conditions remain favorable, clonal plants may live almost indefinitely. Newly established plants should be protected from overtopping by grass, brush, and trees. It is important not to regularly irrigate sea ox-eye plants used in landscaping (Gillman 1999).

Benefits.—Sea ox-eye is available commercially and is widely planted as an ornamental. It is recommended for foundation plantings and as a border shrub (Workman 1980), particularly where salt and salt spray are prevalent and in xeric (unwatered) gardens (Knox 2002). It also attracts butterflies (Gilman 2002). A tea is prepared from branch tips and leaves to relieve colds, coughs, and fish poisoning (Garland 2002).

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***Bourreria virgata* (Sw.) G. Don** roble de guayo

BORAGINACEAE

Synonyms: *Ehretia virgata* Sw.

John K. Francis

General Description.—Roble de guayo, also known as palo de vaca, hoja menuda, guazumilla, raspalengua, and cafecillo, is an evergreen shrub or small tree sometimes reaching 9 m in height and 15 cm in stem diameter at breast height. It is somewhat branchy and may have single or multiple stems emerging from the ground. The stem bark is gray and smoothish to slightly fissured. The wood is light brown, hard, heavy, and relatively brittle. Roble de guayo is deeply and solidly rooted with a tap and lateral root system of brown, somewhat stiff roots. Twigs are slender, hairless to densely hairy, green when young, becoming gray. The coriaceous, shiny, green leaves are alternate but may be crowded near twig ends. Blades are elliptic, oblong, or obovate, 1.5 to 7 cm long by 0.7 to 2.5 cm broad, rounded to slightly notched at the apex, and have a short petiole. The terminal inflorescence is a corymb or a cyme with two to 15 tubular, white flowers with five corolla lobes. Fruits are orange or red-orange, subglobose, 5 to 8 mm in diameter, often three-lobed, drupes with persistant calyx and style. Each fruit contains four or fewer light brown, hard nutlets. The nutlets are a quarter sphere with the outer surface deeply grooved (author's observations, Liogier 1995, Little and others 1974).

Range.—Roble de guayo is native to Cuba, Hispaniola, and Puerto Rico, including the Island of Vieques (Little and others 1974). It is not known to have been planted or naturalized elsewhere.

Ecology.—Roble de guayo grows in areas that receive about 700 to 2000 mm of mean annual precipitation. Elevations of habitat in Puerto Rico range from 30 to 300 m (Little and others 1974). It colonizes well- to excessively well-drained soils with a wide range of textures and pH's from about 5.5 to 8.0. Most of the hillside, ridge, and hilltop soils are shallow and rocky. In Puerto Rico, roble de guayo is locally common in the moist and dry limestone hills and in dry foot hills of igneous and metamorphic (including ultramafic) rocks (Breckon and García 2001, Little and others 1974). The species is an important component of the cactus scrub vegetation type in Cuba (World Wildlife Fund 2001). It is moderately intolerant of shade, growing in the understory of low basal area forests but needs overhead sun to produce good fruit and seed crops. The species survives best in harsh environments where competition is minimal.

Reproduction.—Roble de guayo flowers and fruits throughout the year (Little and others 1974). Production of fruits and seeds is moderate. Two collections of fresh fruits from Puerto Rico weighed an average of 0.453 $\pm$ 0.093 g/fruit (Francis and Rodríguez 1993) and 0.423 $\pm$ 0.012 g/fruit. Air-dried seeds separated from the respective groups of fruits averaged 43,500 seeds/kg and 51,500 seeds/kg. Sown without pretreatment, the first sample of seed failed to germinate and the second gave only 2 percent germination (author's observation). Germination is epigeal. The seeds are undoubtedly dispersed by birds that eat the fruits of this as well as other species of the genus. Seedlings are relatively common.

Growth and Management.—Both seedlings and adult plants grow slowly. Apparently, roble de guayo lives for several decades. No management experience has been published. The species is not weedy in agricultural land or forest plantations and will rarely need control.

Benefits.—Roble de guayo helps protect the soil and furnishes food and cover for wildlife. The stems are too small for use as lumber but should make excellent fuel. The species would probably be a good ornamental for landscaping xeric gardens.

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Brickellia californica (Torr. & Gray) Gray California brickellbush
ASTERACEAE

Synonyms: *Bulbostylis californica* Torr. & Gray
Brickellia wrightii A. Gray
Coleosanthus californicus Kuntze
Coleosanthus albicaulis Rydb.
Brickellia tenera A. Gray

John K. Francis

General Description.—California brickellbush is a suffruticose shrub 0.5 to 1.2 m in height. Stem bases reach a maximum diameter of about 2 cm, and clumps may reach a diameter of 1 m. Plants usually have multiple stems arising from the root crown or short, near-surface horizontal stems. The branches are slender, upright, with even finer twigs. Current-year branches, which annually die back to a few cm from the ground-line, have a white to silver-gray bark, and older branches are fine-furrowed gray or gray-brown. The wood is yellowish white, medium density, and brittle with annual rings. California brickellbush shrubs are supported by tap and lateral roots that are covered by corky brown, finely-furrowed bark. The alternate aromatic, gray-green leaves are deltoid-ovate with a rounded or cordate base and a short-acute tip and a crenate-dentate margin. They are 1 to 5 cm long and almost as wide with petioles 4 to 20 mm long. Inflorescences are heads in terminal clusters on small lateral branches of leafy panicles. The fragrant heads are 7 to 10 mm long and contain eight to 18 greenish-cream florets. The olive green achenes are 3 mm long tipped with a white to brownish pappus. There is a base number of n = 9 chromosomes (author's observation, Abrams and Ferris 1960, Harrington 1964, Munz 1974).

Range.—California brickellbush occurs in two varieties. Variety *californica* grows in Oregon, Idaho, California (including Santa Catalina, Anacapa, and Santa Cruz Islands), Nevada, Utah, Colorado, Arizona, New Mexico, Oklahoma, Texas, and at least Chihuahua State in Mexico. Variety *jepsonii* B.L. Robins is found only in California (Abrams and Ferris 1960, Munz 1974, Natural Resources Conservation Service 2003). Although the species is planted as an ornamental, it has not been reported to have naturalized outside its native range.

Ecology.—California brickellbush is intolerant of shade and does not grow under tree or closed shrub canopies. Stands observed by the author were along trails, intermittent streams, and steep, north-facing colluvial slopes. Abrams and Ferris (1960) say that California brickellbush grows in dry canyons and streambeds. It grows in soils derived from a wide range of parent materials, through the whole range of textures, and with pH's of 5 to 8. California brickellbush grows in habitat that receives annual rainfall amounts ranging from 220 to 640 cm (Las Pilitas Nursery 2003). The species grows at between 915 and 2,290 m in elevation in Arizona (Dittman 2003). It grows in coastal and island vegetation types in California (Munz 1974) and therefore at low elevations. Disturbance is probably required for establishment.

Reproduction.—California brickellbush flowers August through October (Tarweed Native Plants 2003). The species flowers abundantly and potentially produces vast numbers of seeds. Air-dried seeds collected in Utah averaged 3.525 million/kg. Hand-sorted seeds placed without any pretreatment on moist blotter paper germinated at 71 percent beginning between 5 and 14 days after sowing. Germination is epigeal (author's observation). Seed will have to be harvested by hand because wild plants are scattered. Stems layer (root) when covered by soil or colluvial material. The seeds are wind-dispersed. Seedlings probably appear and survive only when conditions are nearly ideal.

Growth and Management.—Save for a few centimeters of caudex, California brickellbush adds and loses its entire height (0.5 to 1.0 m) each growing season. The aerial portion of the caudex also dies back about every 3 to 5 years while others are produced each year. Plant may live for one to several decades, renewing themselves with suckers. The species is rarely abundant and probably does not require control. Management experience has not been published.

Benefits.—California brickellbush helps protect the soil and furnishes food and cover for wildlife. It has been reported to be a larval food plant for the tiger moth, *Dysschema howardi* Hy. Edwards (Walsh 2003). The species has been planted as an ornamental, particularly for the floral fragrance, in natural landscaping (Oklahoma Biological Survey 2003). Native Americans used infusions of the leaves as a ceremonial emetic, as a lotion to treat infant skin sores, and for coughs and fevers (Moerman 1986).

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***Bromelia pinguin* L.** maya

BROMELIACEAE

Synonyms: none

John K. Francis

General Description.—Maya is a pineapple-like plant with large, sword-shaped, dark-green leaves that have alternate curved spines about 5 mm long on their edges. The name used is Spanish meaning "net" which derives from its use as a barrier or possibly because its fibers may have been used for making nets. Other common names are karatas, pingouin, bayonette, and pinguin (Howard 1979). Although it is mostly fleshy, maya is classed as a shrub because it is perennial, of shrub size, and has a woody core at its base and fibrous leaves. The plants are formed of a large basal rosette and rarely develop a discernible stem. The roots are shallow, relatively fine, all of a similar size, and radiate in all directions. At the start of a plant's last year, it grows a stout scape inflorescence with many wooly red-orange flowers. The new leaves surrounding the inflorescence are also intensely red-orange. A few months later, 3.5-cm-long elliptical yellow berries ripen. After the fruits have withered, about 1 year after the start of fruiting, the plant dies.

Range.—The native range of maya extends from Mexico through tropical South America and the Caribbean islands (Howard 1979). In Puerto Rico nearly all the stands are on or near abandoned farmland, which may indicate a relatively recent introduction. It has been planted and naturalized in Hawaii (Neal 1965) and many other tropical areas.

Ecology.—Maya is intermediate in shade tolerance. Although it sometimes grows in open areas, the most vigorous stands are found under forest stands with moderate basal areas. In Puerto Rico, natural stands occur in areas with from 850 to 2000 mm of rainfall and from near sea level to 600 m of elevation. All types of soils except very poorly drained and saline soils are colonized. Maya is sensitive to fire. Although many plants in a colony will recover from a burn, they do so slowly. Usually flowering is synchronized, although an occasional plant flowers out of phase, especially in moist habitat.

Reproduction.—Maya reproduces vegetatively and by seeds. The fruits, whose fresh weight averaged 12.26 $\pm$ 0.35 g in a Puerto Rican collection, contain 0 to over 100 seeds, depending on their size. The fruits have a tough, fibrous rind. In Puerto Rico, most of the fruits are eaten by fine-toothed animals (probably rats, mice, or fruit bats) and it is assumed that the seeds are dispersed by these small mammals. The black, teardrop-shaped seeds averaged 0.245 $\pm$ 0.006 g (air dry). Seventy-five percent of these seeds germinated between 133 and 175 days after sowing. The plants are very fragilely rooted at first and develop at a moderate rate. After maya plants have reached their full size and before flowering, most healthy individuals produce one or sometimes two stiff horizontal stolons about 0.5 m long. A new plant forms at the terminus. The new plants grow rapidly and reach roughly half the parent plant's height and diameter and become independent in about a year. Consequently, (with the exception of those planted by humans) new colonies are started as seedlings from dispersed seeds and most plants within colonies arise vegetatively. Maya has been propagated with apical bud explants with a high degree of success (Mesa and Lajonchere 1996)

Growth and Management.—Maya plants grow to full size (1 to 2 m in height and 2 to 3 m in diameter) in 2 or 3 years. Mature stands can be dense with interlacing crowns and little clear space. Five stands inventoried in Puerto Rico ranged from 723 to 1,948 plants/ha. Four whole plants averaged 81.6 percent water and ranged from 0.3 kg to 1.6 kg dry weight. The maya portion of total stand dry biomass would run from about 500 to 2,000 kg/ha. For the most part, maya is undesirable in forests and pastures because it takes up valuable space, restricts access, inhibits grazing, and provides nesting habitat and cover for rats (Vélez and van Overbeek 1950). Maya stands may be controlled by uprooting and piling the plants. If management objectives so dictate, maya can be established by transplanting top-trimmed wildlings.

Benefits.—Historically, and to some extent today, maya was used as a hedge or living fence to inhibit entry into fields and homesteads (Crane 1945). These hedges were never more than marginally effective—cattle and many species of animals pass relatively easily and people can ignore the spines or cut a path with a machete. The fruit, which has a white flesh, is bitingly acid, and tastes like pineapple, is eaten occasionally out of hand and used to make a refreshing drink (Neal 1965). The long, parallel leaf fibers were found to be of good quality and proposed for commercial production (Guzman 1975). Maya offers food and cover for wildlife, such as small mammals and birds.

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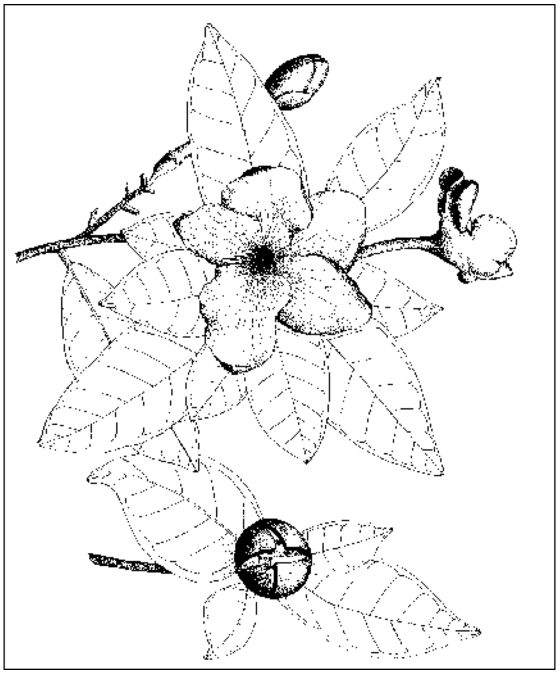
Brunfelsia lactea Krug & Urban

jasmín del monte

SOLANACEAE

Synonyms: none

John K. Francis



General Description.—Jasmín del monte (a Puerto Rican name), also known as aguacero, vega blanca, dama de noche, is an evergreen shrub or occasionally a small tree. It has been recorded to 7 m in height and 10 cm in stem diameter but usually measures only 1 to 3 m in height. Older plants tend to have multiple stems and many, often intertwining branches. The bark is light brown, slightly furrowed, and usually covered with mosses and liverworts. The inner bark is white. The wood is light brown, hard, and brittle. Plants are supported by a tap and lateral root system of light brown, somewhat brittle roots. Roots sometimes arise from the lower trunk. The leathery foliage is moderately abundant. Dark green leaves are elliptic, oval, or obovate, 5 to 15 cm long and 2.5 to 6.5 cm broad, and have petioles 5 to 15 mm long. The flowers are solitary at the terminus of twigs. They are strikingly fragrant, particularly at night. White or pale yellow, later tinged with purple, the corolla is trumpet shaped, 5 to 7 cm long and 5 to 6 cm across, with five rounded lobes. Purple to light brown, fleshy fruits (berries) are globose, 2 to 2.5 cm in diameter and contain many 4-mm brown, elliptic seeds (Liogier 1995, Little and others 1974).

Range.—Jasmín del monte is endemic to high-elevation forests in eastern Puerto Rico (Liogier 1995, Little and others 1974) and is confined to only a few locations. The species has been grown widely in greenhouses and gardens, but there is no record of it naturalizing.

Ecology.—Dwarf forests at the summits of mountains are the habitat of jasmín del monte. These areas lie between 980 and 1,100 m in elevation (Little and others 1974) and receive more than 3000 mm of mean annual precipitation. The soils are clayey over igneous rocks with pH's between 5 and 6 and are saturated in their subsoils most of the time. As an ornamental, jasmín del monte blooms in partial shade (Gehrke 2000). In natural habitat, the species can survive under forest canopies but requires broken or full sunlight to flower and fruit. Hurricane-force winds impact the mountain tops where the species grows every one to few decades, uprooting trees and defoliating the forest. This disturbance, plus occasional landslides, probably allows adult plants of jasmín del monte to flower and fruit and seedlings to establish themselves. In recent years, the disturbance of road cuts and other construction have created additional habitat for the species. The minimum overwintering temperature for jasmín del monte as an ornamental is 10 °C (Kuipplantenkwekerij Gommer 2003).

Reproduction.—Jasmín del monte flowers throughout the year (Little and others 1974). There are good fruit and seed production. A collection of fresh fruits weighed from 2 to 8 g each. Air-dried seed separated from those fruits averaged 0.0062 $\pm$ 0.0002 g/seed. Sown without pretreatment in commercial potting mix, 13 percent germinated between 1 and 3 months after sowing. Germination is epigeal. Seedlings are relatively common in disturbed patches near seed-bearing shrubs but rare elsewhere. Stems layer (root) whenever they come in contact with the ground. Cut roots and stems produce sprouts.

Growth and Management.—Jasmín del monte grows slowly in its natural habitat and appears to be long-lived. The author knows of no wildland plantings or intentional management. Because the species reproduces after disturbance, soil unavoidably exposed during construction and road work should be left in good tilled condition to encourage seedling establishment.

Benefits.—Jasmín del monte helps hold the soil, provides cover and probably food for wildlife, and adds to the aesthetics of the forest. The species is planted as an ornamental in gardens and greenhouses and is available for purchase from a number of commercial nurseries.

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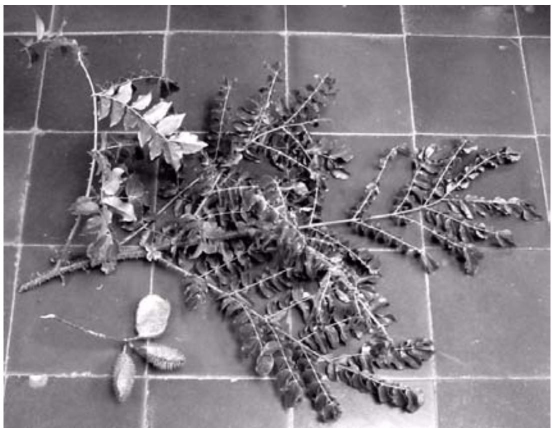
***Caesalpinia bonduc* (L.) Roxb.** gray nicker bean

FABACEAE

Synonyms: *Guilandina bonduc* L.
Guilandina bonducella L.
Caesalpinia bonducella (L.) Fleming
Caesalpinia crista of Small and other authors
Guilandina crista (L.) Small

John K. Francis



General Description.—Gray nicker bean, also known as nicker nut, wait-a-bit, hold back, fever nut, hava de San Antonio, mato de playa, z'yeux à chatte, canique grise, and uri, is a spiny, scrambling shrub to 1.5 m in height (unsupported) and 6 m or more in extension, and has stems up to 5 cm in diameter or more. Plants usually have a single stem arising from the ground but often branch low on the stem. Seedlings form taproots and may retain them later; lateral roots are extensive. The stems grow stiffly upright for 0.75 to 1 m before curving into a more horizontal direction. The stems, twigs, and leaf rachises are covered with straight or curved prickles. The 25- to 80-cm-long leaves are bipinnately compound with four to nine pairs of pinnae, each with four to eight pairs of oblong to elliptic leaflets. Racemes of yellow flowers are lateral or terminal. Prickley, inflated legumes are flattened oval shaped, 5 to 10 cm long, and reddish-brown when dry. Within each pod are one to three (usually two) smooth, hard, 2-cm long seeds that are olive drab in the pods and remain so until exposure to the sun bleaches them to a light gray color. The pods open partially upon drying and eventually release the seeds (author's observation, Howard 1988, Liogier 1988, Nelson 1996). There are 2n = 24 chromosomes (Long and Lakela 1976).

Range.—Gray nicker bean is established in nearly every tropical shore worldwide, including Florida, Louisiana, Puerto Rico, the U.S. Virgin Islands, Hawaii, Guam, and American Samoa (Howard 1988, Liogier 1988, Pacific Island Ecosystems at Risk 2002, Vermillion 2001). It has apparently arrived at these locations by natural means, although unrecorded accidental or intentional introductions cannot be ruled out.

Ecology—Gray nicker bean is intolerant of shade and is usually open-grown or at least grows in broken sunlight. It tolerates salt spray, salty soils, and occasional flooding with seawater. The species grows in all textures of mildly acid to alkaline soil. Annual rainfall in the areas where gray nicker bean grows in Puerto Rico ranges from 750 mm to 1800 mm. The species grows from sea level to 850 m in elevation in India (Parrotta 2001). It grows most frequently on the beach strand, on coastal dunes, and at the better-drained edge of mangroves. Gray nicker bean also grows inland in disturbed areas. It competes well with grass and herbs and may ascend into the crowns of low trees.

Reproduction.—Gray nicker bean flowers and fruits year-round in Florida (Nelson 1996). A collection of seeds from Puerto Rico weighed an average of 2.444 $\pm$ 0.034 g/seed or 409 seeds/kg. Twenty-five seeds each of weathered-scarified (by nicking), weathered-unscarified, fresh-scarified, and fresh-unscarified treatments were incubated in plastic bags of moist potting mix. Most of the scarified seed germinated within a few days and had all germinated within 1 year. By 16 months, 23 of the fresh, unscarified seeds had germinated and just one of the weathered, unscarified seeds had germinated. Germination is hypogeal (author's observation). Gray nicker bean seeds are apparently carried to sea by floods and storm surges where they float until deposited on shore. The seeds are found on beaches in northern Scotland and are known to be able to float in sea water for as long as 19 years (Markland 2002). The scarifying action of sand, weathering, insects, or rodents eventually allows water to enter the seeds and they germinate and establish themselves in the new environments. A seed collected at Macquarie Island, Antarctica, a drift of not less than 1 year, was scarified and grown successfully (Costin 1965). The stems layer (root) whenever they come in contact with the ground. Stems sprout when cut and lateral roots sometimes sucker. Clonal plants tend to remain attached to one another.

Growth and Management.—Growth of gray nicker beans is fairly rapid at all stages. Seedlings reached 26 cm in 40 days after sowing. Older plants grow a meter or more per year. Individual stems live at least 4 years. The author knows of no published management experience. Plantations undoubtedly could be established with potted seedlings or by direct seeding scarified seeds. Control could probably be obtained by lopping with a machete followed by herbicide treatment of the sprouts.

Benefits.—Gray nicker bean contributes to the biodiversity of the forests where it grows, helps protect the soil, and furnishes cover for wildlife. The seeds have been used for centuries and are still used as jewelry, prayer beads, good luck charms, and worry stones (Rancho Leona 2002, Workman 1980). They were anciently used as standards of weight in India (Vijayanagara Coins 2002). The ancient African game of mancala traditionally employs gray nicker beans as game pieces (Driedges 1972). The species is sometimes planted as a hedge to prevent undesired entry into property (Nelson 1996) and could be planted for dune stabilization. Preparations of the seeds and other plant parts are used to treat a large range of ailments (Burkill 1995, Parrotta 2001). Triterpenoids, fatty acid triglicerides, and sterols isolated from seeds may possibly explain some of the activity (Ali and others 1997, Rostogi and others 1996). Seed extracts have been shown to lower blood sugar in laboratory animals (Biswas and others 1997, Sharma and others 1997) and effectively suppress or cure infections of several species of round worms (Amarsinghe and others 1993, Rastogi and others 1996). The fat content of gray nicker nut seeds was measured at 34 $\pm$ 0.83 percent. The semidrying oil extracted would be useful for manufacture of high-quality alkyd resins, polishes, and paint (Ajiwe and others 1996).

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Cajanus cajan (L.) Millsp. pigeon pea
FABACEAE

Synonyms: *Cystisus cajan* L.
Cajanus bicolor DC.
Cajanus flavus DC.
Cajanus indicus Spreng.
Cajanus luteus Bello

John K. Francis

General Description.—Pigeon pea, also known as red gram, Congo pea, gungo pea, no eye pea, dhal, gandul, gandure, frijol de árbol, and pois cajan, occurs in several varieties. The old varieties in cultivation and semicultivation in the West Indies treated here are semideciduous, short-lived shrubs usually 1 to 4 m in height and 1 to 4 cm in basal stem diameter. They are usually single stemmed, freely branching, and become woody after a few months. The wood is moderately hard and brittle. They have a deep taproot (to 3 m) with lateral roots and nodulated fine roots. The branches and fine twigs support abundant light-green or yellow-green foliage. Spirally arranged, silky-pubescent, trifoliolate leaves have narrowly elliptic, lanceolate or oblong leaflets, 2.5 to 9 cm long, the center leaflet being slightly longer than the laterals. The five- to 12-flowered racemes are axillary. Flowers are about 2 cm long, yellow, the standard often being orange to purple outside. The legumes, which are flattened, somewhat constricted between seeds, and 4 to 8 cm long, are mottled bronze-purple when immature, drying to brown. They contain two to nine mottled brown (white, red, brown, gray, or black in improved varieties) seeds, 7 to 8 mm long by 6 mm broad. There are 2n = 22, 44, or 66 chromosomes (Liogier 1988, Long and Lakela 1976).

Range.—Pigeon pea probably originated in India, but may have come from Africa. Both are centers of diversity for the genus *Cajanus*. It is clear that the species has been under cultivation for a long time and was spread by traders thousands of years ago. The wild progenitor may be *Cajanus cajanifolius* (Haines) van der Maesen of India and Myanmar (van der Maesen 1990). Today, pigeon pea is cultivated throughout the tropics and has naturalized in many areas including Florida, Puerto Rico, and the U.S. Virgin Islands (Liogier 1988, Long and Lakela 1976).

Ecology.—Pigeon pea grows on a broad range of well-drained soils, from sands to clays over sedimentary, igneous, and metamorphic parent materials. It tolerates pH's of from 4.5 to 8.4 and some varieties tolerate 6 to 12 mmhos/cm of salinity. However, the species is sensitive to waterlogging. Pigeon pea will grow in areas that receive from 530 to 4000 mm of mean annual precipitation (Van Den Beldt 1988). Pigeon pea grows best in temperatures of 18 to 30 °C. It is subject to frost damage (Skerman and others 1988). The species is grown under cultivation from near sea level to 3,000 m in elevation (Van Den Beldt 1988). Although a large number of insects and diseases affect it (American Phytopathological Society 2002), the actual incidence of attack is low (Center for New Crops and Plants Products 2002). Pigeon pea is intolerant of shade and tolerates only moderate competition. It does best in full sun on bare ground but can grow with side shade or broken shade from trees and a low cover of grass and forbs. Growth is moderately slow during the first 2 to 3 months of life during which time seedlings are not competitive with grass and weeds; afterwards pigeon pea competes well with vegetation equal or lower in height (van der Maesen 1990). In Puerto Rico, the species persists for a generation or two after cultivation and grows along roadsides and in waste places where seeds have fallen, but the populations are not sustained indefinitely. Although seldom devastating, a large number of insects and diseases affect pigeon pea and can reduce yield or shorten a plant's life (American Phytopathological Society 2002).

Reproduction.—Pigeon pea flowers nearly throughout the year (Red de Grupos de Agricultura de Cobertura 2002). The flowers are self-compatible and usually self-pollinated (Smartt 1976). Insects visit and pollinate the flowers (5 to 40 percent cross pollination), but it is not known whether they increase seed yield (McGregor 2002). Upon drying, the pods spring and coil to release the seeds. Pigeon pea seeds weigh about 0.1g and germinate in about 2 weeks (Center for New Crops and Plants Products 2002).

Growth and Management.—Pigeon pea is normally sown directly into prepared ground. Seeding rates for pure stands are 12 to 25 kg of seed/ha (Smartt 1976). Seeding depths of 2.5 to 5 cm are recommended (Center for New Crops and Plants Products 2002). No pregermination treatment of the seed is needed. Although some varieties mature seed in 5 to 6 months, longer-lived, tall varieties including those that are more competitive in the wild take 10 to 12 months to mature seed. These plants live about 5 years (Smartt 1976). Experimental yields of 50 dry t/ha/year have been demonstrated; yields of 3 to 8 dry t/ha/year are obtained under normal management (Van Den Beldt 1988).

Benefits.—Pigeon peas are an important food in developing tropical countries. An excellent source of protein, the seeds (and sometimes the pods) are eaten as a vegetable, as a flour additive to other foods, in soups, and with rice (Center for New Crops and Plants Products 2002). Although they vary slightly, typical nutritional values for seeds are: moisture, 10.1 percent, protein 19.2 percent, fat, 1.5 percent, carbohydrates, 57.3 percent, fiber 8.1 percent, and ash, 3.8 percent (Smartt 1976). About 3.4 million ha were under cultivation in 1978-1988 period, 88 percent of it in India (Nene and Sheila 1990). Although pigeon pea makes excellent forage, because of the brittleness of its stems, the plant is damaged by browsing, especially by cattle (Department of Primary Industries 2002). The species is planted as a green manure crop, nurse crop, cover crop, a windbreak hedge, as a host for lac insects, and as food for silk worms. The stalks are used for fuel, thatch, and basketry (Center for New Crops and Plants Products 2002). Pigeon pea forms root nodules in association with *Rhizobium* sp. bacteria and is capable of fixing 41 to 280 kg/ha of nitrogen (Red de Grupos de Agricultura de Cobertura 2002). Preparations of the leaves are used to treat jaundice, inflammation, and sores of the mouth (Parrotta 2001).

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***Callicarpa americana* L.** American beautyberry

VERBENACEAE (also placed in LAMIACEAE alt. Labiatae)

Synonyms: None

Kristina Connor

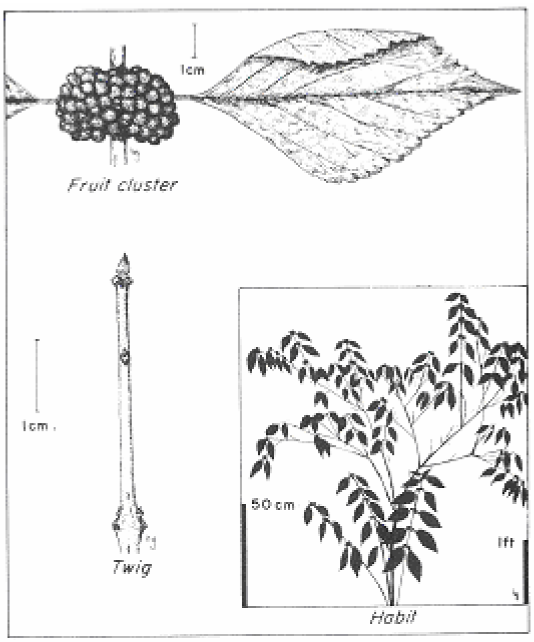

Illustration source: UDA [no date]

General Description.—American beautyberry, also known as beauty-berry, Bermuda mulberry, French mulberry, sourbush, sow-berry, or Spanish mulberry, is a shrub that can reach 2.4 to 2.7 m in height but is typically shorter, averaging 0.9 to 1.8 m. The irregular, spreading bush has an open growth habit and grows as a single plant or in colonies. Bark is brown and raised lenticels are found on older stems. Branches are scurfy or tomentose, gray to reddish brown in color. The opposite, short-petioled, simple, deciduous leaves are ovate to elliptic in shape. They are pointed at both the base and the apex, and the margins are coarsely serrate. Leaves are glabrous or slightly pubescent above and pubescent with stellate trichomes below (Radford and others 1968, Martin and Mott 1997). Leaf size is variable, ranging from 7.6 to 20.3 cm in length and 5 to 12.7 cm in width.

Range.—American beautyberry ranges through the Southeastern United States from Maryland and Virginia south to Florida and west to Arkansas, Oklahoma, and Texas. It also grows in the Bahamas, Bermuda, Cuba, northern Mexico, and in the West Indies (Bailey and Bailey 1976, Brickell and Zuk 1996).

Ecology.—American beautyberry is a drought-tolerant perennial shrub. Classified as a pioneer species (Odenwald and Turner 1988), it is common along forest edges and fence rows, and is also a common understory plant in open pine plantations in the southeastern United States. It is found in openings after clear-cutting (Odenwald and others 1996) and in moist thickets and bordering swamps (Krüssman 1976). American beautyberry is very tolerant of fire and resprouts easily. However, it is intolerant of deep shade and is only found in the better drained areas of bottomland hardwood stands. It will grow in a variety of soil textures and in a wide pH range (USDA-NRCS 2001). Tolerant of temperatures ranging from –17 °C to over 37.8 °C (Martin and Mott 1997), it is cultivated for its fall display of purple to violet fruits.

Reproduction.—The perfect, bluish white to white axillary flowers first appear in early spring. The bloom period can continue through late summer. It is not uncommon to see both flowers and fruits on the same plant (Grelen and Duvall 1966). The flowers are borne in dichotomous cymes 8 to 36 mm long (Bonner in press). The 3- to 6-mm fruits are violet to purple berry-like drupes, formed in clusters that encircle the stem. Each drupe contains four small seeds that germinate without scarification or stratification, although germination can be slow. If seeds are sown in the fall, germination the following spring may be excellent (Dirr and Heuser 1987). Bonner (in press) reported that seeds can be easily cleaned using any type of macerator, even a kitchen blender for small lots. Seeds average 600 per gram. Longevity of seeds in storage is unknown, but they survive for at least 1 year in the soil seed bank and are thought to be orthodox. Orthodox seeds can be dried to a moisture content of less than 12 percent and stored under refrigeration for long periods (Roberts 1973). These seeds are transported by animals and birds. American beautyberry may also be propagated from softwood stem cuttings taken in the summer and fall that are treated with indol-3-butyric acid (IBA; 1000 ppm) and put in a mist bed (Dirr and Heuser 1987).

Growth and Management.—American beautyberry is a short-lived shrub that is easy to grow and widely distributed in the Southeastern United States. It can be used as a landscape border and makes a good mass planting. However, regular pruning is required if it is to maintain its form and produce masses of the fruits so attractive in the fall of the year. The fruits occur only on new growth, and plants should be heavily pruned in early spring (Martin and Mott 1997). It will not do well in areas that experience flooding but can be used to restore surface-mined sites (Martin and Sick 1995). It will resprout after fire (Martin and Mott 1997) and can be easily transplanted.

Benefits.—American beautyberry is a good source of food for deer and the fruits attract birds. It can be used in reclamation work and for erosion control (Brown 1945). It easily reseeds in nature.

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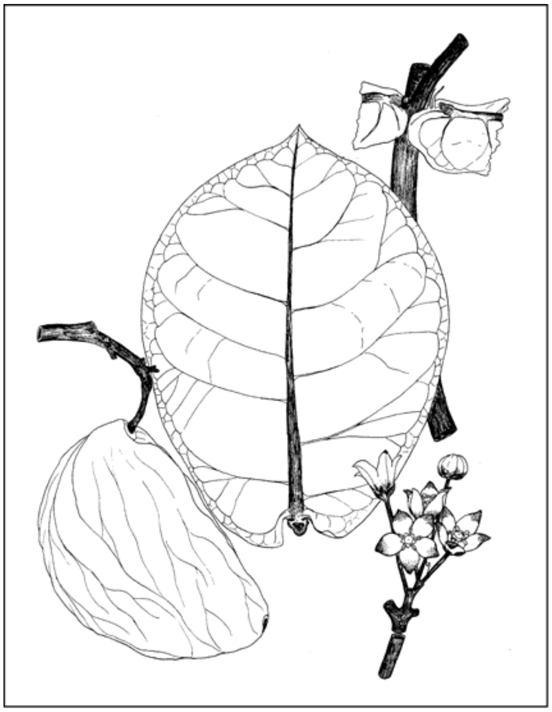
Calotropis procera (Ait.) Ait. f. — giant milkweed

ASCLEPIADACEAE

Synonym: *Asclepias procera* Ait.

John K. Francis



General Description.—Giant milkweed is also known as sodom apple, calotrope, French cotton, small crown flower (English), algodón de seda, bomba (Spanish), cotton-france, arbre de soie, and bois canon (French) (Howard 1989, Liogier 1995, Neal 1965, Parrotta 2001).

This plant is a soft-wooded, evergreen, perennial shrub. It has one or a few stems, few branches, and relatively few leaves, mostly concentrated near the growing tip. The bark is corky, furrowed, and light gray. A copious white sap flows whenever stems or leaves are cut. Giant milkweed has a very deep, stout taproot with few or no near-surface lateral roots. Giant milkweed roots were found to have few branches and reach depths of 1.7 to 3.0 m in Indian sandy desert soils (Sharma 1968). The opposite leaves are oblong-obovate to nearly orbicular, short-pointed to blunt at the apex and have very short petioles below a nearly clasping, heart-shaped base. The leaf blades are light to dark green with nearly white veins. They are 7 to 18 cm long and 5 to 13 cm broad, slightly leathery, and have a fine coat of soft hairs that rub off. The flower clusters are umbelliform cymes that grow at or near the ends of twigs. The flowers are shallowly campanulate with five sepals that are 4 to 5 mm long, fleshy and variable in color from white to pink, often spotted or tinged with purple. The fruits are inflated, obliquely ovoid follicles that split and invert when mature to release flat, brown seeds with a tuft of white hairs at one end (Howard 1989, Liogier 1995, Little and others 1974).

Range.—Giant milkweed is native to West Africa as far south as Angola, North and East Africa, Madagascar, the Arabian Peninsula, southern Asia, and Indochina to Malaysia (Rahman and Wilcock 1991). The species is now naturalized in Australia, many Pacific islands, Mexico, Central and South America, and the Caribbean islands.

Ecology.—Giant milkweed favors open habitat with little competition. This condition is most completely met in overgrazed pastures and rangeland. Other common habitats are beachfront dunes, roadsides, and disturbed urban lots. The species grows in dry habitat (150 to 1000 mm precipitation) and sometimes in excessively drained soils in areas with as much as 2000 mm of annual precipitation. Giant milkweed may be found in areas up to 1,000 m in elevation in India (Parrotta 2001). It roots very deeply and rarely grows in soils that are shallow over unfractured rock. Soils of all textures and derived from most parent materials are tolerated, as well as soils with high sodium saturation. Beachfront salt spray is not detrimental. Competition with tall weeds, brush, and especially grass weakens existing plants, and being overtopped and shaded by trees soon eliminates them. During droughts in Puerto Rico, giant milkweed is attacked by the orange aphid, *Aphis nerii* Boyer de Fonscolombe, which causes defoliation, death of branches, and aborted fruits (Little and others 1974).

Reproduction.—Flowering and fruiting takes place throughout the year (Little and others 1974). Hundreds to thousands of seeds may be produced per plant each year. The seeds in a Puerto Rican collection averaged 0.0095 $\pm$ 0.0027 g/seed or about 100,000 seeds/kg (author's observation). Eighty-nine percent germination took place in potting mix between 7 and 64 days after sowing. Half the seed weight was found in the wing (silk). The seeds are dispersed by wind and may fly for several hundred yards in gentle breezes. Seedlings may arise in abundance after rainy periods, but only a few survive the first season. Using the reserves in its large taproot, giant milkweed can resprout year after year when burned or cut.

Growth and Management.—Giant milkweed usually reaches heights of about 2 m, but may occasionally reach 5 m in height and stem diameters of 25 cm (Little and others 1974). Growth is about 1 m the first year after sprouting in Puerto Rico. Senescence of individual stems takes place in about 5 years, but plants often resprout afterwards. Giant milkweed does not form dense stands, normally occurring as scattered individuals. It can be a serious weed in pastures, overgrazed rangelands, and poorly managed hay fields. Although it probably is not possible to eliminate existing stands through management without ceasing grazing and harvest, it may be possible to prevent their establishment. Some form of chemical control would seem to be the only practical option for eliminating existing stands but no specific guidelines are available. Establishing giant milkweed has been advocated for environmental protection and as a nurse crop for more valuable species (Campolucci and Paolini 1990). This can be done easily by planting containerized seedlings or rooted cuttings.

Benefits.—Giant milkweed tissues, especially the root bark, are used to treat a variety of illness including leprosy, fever, menorrhagia, malaria, and snake bite (Parrotta 2001). The latex is toxic and can cause blisters and rash in sensitive persons. The plant is occasionally grown as an ornamental in dry or coastal areas because it is handsome, of a convenient size, and is easy to propagate and manage. It is recommended as a host plant for butterflies (Mikula 2001). In the past, the silky hairs were used to stuff pillows (Little and others 1974). Giant milkweed was tested as a host for sandalwood, *Santalum album* L., a partial root parasite. It resulted in greater growth of sandalwood than all other species tested (Shinde and others 1993). Extracts, chopped leaves, and latex have shown great promise as nematicides, i*n vitro* and *in vivo* (Anver and Alam 1992, Charu and Trivedi 1997). Sheep, goats, and camels will eat the leaves of giant milkweed during droughts, but consumption is low. If the leaves are chopped and mixed with other feed, consumption greatly increases with no ill effects. (Abbas and others 1992, Nehra and others 1987). Shade-dried giant milkweed leaves contained 94.6 percent dry matter, 20.9 percent ash, 19.6 percent crude protein, 2.2 percent fat, 43.6 percent acid detergent fiber, and 19.5 percent neutral detergent fiber (Abbas and others 1992). Although it is lightweight, the wood is used in impoverished desert areas for a cooking fuel (Varshney and Bhoi 1988).

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***Capparis indica* (L.) Druce** sapo prieto

CAPPARACEAE

Synonyms: *Capparis indica* (L.) Rawc. & Rendle
Breynia indica L.
Capparis breynia L.
Capparis amygdalifolia Jacq.
Capparis amygdalina Lam.
Linnaeobreynia indica (L.) Hutch.

John K. Francis

General Description.—Sapo prieto, a name used in Puerto Rico that means black toad in Spanish, is also known as caper, linguam, burro, white willow, colorín, vara prieta, palo zapo, taiche, endurece maíz, curumo, guacoco, naranjuelo, pachaca, olivo macho, olivo, bois de mêche, bois-puant, bois-noir, pois à mabou, paaloe pretae, and raba stokki (Little and others 1974, Zamora 1989). It is a shrub or a small tree, which under favorable circumstances may reach 8 m in height and 15 cm in diameter at breast height. Sapo prieto usually has a single stem unless it has been damaged, but the species is very limby and may have major branches emerging low on the trunk. The stem and branch bark is gray or light brown and smooth with a bitter, yellow or reddish inner bark. The twigs, petioles, and undersides of leaves are covered with silvery, gray, or golden scales. The alternate, simple leaves are supported by 6- to 10-mm petioles and have narrowly elliptic, leathery blades 4 to 11 cm long and 2 to 4.5 cm broad. The inflorescences (corymbs) are near the ends of branches and contain a few small, white flowers with long white stamens and short yellow anthers. The fruits are silvery-brown legume-like pods 4 to 26 cm long that split along one side at maturity to expose a bright-red interior and pulp-covered seeds. The seeds are black, elliptic, and 5 to 7 mm in diameter (Howard 1988, Liogier 1985, Little and others 1974, Zamora 1989).

Range.—The range of sapo prieto includes Jamaica, Hispaniola, Puerto Rico, the Virgin Islands, the Lesser Antilles, the Dutch Antilles, Trinidad, Venezuela, Southern Mexico to Costa Rica and possibly Panama (Liogier 1985, Little and others 1974, Zamora 1989).

Ecology.—Sapo prieto grows in a wide range of well-drained soils derived from both sedimentary (including limestone), igneous, and metamorphic rocks. It may be found from near sea level to about 600 m on steep as well as level slopes, and in areas receiving from 750 to about 1700 mm of precipitation in Puerto Rico. In Costa Rica, sapo prieto grows from sea level to 300 m in elevation in very rocky soils (Zamora 1989). The species is reported to root deeply (Zoológico Virtual de Barranquilla 2002). Sapo prieto may be found growing in secondary and remnant forests. It is not a pioneer and will rarely be found in abandoned fields or areas where all vegetation has been removed. It is moderately intolerant of shade and consequently does not grow under dense forest canopies. It most frequently grows in an intermediate crown position in relatively open dry forests or as a codominant in clumps of shrubs and low trees in disturbed secondary forests.

Reproduction.—Little and others (1974) state that sapo prieto flowers and fruits intermittently. Flowers were observed in Costa Rico in May and September and fruits were present from May to September (Zamora 1989). A collection of sapo prieto fruits from Puerto Rico weighed an average of 6.948 ± 0.773 g/fruit. The air-dry seeds collected from these fruits weighed an average of 0.0838 ± 0.0021 g/seed or 12,000 seeds/kg. Sown on commercial potting mix without any pre-treatment, the seedlings began to emerge in 7 days and reached a maximum germination of 49 percent in 64 days (author's observation). The seeds are covered with a thin, pasty, scarlet pulp that is presumably eaten by birds that transport the seeds.

Growth and Management.—Sapo prieto has been referred to as slow growing (Zoológico Virtual de Barranquilla 2002). Weaver (1990) measured one tree in St. John, U.S. Virgin Islands, as a part of a larger study and found a 0.4 mm annual diameter increment over a 5-year period. Increases in sapo prieto density can probably be encouraged by treatments to dry and moist forests near seed sources to eliminate dense shade and create brush patches and small openings. No wildland planting experience has been reported.

Benefits.—Sapo prieto makes a good ornamental that is evergreen, with attractive bicolor leaves. It has showy flowers and fruits, and a crown that can be shaped by pruning. However, the species is not commonly used because it grows very slowly (Virgin Islands Wetlands Reserve 2002, Zoológico Virtual de Barranquilla 2002). The wood is heavy and hard and useful for fuel, stakes, and small-diameter fence posts. Sapo prieto contributes to the biodiversity of the forests it inhabits, helps protect those sites from erosion, and furnishes minor amounts of food and cover for wildlife. The flowers are nectar sources for butterflies (Debrot and others 1999).

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***Capraria biflora* L.** goat-weed

SCROPHULARIACEAE

Synonyms: *Capraria lanceolata* Vahl

John K. Francis

General Description.—Goatweed, also known as wild tea, savadilla, té del país, thé du pays, ditay paye, and balsaminha, is an evergreen (or sometimes suffruticose) shrub to 1.5 m in height and 6 mm in basal stem diameter. The plant is supported by a well-developed taproot with laterals through its length. The shrub usually has multiple stems and many fine branches and twigs. The degree of hairiness is variable. Most plants have foliage the full length of their stems. The leaves are subsessile, narrowly lanceolate to obovate, 2 to 12 cm long, with entire to serrate margin. The white, five-lobed, campanulate, 5 mm-long flowers are borne in groups of one to three in the leaf axils. Ovoid, 5-mm capsules contain many tiny, yellow seeds about 0.4 mm long (Howard 1989, Liogier 1995, Stevens and others 2001).

Range.—Goatweed is native to Florida and Texas, the Bahamas, the West Indies, Trinidad, Mexico through Central America, South America as far south as Bolivia, and the Galapagos Islands (Flora of Texas Consortium 2002, Grisebach 1963, Pezzatti and others 1998). The species has naturalized in Ghana, the Cape Verde Islands, and Mauritius (Burkill 2000).

Ecology.—Goatweed is intolerant of shade. It is usually open-grown but may be found in stands of brush and in the understory of open forest. It will die as the shade becomes dense. In Puerto Rico, it grows in pastures, occasionally burned grasslands, dry, early secondary forest, rocky coasts, and sandy areas behind beaches. It is reported to grow on beaches, sandy soils, and disturbed areas in Florida (Long and Lakela 1976). The species grows on soils derived from both sedimentary and igneous rocks in a wide range of soil textures and fertility but requires well-drained conditions. In Puerto Rico, goatweed occurs in areas that receive from 750 to about 1700 mm of precipitation. It grows at elevations from near sea level to 1,000 m in Nicaragua (Stevens and others 2001). Disturbance is probably required for establishment. Once established, goatweed competes relatively well with grass, weeds, and low brush. It is little browsed by cattle.

Reproduction.—Goatweed blooms and fruits all year (Long and Lakela 1976, Stevens and others 2001). A collection of seeds from Puerto Rico averaged 42,300 seeds/g. Placed on moist filter paper, 21 percent germinated between 10 and 35 days after sowing. Germination is epigeal. The tiny seeds are apparently dispersed by wind and water, or by fortuitously sticking to animals or machinery. Natural seedlings are not abundant. Plants readily sprout from the lower stem or root when cut or burned.

Growth and Management.—Individual goatweed stems live 2 or 3 years or more and are replaced by other sprouts. The plant may live for many years. Sprouts grow about 0.5 m in their first year, much less in succeeding years. Large numbers of seeds can be collected by picking unopened capsules, drying them in a paper bag, and separating with a fine screen. Nursery procedures have not been published. Goatweed is considered weedy in pastures. In the absence of tested procedures for its control, standard techniques of grubbing or spot spraying with broadleaf herbicides is recommended. Mowing has little lasting effect on stands.

Benefits.—Goatweed helps revegetate disturbed areas, protects the soil, and furnishes cover for wildlife. It is a nectar source for butterflies and is recommended in natural landscaping (University of Florida Extension 2002). Goatweed has many uses in herbal medicine. A tea prepared from the leaves is used as an eyewash (Burkill 2000), to soothe skin itch (Secritaría de Medio Ambiente y Recursos Naturales 2002), and as a general tonic. However, overindulgence can result in stupor, disorientation, and paralysis (Guzmán 1975). The infusion is also used to treat fever, flu, vomiting, childbirth recovery, diarrhea, hemorrhoids, rheumatism, and swelling (Scofield 2002). The alkaloid, biflorine, present in the leaves has antibiotic properties (Burkill 2000), and sesquiterpenoids, caprariolides A and B from aerial parts, have demonstrated strong insecticidal activity against adult sweet potato weevils, *Cylas formicarius elegantulus* (Collins and others 2000).

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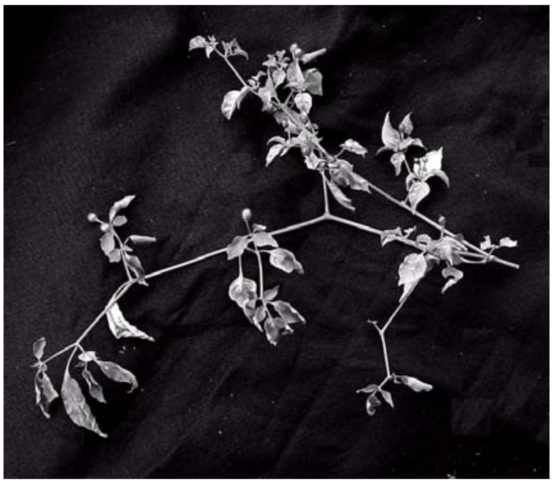
***Capsicum annuum* L.** bird pepper
SOLANACEAE

Synonyms: *Capsicum indicum microcarpum* var. *aviculare* Dierb.
Capsicum bacatum of authors, not of L.

John K. Francis



General Description.—Bird pepper is also known as red pepper, wild pepper, wild chili, pimiento, and ají de gallina (Liogier 1995). The current growth is herbaceous, but it later hardens and becomes woody. The wood is brittle. Older plants are multistemmed and very branchy, with a thick, leafy crown. The leaves are dark green, ovate to lanciolate, 4 to 15 cm long, with petioles 0.5 to 3 cm long. The twigs are stiff and straight between nodes. The flowers are mostly solitary or in pairs. The corolla is greenish-white or yellowish-white, 1 to 2 cm broad, with blue, violate, or yellow anthers. The fruits, which are ellipsoidal berries with thin flesh, are 0.4 to 3 cm long (usually about 0.8 cm in wild plants) and red or orange-red. The seeds are cream to yellow in color (Howard 1989, Liogier 1995). The variety growing as a shrub in wildland vegetation in Puerto Rico, Florida, and elsewhere is *C. annuum* var. *glabriusculum* (Dunal) H. Pickersgill (Liogier 1995).

Range.—Bird pepper ranges today from the Southern United States to Argentina and throughout the West Indies (Liogier 1995). The species has been widely spread and cultivated by Native Americans and European settlers. Escapes from cultivation have masked the original range. Bird pepper may be found competing with native vegetation in Puerto Rico (author's observations), Florida (Nelson 1996), Texas (Everitt and Drawe 1993), and Arizona (Tewksbury and other 1999). It is felt that the species was introduced into Puerto Rico by the aboriginal inhabitants (Barrett 1925). Bird pepper is also widely cultivated and escaped in the tropical and subtropical Eastern Hemisphere (Bailey 1941). It is the wild ancestor of the pimento, the bell pepper, and some of the hot peppers (Bailey 1941). The domestication of these pepper varieties from bird pepper is reported to have taken place in Mexico or Central America (Hawkens 1991).

Ecology.—In Puerto Rico, bird pepper inhabits the subtropical moist forest and the wetter portion of the subtropical dry forest (about 800 to 2000 mm of annual precipitation). It is cold sensitive, and hot, dry weather is desirable for fruit ripening (California Antilles Trading Consortium 2001). In favorable habitat, bird pepper can grow under a broken canopy or in disturbed areas without tree cover. However, in Arizona, the plants were found exclusively under partially shading (nurse) plants (Tewksbury and other 1999). Under conditions of low fertility, moisture, and light, bird pepper plants do not become large and probably do not live more than 1 year. The species favors a near-neutral soil reaction and a generous supply of bases. Well-drained soil with a sandy loam or silt loam texture is best (California Antilles Trading Consortium 2001). After it is well established, bird pepper can survive dry seasons of 2 to 4 months. During this period, it will partially defoliate and take on a wilted appearance, but will refoliate and grow vigorously after the rains return.

Reproduction.—When conditions are favorable, bird pepper begins flowering at about 3 months of age (California Antilles Trading Consortium 2001) and flowers and fruits throughout the year. A sample of fruits collected in Puerto Rico weighed an average of 0.0926 $\pm$ 0.0057 g/fruit. Seeds from the sample weighed an average of 0.0039 $\pm$ 0.0001 g/seed or 260,000 seeds/kg. Bird pepper plants are prolific seed producers. Large plants may produce hundreds of fruits per year. Fruits in the above sample contained an average of 8.2 seeds/fruit.

Twenty-eight percent of the seeds in this collection germinated between 17 and 118 days after being sown in potting mix. Seedlings may be established by sowing in prepared seed spots in the field or grown in the nursery and transplanted. The seeds are dispersed by birds that are immune to the capsaicin the fruits contain. Rodents that would otherwise chew up and destroy the seeds will not eat the fruits (UniSci 2001). Seedlings and plants are common but scattered in early secondary forest in Puerto Rico. However, bird pepper may occasionally form small thickets.

Growth and Management.—Because the species name "annuum" means annual and because cultivated forms are, or are treated as, annuals, bird pepper has been assumed to be an annual (see Liogier 1995). In its wild state, it is, in fact, a short-lived perennial (Floridata 2001), living 3 or 4 years, if conditions are favorable. Plants may occasionally reach 5 m in height (Howard 1989). Heights in Puerto Rico are commonly 2 to 3 m. The stems are slender, about 1 cm in diameter, in larger plants (author's observation).

Benefits.—Bird pepper has been cultivated for thousands of years and is the wild ancestor for hundreds of named varieties of cultivated peppers. However, the wild fruits are still harvested and used today. Bird pepper fruits are "hot" to very "hot" with a slight musky flavor. They are used to flavor food and make sauces. Capsicum derivatives are used in a wide variety of medicinal applications, mostly related to pain relief (eg: sore muscles, toothache, phantom limb pain). Capsaicin causes the brain to release endorphins that promote a sense of well-being and deadens pain receptors (Floridata 2001). Concentrated pepper sprays are used for riot control and personal defense. Gardeners also use pepper extracts to protect crops from insects and animals. Extracts of leaves and fruits of bird pepper have shown insecticidal and fungicidal properties in laboratory tests (Hongo and Karel 1986, Patil and Joi 1992, Williams and Mansingh 1993). However, to sensitive individuals, exposure to *C. annuum* fruits can be dangerous. This species ranked fourth in plant poisoning incidents reported to American poison information centers (Krenzelok and Provost 1995). In Texas and Arizona, several species of birds including the Rio Grande turkey and the curve-billed thrasher eat the fruits (Everitt and Drawe 1993, UniSci 2001).

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***Capsicum frutescens* L.** red pepper
SOLANACEAE

Synonyms: *Capsicum fastigiatum* Blume
Capsicum annuum L. var. *frutescens* (L.) Kuntze

John K. Francis

General Description.—Red pepper, also known as bird pepper, chili pepper, Cayenne pepper, Guinea pepper, ají, and ají picante, is a short-lived evergreen shrub usually 1 to 1.5 m in height and 1 to 3 cm in basal stem diameter. The shrub is supported by a short to long taproot (depending on soil conditions), many spreading lateral roots, and moderately abundant fibrous roots. The stem and larger branches of mature plants are woody but moderately soft and weak. Bark of stems and older branches is light gray. The form is upright, the abundant branching is often dichotomous, and the branches and twigs are slender. The ovate to ovate-lanceolate leaves vary in size. The larger of them are 4 to 12 cm long and 1 to 4.5 cm broad. Greenish-white to yellowish-white flowers with blue, violet, or yellow anthers occur in groups of two or more at the nodes. The berries are red or red-orange at maturity, elongated with a pointed or rounded tip, 1.5 to 3.5 cm long and 0.5 to 1.2 cm thick. The fruits are somewhat dry and contain few to many (depending on fruit size) cream to yellow lenticular seeds about 3 mm in diameter. The fruits, especially the seeds and placenta, have a biting, pungent taste. The species has 2n = 24 chromosomes (Bailey 1941, Bentley and Trimer 1880, Bosland and Votava 2000, Liogier 1995).

Range.—The original range of red pepper is unknown, but it is believed to have been domesticated in Central America, possibly Panama, thousands of years ago. It spread throughout the Neotropics before Columbus and has since become almost pan-tropically cultivated and naturalized (Bosland and Votava 2000). Unlike *C. annuum* L., which has many widely varying varieties, domesticated red pepper has relatively few varieties with a minimum of variation (Bentley and Trimer 1880) and is not greatly different from the wild type.

Ecology.—Red pepper grows on soils of all textures in a wide range of fertilities. Moist, well-drained conditions and loose structure is best for rapid growth. Soil pH's of 4.3 to 9.7 are tolerated (Center for New Crops and Plant Products 2002). The species is intolerant of shade: it will grow with broken overhead shade and moderate competition from grass and forbs, but fruits best in full sun. Red peppers can be cultivated in areas that receive from 30 to 430 cm of annual precipitation at elevations from near sea level to more than 2,000 m. The species is not frost tolerant and does not grow in temperatures below 7 °C (Center for New Crops and Plant Products 2002). Wild red pepper grows as individuals or groups in gardens, fields, vacant lots, river flood plains, abandoned fields, roadsides, and early secondary forest. Although damping-off fungi, various species of insects, and nematodes sometimes damage or kill individual plants, serious effects are rarely widespread.

Reproduction.—After about 3 months of growth, red pepper plants flower (Center for New Crops and Plant Products 2002) and fruit continuously as long as they live. The flowers are insect pollinated (Bosland and Votava 2000). Production of fruits and seeds can be abundant. Fresh fruits from several plants in a stand in Puerto Rico averaged 0.3668 $\pm$ 0.0242 g/fruit. The variability was high (CV = 39.5 percent). They ranged from 2 to 35 seeds/fruit and averaged 16.6 $\pm$ 2.9 seeds/fruit. Air-dried seeds averaged 0.0041 $\pm$ 0.0001 g/seed or 244,000 seeds/kg. Placed in moist potting mix, 72 percent of the seeds germinated between 13 and 34 days after sowing. Germination is epigeous. The seeds can be safely stored under refrigeration after air-drying and need no treatment before planting. The seeds are dispersed by birds that eat the fruits and are immune to the pungent chemicals they contain. Young plants coppice when cut or broken. Rooting of cuttings and tissues has been demonstrated for *Capsicum* (Bosland and Votava 2000).

Growth and Management.—Under continually favorable conditions, red peppers live about 2 years. They grow rapidly during the first year, then much more slowly, and finally dwindle and die. Red peppers grown commercially are managed as annuals, much as other *Capsicum* peppers but for a longer season. Plants that arise spontaneously in gardens and vacant land are usually allowed to grow for occasional future harvest.

Benefits.—Red pepper is used and loved the world over as a condiment, added to food fresh, dried, refined, and ground (for Cayenne pepper and curry), and as the principal or incidental ingredient in sauces. The source of the popular biting sensation are the capsaicinoids, principally capsaicin, which ranges from 600 to 13,000 ppm in the fruits (Center for New Crops and Plant Products. 2002). The fruits are an excellent source of vitamins A and C (Bosland and Botava 2000). A few thousand hectares are grown commercially, and probably even more are grown in gardens or harvested from the wild in rural areas of the tropics. Coatings and powders are used with varying degrees of success to deter browsing animals and insects, and break children of thumb sucking and nail biting. Pepper spray, whose active ingredient is capsaicin, is used widely for personal protection, law enforcement, and defense. Acetone and petroleum ether extracts caused complete mortality of rice weevil (*Sitophillus oryzae*) in 15 days. Fruit powder was much less effective (El-Lakwah and others 1997). Red pepper has many medicinal applications. Some of the most widely used and reliable are as a salve to relieve muscle, joint, and toothache pain, to treat cough, asthma, and sore throat, as a stimulant, and to treat stomach ache, seasickness, and flatulence. Anciently, it was even used as an instrument of torture (Bentley and Trimer 1880, Bosland and Votava 2000, Center for New Crops and Plant Products 2002, Gardenguides.com 2002).

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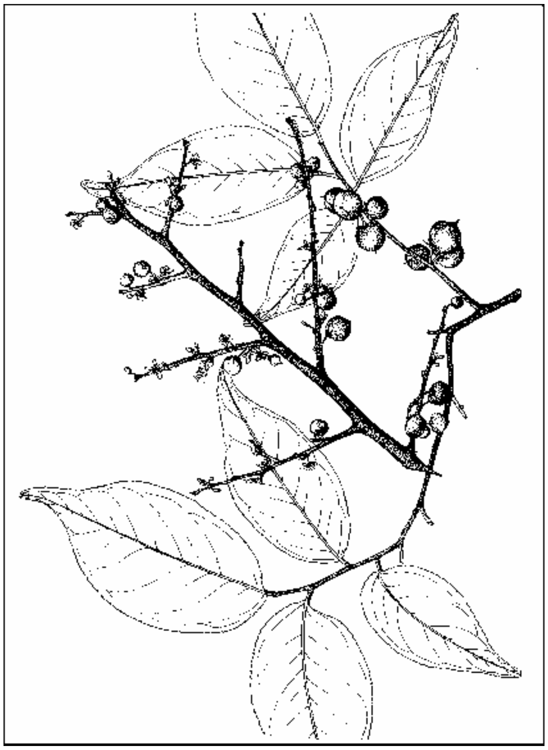
Casearia decandra Jacq. tostado
FLACOURTIACEAE

Synonyms: *Casearia parvifolia* Jacq.
Casearia parvifolia Will.
Casearia albicaulis Risby
Samyda lancifolia Sessé & Moç.

John K. Francis



General Description.—Tostado (a name used in Puerto Rico) is also known by wild honey-tree, wild-cherry, pipewood, biscuitwood, jumbie-apple, palo blanco, caracolillo, cerezo, corcho blanco, cotorrerillo, duro-duro, guía mansa, machacomo, tapaculo, limoncaspi, bois jaune, coco-ravet, jaune d'oeuf, and fortuga caspi. It is a shrub or small tree usually 2 to 6 m in height and 2 to 8 cm in diameter at breast height (d.b.h.). Tostado is supported by a strong taproot, somewhat finer lateral roots, and abundant near-surface fine roots. The roots are stiff and ivory-colored. The species usually has a single stem, unless disturbed, and smooth gray bark. The stemwood is moderately hard and moderately heavy. The branches and twigs are numerous, slender, and form a relatively dense crown. The alternate leaves have petioles 2 to 5 mm long, elliptic blades 3 to 9 cm long, with a finely saw-toothed margin. The small white, cream, or greenish-white flowers are born in nearly sessile clusters at the defoliate leaf nodes. The globose fruits are capsules about 8 to 10 mm in diameter, opening on three valves. The fruits are ripe when they turn from greenish-white to cream with a salmon-colored blush or light brown. The fleshy part of the fruit is orange to red. There are one to four, 4- to 5-mm seeds per fruit, depending on fruit size (Howard 1989, Liogier 1994, Little and Wadsworth 1964).

Range.—The native range of tostado covers the islands of the West Indies from Hispaniola south and extends from Honduras through Panama and into South America as far south as Paraguay, Bolivia, and Northern Argentina (Howard 1989, Liogier 1994, Little and Wadsworth 1964).

Ecology.—Tostado grows on well-drained soils ranging from coastal sands to upland clays, and on soils derived from sedimentary (including limestone), igneous, and metamorphic rocks. Annual precipitation in habitat in Puerto Rico ranges from about 900 mm to about 2200 mm. The species grows to altitudes of at least 1,120 m in Brazil (Silva and others 2002). In Bolivia it occurs from 230 to 650 m in elevation (Killeen and others 1993), and in Puerto Rico, it grows from near sea level to over 600 m. Tostado is moderately intolerant of shade. It grows in disturbed areas, forest openings, very rocky sites, and the understories of lower density forests. In southern Brazil, it occurs in the third canopy layer of *Araucaria* forests (Silva and others 2002), and in Bolivia in Amazon forests and savanna woodlands (Killeen and others 1993). In Venezuela, the species functions as a gap-filling species in bush island savannas (San José and others 1991).

Reproduction.—Tostado flowers and fruits irregularly throughout the year in Puerto Rico (Little and Wadsworth 1964), only a minority of plants being in flower or fruit at any time. It is reported to flower from August to October in Bolivia (Killeen and others 1993). Plants 1 m or more in height in partial or full sunlight bear fruits. Shrubs and small trees bear from hundreds to thousands of fruits each year. A collection of fruits from Puerto Rico weighed an average of 0.340 ± 0.031 g/fruit. They are extremely variable (CV = 69.9 percent), even within the same plant. Seeds separated from the above collection weighed (air-dried) an average of 0.0406 ± 0.0005 g/seed or 24,600 seeds/kg. Without pre-treatment, these seeds were sown on commercial potting mix and 91 percent germinated 7 days later (author's observation). Tostado sprouts when cut or burned.

Growth and Management.—Although tostado is usually a shrub, if it survives several decades in fertile sites with sufficient sunlight, it may occasionally become a tree 12 to 18 m in height (Howard 1989, Liogier 1994). Weaver (1990) reported an average 5-year annual diameter increment of only 0.05 cm for plants 4 to 9 cm d.b.h. in St. John, U.S. Virgin Islands. The air-dried specific gravity of stemwood was measured at 0.630 ± 0.031. The above-ground average carbon content was measured at 0.508. Total above-ground dry weight in plants up to 5 cm d.b.h. can be estimated by the model: $Wt = 34.356(D^2S)$, where Wt is weight in grams, D is diameter in cm at 30 cm above the ground-line, S is total stem length in meters, and adjusted r-squared equals 0.977 (Francis 2000).

Benefits.—The stems of tostado are sometimes used as fuel and fenceposts. This is an important honey plant. The small fruits are edible, but almost tasteless according to Little and Wadsworth (1964). However, the author found them sweet and pleasantly flavored. The species furnishes food and cover for wildlife, contributes to biodiversity, and helps stabilize the soil.

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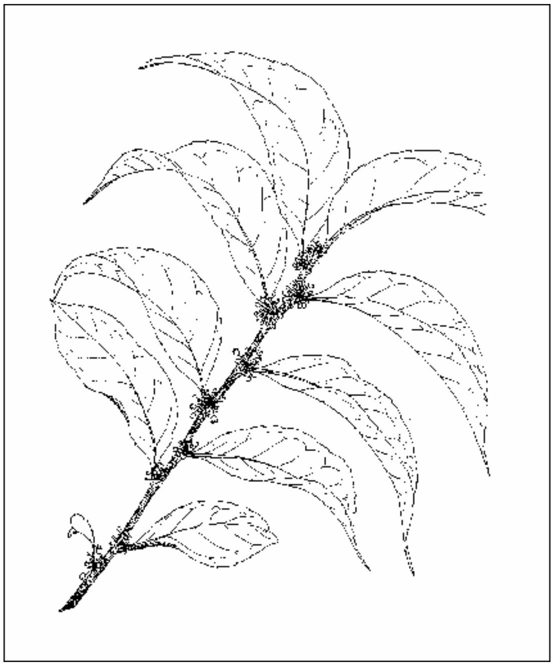
Casearia sylvestris **Sw.** wild-coffee
FLACOURTIACEAE

Synonyms: *Samyda parviflora* L.
Casearia parviflora L.
Anavinga samyda Gaertn. f.

John K. Francis



General Description.—Wild-coffee, also known as crack-open, cafeíllo, café silvestre, sarnilla, corta-lengua, guayabillo, guassatonga, and papelite, is a shrub or small tree usually 2 or 3 m in height, but occasionally reaching 10 m or more. On clay soils, the plant relies for absorption and support on extensive lateral roots that are white, moderately stiff, and have a corky bark. The plant may have a single or multiple stems with nearly smooth, thin gray bark and a moderately branchy habit. The sapwood is light brown and the heartwood is dark-brown, fine-textured, hard, heavy, and strong. The twigs are long and slender, often horizontal or drooping. The previous year's growth often has tufts in the leaf axils of what were the fruit stalks. The alternate leaves have petioles 2 to 8 mm long and ovate to lanciolate blades 4 to 13 cm long by 2 to 5 cm broad with a wavy edge and a long-pointed tip. Tiny white, cream, or greenish flowers are crowded (20 to 50) on short stalks in the leaf axils. The flowers smell like a mixture of honey and urine. The fruits are globose or slightly flattened, 3 to 4 mm in diameter, splitting open on three valves to reveal usually three brown seeds covered with a red or red-orange aril (author's observations, Croat 1978, Howard 1989, Liogier 1994, Little and Wadsworth 1964).

Range.—Wild-coffee is native to Cuba, Jamaica, Hispaniola, Puerto Rico, the Virgin Islands, the Lesser Antilles, Trinidad and Tobago, Mexico through Central America, and South America as far south as northern Argentina, Uruguay, and Bolivia (Howard 1989, Instituto de Botánica Darwinion 2002, Killeen and others 1993, Little and Wadsworth 1964).

Ecology.—Wild-coffee grows on soils of all textures derived from nearly all parent materials. However, it does not grow on swampy ground and usually not on excessively drained sites. In Puerto Rico, wild-coffee grows in areas receiving from about 900 to over 3000 mm of annual precipitation (author's observation). However, in southern Brazil, wild-coffee grows even in annually flooded areas called várzeas (Universidad do Extremo Sul Catarinense 1999). In Nicaragua, the species grows from near sea level to 1,300 m in elevation (Stevens and others 2001). Wild-coffee demonstrates an intermediate tolerance to shade, being able to survive and grow slowly under a forest canopy that is not too dense but requiring partial sunlight to reproduce. Plants growing in pine plantations and natural secondary forests in Puerto Rico held similar concentrations of N, P, and ash in their leaves, but K levels were nearly twice as high in natural forest (Lugo 1992). Wild-coffee is common in brushy pastures, early secondary forests, roadsides, fence rows, and gallery forests of stream bottoms (author's observation, Little and Wadsworth 1964). It is one of the principal arborescent species of the Llanos (plains) of the Orinoco area of Venezuela (van Os 2000).

Reproduction.—Under favorable conditions, wild-coffee is able to flower and fruit at a young age, about the second year as a sprout or at about 1 m in height. Although individual plants do not flower continuously, members of the population may be seen flowering throughout the year (Little and Wadsworth 1964, Stevens and others 2001). In Panama, the species flowers principally in August to December with sporadic flowering during the dry season. The fruits mature in about 1 month (Croat 1978). A collection of fresh fruits (seed + aril) from Puerto Rico weighed an average of 0.0286 ± 0.0021 g/fruit. They vary considerably in size (coefficient of variation = 60.5). Air-dry seeds from the same collection averaged 0.0011 ± 0.0001 g/seed or 909,000 seeds/kg. Sown on peat, these seeds germinated at 31 percent between 20 and 103 days after sowing (author's observation). In southern Brazil, 84,000 seeds/kg were reported and a low rate of germination (Universidad do Extremo Sul Catarinense 1999). Germination is epigeal. Just one or two fruits per inflorescence are ripe at any time. The only method of seed collection known to the author is to hand-pick the tiny ripe fruits (capsules split exposing the red aril) and wet sieve to separate the seeds. Birds disburse the seeds. Natural seedlings are rare to common. Plants past the seedling stage have a high survival rate. Damaged plants coppice readily.

Growth and Management.—Wild-coffee has a moderate growth rate and lives for at least 20 years. Artificial reproduction is usually by seeds, but cuttings can also be rooted. Recommended spacing for plantings in Brazil is 4 by 4 m (Universidad do Extremo Sul Catarinense 1999). Because it becomes established as part of the early secondary forest or in disturbed openings of more advanced forest, management to promote regeneration of the species might include the use of clearcuts or group selection in closed forest and protection of open land from fires.

Benefits.—The wood of wild-coffee is used for or is suitable for fuel, fence posts, stakes, small poles, rustic carpentry, and tool handles (Little and Wadsworth 1964). The species is recommended for urban planting as a food source for birds (Rio Grande Energia 2002). It is a honey plant (Little and Wadsworth 1964). Leaves of wild-coffee contains 2.5 percent essential oils with a pleasant aroma. They also contain caprionic acid, saponins, alkaloids, flavonoids, and a host of other chemicals. Extracts (particularly of the leaves) are used in traditional herbal medicine to treat a large number of different ailments (Universidad do Extremo Sul Catarinense 1999). Laboratory experiments have confirmed antiseptic, antitumor, antiulser, and abortive activity (Basile and others 1990, Carvalho, and others 1999, Itokawa and others 1990, Silva and others 1988). A commercial perfume and a weight-loss product contain extracts of wild-coffee (Fontovit 2002, Multinível do Brasil S.A. 2002).

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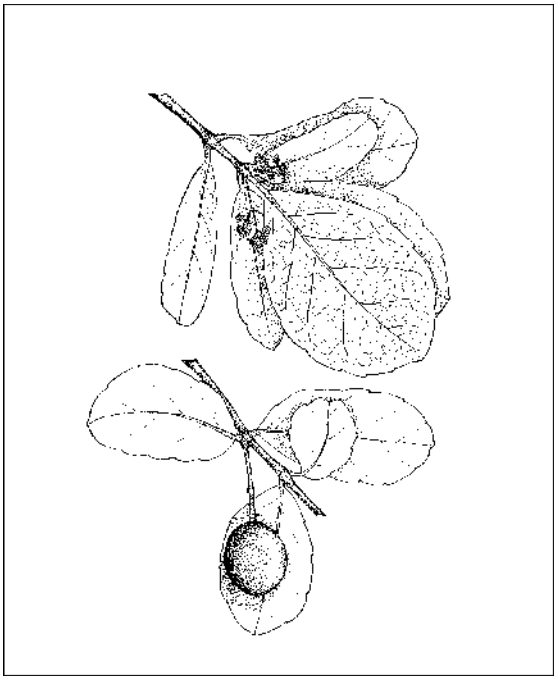
***Cassine xylocarpa* Vent.** marble tree

CELASTRACEAE

Synonyms: *Elaeodendron xylocarpum* (Vent.) DC.
Freziera dioica Macfad.
Elaeodendron dioicum (Macfad.) Griseb.
Elaeodendron attenuatum A. Rich.
Elaeodendron xylocarpum (Vent.) DC.
Cassine rotundata (DC.) Kuntze

John K. Francis



General Description.—Marble tree, also known as spoon tree, poison tree, wild nutmeg, coscorrón, aceituno, guayarote, mate prieto, pinipinche de sabana, bois-tan, bord-de-mer, and grosse-peau, is an evergreen shrub or small tree commonly 2 to 4 m in height and 5 to 8 cm in diameter at breast height. The plant is supported by an extensive shallow and deep lateral root system with sinkers and sometimes a discernable taproot. The roots are orange and stiff. Marble tree often has several stems emanating from the root crown or low on the trunk. The crowns are fairly dense (especially when open-grown), branchy, and often contorted. The bark is gray, smooth to finely fissured, with inner bark that is purplish or pinkish. The twigs are slender and green, becoming gray with age. Leaves are variable, whitish-green to yellow-green, mostly opposite, but sometimes alternate, thick and stiff. They are entire or with a few teeth, elliptic to obovate, 2.5 to 12.5 cm long, with a rounded to spine-tipped apex. The inflorescences are tiny-flowered, branched axillary cymes. The fruit is a yellow (at maturity), rounded drupe, 1.5 to 3 cm long with a thin, hard-fleshy exocarp and hard, thick-walled stone with one to three cells and elliptic seeds (Howard 1989, Liogier 1994, Little and others 1974).

Range.—The range of marble tree consists of the Bahamas, the Greater and Lesser Antilles, Mexico, Belize, Costa Rica, Nicaragua, Panama, and Venezuela (Howard 1989, Instituto Nacional de Biodiversidad. 2000, Liogier 1994, Missouri Botanical Garden 2002a, 2002b).

Ecology.—Marble tree is moderately intolerant of shade. It can persist and grow slowly under low forest but needs to be open-grown or at least have broken sunlight to flower and fruit. The species is drought-tolerant and usually grows on excessively well-drained situations—beaches, bluffs, rocky headlands, and rocky ridges. Marble tree often grows out of cracks in rocks. It is most often seen in areas of limestone and ultramafic (serpentine) rocks. The species is reported to be a nickel accumulator (Medina and others 1994). Colonized areas in Puerto Rico range from 750 to about 1800 mm of mean annual rainfall and at elevations from near sea level to 300 m or more. The species may be found in remnant and late secondary forests.

Reproduction.—Marble tree flowers and fruits intermittently throughout the year (Little and others 1974). A collection of air-dried seeds in Puerto Rico averaged 3.19 $\pm$ 0.076 g/seed or 313 seeds/kg. Sown in commercial potting mix, they began germinating in 26 days and completed 82 percent germination. The species can also be propagated by asexual means. Fifty-six and 21 percent, respectively, of air layers and misted cuttings treated with IBA rooted. The newly formed roots are fragile and easily broken off during transplanting (author's observation). The seeds are probably dispersed by fruit bats. Seedlings and saplings are relatively common in and around Puerto Rican stands of the species.

Growth and Management.—Marble tree grows slowly. A 1-m tall sapling with a basal diameter of 1.5 cm growing in the understory of low basal area moist forest had 37 annual rings (author's observation). Individuals as large as 20 cm in diameter at breast height (Little and others 1974) must be several decades old. Management of the species should include protection from fire and from commercial development of habitat. Existing understory seedlings and saplings could be released from competition by thinning or eliminating the overstory in patches.

Benefits.—Marble tree is pretty enough to make a good ornamental but has rarely been used as such. It is an important component of the plant community in the harsh environment where it is most common and furnishes food and cover for animals. The fruits of marble tree are listed as a food item for the endangered Anegada iguana *(Cyclura pinguis*) (Zoological Society of San Diego 2002). The wood is light-brown, hard, heavy, fine-textured, strong, and durable (Little and others 1974). It is certainly useful for fuel and fence posts and possibly carving and turnery. The fruits are reported to be edible, and extracts of the plant are a stimulant (Liogier 1990).

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***Castela erecta* Turp.** cockspur

SIMAROUBACEAE

Synonyms: *Castela nicholsoni* Hook.
Castelaria micholsoni (Hook.) Small

John K. Francis

General Description.—Cockspur, also known as goat-bush, retama, and urupagüita, is an evergreen, spiny shrub 1 to 4 m in height and up to 10 cm on stem diameter. The plant is multi-stemmed and branchy. The twigs are stiff, sometimes zig-zag, whitish from fine hairs, and end in spines. There are also short spines at the leaf bases. The foliage is sometimes dense, composed of alternate simple oblong to elliptic, almost sessile leaves, 0.6 to 2.5 cm long by 0.3 to 1.2 cm broad, dark green and glabrous above, and hairy below. The foliage and twigs are bitter. Flowers are tiny, whitish to red and tightly clustered in the leaf axils. The fruits are 6- to 10-mm, red, fleshy drupes, one to four developing from a flower. Each fruit contains one hard seed (Howard 1988, Liogier 1988, Little and others 1974).

Range.—Cockspur is native to Puerto Rico, the Virgin Islands, Antigua, Barbuda, Anguilla, Curacao, Aruba, northern Venezuela and northern Colombia (Howard 1988, Little and others 1974). It is not known to have been planted or naturalized elsewhere.

Ecology.—Cockspur is a coastal species. It grows in beach strand vegetation, in sandy soils behind it, and on rocky escarpments and hills somewhat inland (Fundación La Salle de Ciencias Naturales 2002), a dominant to minor part of local xeric scrub communities (Locklin 2002). It occurs to an elevation of about 100 m in Puerto Rico (Little and others 1974). These areas receive annual rainfall totals of about 700 to 900 mm. Soil type does not appear to be critical except that because of the species' short stature and slow growth, it tends to be more successful in poor sites. Although cockspur tolerates salt spray and mild salt in the soil, it does not grow in very salty soils.

Reproduction.—In Puerto Rico, cockspur flowers and fruits in the spring. The species bears male and female flowers on different plants (dioecious). Fleshy, red fruits are probably eaten and the seeds dispersed by birds.

Growth and Management.—Cockspur is a slow-growing species. No management experience has been published.

Benefits.—Cockspur helps protect the soil and furnishes food and cover for wildlife. The sister species *C. texana* (T.&G.) Rose, once considered a part of cockspur as *C. erectas* subsp. *texana* (T. & G.) Cronq., is considered an important browse species (Secretaría de Medio Ambiente y Recursos Naturales. 2002). The common name, goat-bush, suggests that it is browsed by goats.

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Ceanothus velutinus **Dougl. ex Hook.** snowbush ceanothus
RHAMNACEAE

Synonyms: none

John K. Francis

Drawing source: Britton and Brown 1913

General Description.—Snowbush ceanothus is also known as shiny-leaf ceanothus, varnish-leaf ceanothus, sticky laurel, tobacco brush, mountain balm, buckbrush, deerbush, and snowbrush. It is an evergreen, upright to semiprostrate shrub 1 to 2 m (rarely to 4 m) in height. The shrub has one to many stems with reddish-brown bark. The twigs are rigid, slightly flattened, and olive green. The plant is supported by a taproot and a deep, spreading root system. Simple, alternate leaves are shiny dark green above, and pale beneath leathery, and covered with a sticky resin. The 2- to 8-cm blades are broadly elliptical to ovate with rounded tips and rounded or subcordate bases. They have a fine serrate margin and three prominent veins proceeding from the base. The foliage is strongly aromatic, especially when crushed. Some have described it as being similar to cinnamon or balsam. Inflorescences, which are borne on short lateral branches on the previous year's growth, contain many small white, five-maris, perfect flowers. Fruits are three-lobbed capsules 3 to 6 mm long. The seeds are shiny and tan to dark brown. There are 2n = 24 chromosomes (Anderson 2001, Banner 2002, Brayshaw 1996, Harrington 1964, Nobs 1963, Pollock 2003, Welsh and others 1987).

Range.—The native range of snowbush ceanothus includes British Columbia and Alberta south to California and east to South Dakota and Colorado (Abrams 1951, Anderson 2001, Natural Resources Conservation Service 2003). There are two varieties: *hookeri* and *velutinus*. The former, of the Coast and Cascade ranges, in glaberous beneath the leaves. The latter, occurring farther inland, is finely hairy on the underside of the leaves (Brayshaw 1996). The species is not known to have naturalized outside its native range.

Ecology.—Snowbush ceanothus is a member of a large number of plant associations (Anderson 2001). It favors well-drained soils and is susceptible to root rot in more poorly drained conditions (Hansen 2002). These are moderately acid to neutral, often rocky or gravely soils, poor in nutrients, and of granitic parent material. The taproot penetrates 1.8 to 2.4 m deep (Pollock 2003), and with the moisture-conserving leaf structure, impart the plant a great deal of drought resistance. Snowbush ceanothus grows in relatively low coastal habitat and in mountain sites up to 2,900 m in elevation (Welsh and others 1987). Although found on all aspects, it is more likely to occur on southerly exposures (Anderson 2001). Precipitation and length of growing season vary a great deal because of the wide elevational and latitudinal range of the species. Snowbush ceanothus is a pioneer species. Large numbers of seedlings often appear after logging and especially after fires. The species generally grows in small to large thickets, usually as the dominate species. It develops best in full sun but can persist in open forest stands. It grows more rapidly than conifer seedlings and will suppress them for a time. However, after 10 to 75 years, conifers overtop it, and its vigor and abundance declines (Pollock 2003).

Reproduction.—Snowbush ceanothus flowers from May through July and the fruits mature in

August and September (Banner 2002). The flowers are pollinated by at least bees (Clark 1976). There is an average of 207,000 seeds/kg. When seeds mature, beginning in August, they are ejected from the pod and dispersed a short distance (Anderson 2001). Good seed production begins when plants are about 8 years old. As many as 1,250,000 seeds/ha/year can be produced. However, as much as 99 percent of the annual seed crop can be consumed by ants, birds, and rodents. (Pollock 2003). Seeds still accumulate in large numbers in the soil seed bank and can apparently remain viable for 200 to 300 years until conditions become favorable. Germination is epigeal (Reed 1974). Heat, as from forest fires, appears to scarify the seeds. Burned or damaged plants sprout from the root crown. Layering also occurs when branches come in contact with the soil (Anderson 2001).

Growth and Management.—The natural life span of snowbush ceanothus is longer than 25 years, and plants sometimes reach 50 years old. However, stands sometimes begin to deteriorate after 15 years (Anderson 2001). A 17-year-old stand in the Cascade Mountains in Oregon contained over 4,000 stems/ha and averaged 34,000 kg/ha of above-ground biomass (Pollock 2003). Seeds may be sown in the late summer and will germinate in the spring. Pretreatments are necessary for good germination of spring-planted seeds. A hot water soak (90 °C until the water cools) followed by cold stratification at 1 to 5 °C for 30 to 90 days. Seeds should be sown in flats at depths of twice the diameter of the seed in amended mineral soil. Germination may be as high as 82 percent. Seedlings should be pricked into pots when they have gained several sets of true leaves (Reed 1974). Plants can be propagated with stem cuttings. Survival of transplanted seedlings is low (about 9 percent). Small seedlings survive better than large ones (Pollock 2003). Snowbush ceanothus stands are difficult to control. Broadleaf herbicides such as 2,4-D tend to top-kill rather than eliminate it. Opening the brush canopy also allows seeds to germinate and grow. Glyphosate and hand slashing result in greater densities of the species in the long run (Anderson 2001).

Benefits.—Snowbush ceanothus adds to the beauty of the forest, helps protect the soil, furnishes food and cover for wildlife, and is a useful ornamental and medicinal plant. The species is little used by cattle and horses. Sheep browse it only when other forage is unavailable. Deer and elk browse snowbush ceanothus year-round, although it makes up only a small portion of their diet. It is important fall and winter moose browse in some areas. It has an *in vitro* dry matter digestibility of about 57 percent and a crude protein content of 7 to 18 percent (Anderson 2001). Snowbush ceanothus is important resting and escape cover for many types of wildlife (Pollock 2003). Nitrogen is fixed by actinomycetes of the genus *Frankia* in root nodules (Dalton 1997). Snowbush ceanothus makes a beautiful and hardy ornamental that can be pruned and shaped (Hansen 2002). Native Americans used the leaves as a deodorant, smoke of the plant to kill bedbugs, and decoctions to treat flu, pain, and gonorrhea (Moerman 1986). They also used the leaves as a tobacco substitute (Pollock 2003).

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***Celastrus orbiculatus* Thunb.** oriental bittersweet
CELASTRACEAE

Synonyms: *Celastrus articulatus* Thunb.
Celastrus insularis Koidz.
Celastrus jeholensis Nakai
Celastrus lancifolius Nakai
Celastrus stephanotiifolius Makino
Celastrus strigulosus Nakai
Celastrus tatarinowii Rupr.
Celastrus versicolor Nakai

Jinshuang Ma and Gerry Moore


Photo credit: Steven Clemants

General Description.—Oriental bittersweet is the name used most often in North America to refer to this nonnative vine. Other common names include Asian or Asiatic bittersweet and round-leaved bittersweet. The woody roots can be up to 2 cm thick and are yellow to orange. Oriental bittersweet is multistemmed with brown, round twigs; the pith is solid and white. It can behave like a shrub but it is usually a climbing woody vine that can reach up to 20 m in height. Oriental bittersweet is able to climb and effectively cover other woody vegetation. The plant lacks tendrils or aerial roots. The leaves of oriental bittersweet are deciduous, alternate, spiral, stipulate, and measure (including the petiole) 2.8 to 13.7 by 2.9 to 7.6 cm, with the blades suborbicular to broadly obovate in outline with crenulate to serrulate margins. The leaf blades can have white hairs along the midvein on the underside but are otherwise glabrous; the lateral veins are ascending. The leaf scars are flush with the stem, not raised. The small, greenish-white, five-parted flowers are in axillary cymes of three or four functionally unisexual flowers, with the partially fused sepals 3 to 7 by 1 to 2 mm and the petals 2.6 to 5.0 by 0.9 to 2.0 mm. The functional male flowers have five stamens about as long as the petals and a vestigial pistil. The functional female flowers have a syncarpous pistil with a three-lobed stigma, short columnar style, and well-developed superior ovary. The fruit of Oriental bittersweet is a bright orange, three-valved, globose capsule, with each valve covering one or two seeds that are enclosed in a fleshy, crimson aril. The seeds (sans aril) are smooth, light orange, oblong, 2.5 to 2.6 mm by 1.5 to 1.6 mm (Clemants 2003). The genus name is derived from the ancient Greek name *Celastros (Kelastros),* which in Greek was applied to a different Mediteranean evergreen tree probably in the genus now known as *Phillyrea* (Rehder 1940).

Range.—Oriental bittersweet is native to east Asia in Japan, Korea, and China, its southern limit occurring along the Yangtze River watershed in China. In its native range it occurs in areas with elevation ranges from 450 to 2200 m (Cheng and Huang 1999). The plant has become widely established in the Eastern United States, occurring in 25 states (Shetler and Orli 2000, USDA 2003). It is also known in Canada from Ontario and Quebec (Scoggan 1978).

Systematic Botany.—Oriental bittersweet is similar to American bittersweet (*Celastrus scandens* L.), and can be distinguished from it on the basis of its leaves and inflorescences (Hou 1955). The leaves of oriental bittersweet are suborbicular to obovate and are usually less than twice as long as wide, whereas the leaves of American bittersweet are elliptic to oblong and are usually twice as long as wide. The flowers (and fruits) of oriental bittersweet are in short axillary clusters; the flowers (and fruits) of American bittersweet are in long terminal clusters. Both species have the same chromosome number (n = 23; Bowden 1945) and they can be hybridized (White and Bowden 1947, Pooler and others 2002). The presence of some intermediate material in the wild with both axillary and terminal inflorescences has led to the speculation that the two species may hybridize in the wild (Dreyer and others 1987, Mehrhoff in Pooler and others 2002). Some spell the specific epithet "orbiculata" instead of "orbiculatus" used here. This is because botanists disagree as to whether the genus name *Celastrus* L. should be treated as feminine ("orbiculata") or masculine ("orbiculatus") (Paclt 1998). In classical Greek, the generic name was treated as feminine; however, Linnaeus treated the genus as masculine. The matter is now being reviewed by a formal nomenclatural committee (Brummitt 2000).

Ecology.—Oriental bittersweet grows in a wide variety of habitats, including, dune thickets, fencerows, forests, forest edges, and roadsides. It seems to do particularly well in disturbed habitats (Dreyer 1994, Steward and others in press). This species was perhaps first introduced in the New World during the 1860s and was later popularized for ornamental plantings (Patterson 1973, Rehder 1940). Oriental bittersweet is an aggressive invader that can dominate all vegetation levels of forested and open areas (Bergmann 2003). It grows over other vegetation, completely covering it. It can kill other plants by preventing them from photosynthesizing and through girdling and uprooting. Based on its native range and habitat types, Oriental bittersweet can be expected to spread to additional areas in the United States and Canada (J. Ma, personal observation). Oriental bittersweet is a shade tolerant species, able to acclimate to low light levels under heavy shading and grow explosively if shading is reduced. Once large clones are established, it is difficult to eliminate since it has developed such an extensive root system. While oriental bittersweet is spreading and increasing in abundance, the native American bittersweet is concurrently declining (Dreyer and others 1987, Forman and Stark 2001, Steward and others in press). Pooler and others (2002) have hypothesized that the spread of Oriental bittersweet and its hybridization with American bittersweet may be threatening the genetic identity of the American bittersweet. The very properties–faster growth (Bailey 1922, Rehder 1940), greater fecundity (Clemant and others 1991, Dreyer and others 1987, Hart 1928), greater tolerance of environmental heterogeneity (Baker 1974, Newsome and Noble 1986, Sakai and others 2001)–that made early horticulturists prefer oriental bittersweet over American bittersweet (*C. scandens* L.) are the same characteristics that enable oriental bittersweet to be an extremely successful invasive plant.

Reproduction.—Oriental bittersweet blooms in the spring and is pollinated by hymenopterous insects, especially bees, although wind may also be involved (Brizicky 1964). The fruit ripens in the fall. The seeds are dispersed by birds and small mammals (Dreyer 1994). Humans are also important dispersal agents since the fruiting stems are commonly used in dried flower arrangements and subsequently discarded in compost and brush piles (Dreyer 1994). Oriental bittersweet can also reproduce asexually through root suckering.

Growth and Management.—Due to the plant's highly invasive nature, it is not recommended that this plant be grown. Small infestations can be controlled by cutting the stems and removing the roots. Larger infestations require the application of glycophosphate herbicides (Miller 2002).

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***Celastrus scandens* L.** American bittersweet
CELASTRACEAE

Synonyms: *Celastrus bullata* L.
Euonymoides scandens (L.) Medic.

Jinshuang Ma and Gerry Moore

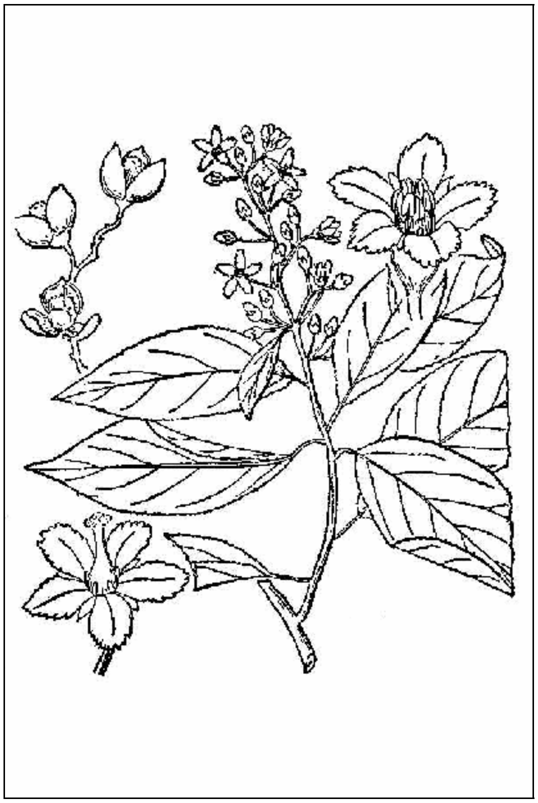
Illustration source: Britton and Brown 1897

General Description.—American bittersweet is the name used most often in North America to refer to this native vine. Other common names include climbing orange root, false bittersweet, fever twig, staff-tree, waxwork, and yellow-root (Dillingham 1907). The woody roots can be up to 2 cm thick and are yellow to orange. American bittersweet is multistemmed with brown, round twigs; the pith is solid and white. It can behave like a shrub but it is usually a climbing woody vine that can reach up to 10 m in height. The plant lacks tendrils or aerial roots. The leaves of American bittersweet are deciduous, glabrous, alternate, spiral, stipulate, and measure (including the petiole) 4.5 to 14.8 by 2.7 to 5.5 cm, with the blades elliptic to ovate in outline with serrulate margins. The lateral veins are ascending. The leaf scars are flush with the stem. The small, greenish-white, five-parted flowers are in terminal racemes of 14 to 50 functionally unisexual flowers, with the partially fused sepals 3 to 7 by 1 to 2 mm and the petals 1.8 to 4.0 by 0.9 to 1.2 mm. The functional male flowers have five stamens about as long as the petals and a vestigial pistil. The functional female flowers have a syncarpous pistil with a three-lobed stigma, short columnar style, and well-developed superior ovary. The fruit of the American bittersweet is a bright orange, three-valved, globose to ellipsoid capsule, with each valve covering one or two seeds that are enclosed in a fleshy, crimson aril. The seeds (sans aril) are smooth, light orange, ellipsoid, 3.5 to 4.5 by 1.8 to 2.0 mm (Clemants 2003). The genus name is derived from the ancient Greek name *Celastros (Kelastros),* which in Greek was applied to a Mediterranean evergreen tree probably in the genus now known as *Phillyrea* (Rehder 1940).

Range.—American bittersweet has been reported throughout most of the United States, except Florida and the Western States of Arizona, California, Colorado, Idaho, Nevada, New Mexico, Oregon, Utah and Washington (USDA. 2003). It is also known in Canada from Manitoba, New Brunswick and Quebec (Scoggan 1978). Reports (Bailey 1949, Britton and Brown 1897) of this plant from New Mexico (then a territory with the same area as the present state) are probably in error. No voucher specimens exist for these reports and there has been no other report of American bittersweet from New Mexico.

Systematic Botany.—American bittersweet is similar to the Oriental bittersweet (*Celastrus orbiculatus* Thunb.) and can be distinguished from it on the basis of its leaves and inflorescences (Hou 1955). The leaves of American bittersweet are elliptic to oblong and are usually twice as long as wide, whereas the leaves of Oriental bittersweet are suborbicular to obovate and are usually less than twice as long as wide. The flowers (and fruits) of American bittersweet are in long terminal clusters; the flowers (and fruits) of Oriental bittersweet are in short axillary clusters. Both species have the same chromosome number (n =

23, Bowden 1945) and they have been hybridized (White and Bowden 1947, Pooler and others 2002). The presence of some intermediate material in the wild with both lateral and terminal inflorescences has led to the speculation that the two species may hybridize in the wild (Dreyer and others 1987, Mehrhoff in Pooler and others 2002).

Ecology.—American bittersweet grows in a wide variety of habitats, including dune thickets, fencerows, forests, forest edges, and roadsides. The native American bittersweet is declining, while the nonnative Oriental bittersweet (*Celastrus orbiculatus* Thunb.) is spreading and increasing in abundance (Dreyer and others 1987, Forman and Stark 2001, Steward and others in press). Pooler and others (2002) have hypothesized that the spread of Oriental bittersweet and its hybridization with American bittersweet may be threatening the genetic identity of the American bittersweet. The very properties--faster growth (Bailey 1922, Rehder 1940), greater fecundity (Clemant and others 1991, Dreyer and others 1987, Hart 1928), greater tolerance of environmental heterogeneity (Baker 1974, Newsome and Noble 1986, Sakai and others 2001)--that made early horticulturists prefer Oriental bittersweet over American bittersweet are the same characteristics that enable Oriental bittersweet to outcompete American bittersweet.

Reproduction.—American bittersweet blooms in the spring and is pollinated by hymenopterous insects, especially bees, although wind may also be involved (Brizicky 1964). The fruit ripens in the fall. The seeds are dispersed by birds and small mammals (Dreyer 1994). American bittersweet can also reproduce asexually through root suckering.

Growth and Management.—American bittersweet does well in many conditions. It is a rapid grower, adding up to several meters in one growing season. Adequate sun is important for fruit production. It can be planted in Hardiness Zones 3 to 8, in soils with pH ranges from 3.7 to 6.5. It cannot tolerate saturated soils. Propagation can be effected either through layering or seed (Chittenden and Synge 1956). Seeds should be stratified in the dark at about 4 °C for 3 months (Young and Young 1992)

Benefits.—The branches of American bittersweet were used by Native Americans, including the Chippewa, as a last resort food source (Dillingham 1907, Palmer 1871). The leaves have been reported as being poisonous to cattle (Brizicky 1964). Fruiting stems of the species are often used in dried arrangements.

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***Celtis reticulata* Torr.** netleaf hackberry

ULMACEAE

Synonyms: *Celtis douglasii* Planch.
C. occidentalis L. var. *reticulata* (Torr.) Sarg.
C. laevigata Willd. var. *reticulata* (Torr.) L. Benson

Ann M. DeBolt

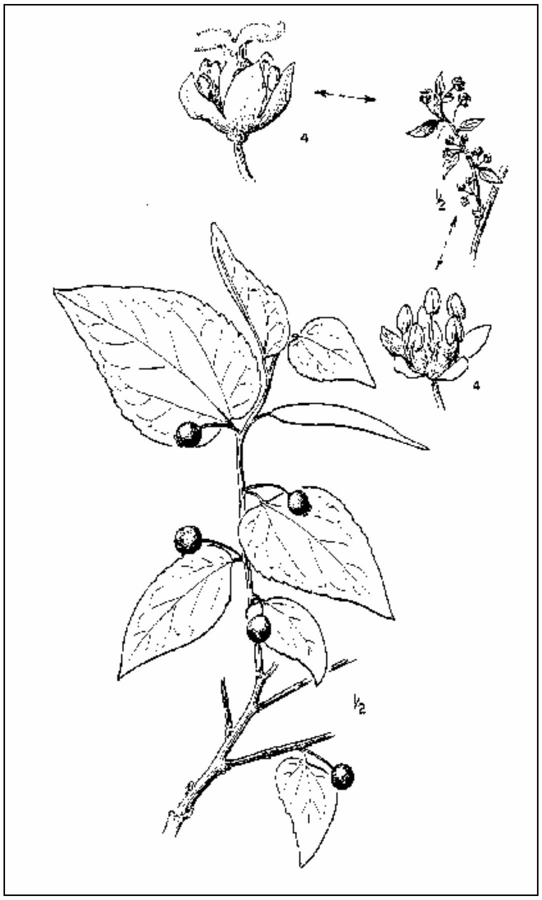

Illustration credit: J.R. Janish *in* Hitchcock and others 1964.

General Description.—Netleaf hackberry is also known as western or Douglas hackberry. It is a deciduous shrub to small tree from 3 to 20 m tall. Near the northern edge of its range in Idaho, its maximum height is 12 m (DeBolt and McCune 1995). This species' growth form varies from a singular, reasonably straight-stemmed tree to a gnarled shrub with multiple stems. The bark is gray, hard, and moderately thick, forming protruding corky ridges with age (Elias 1980). Leaves are 3 to 9 cm long, alternate, simple, ovate to ovate lanceolate, and somewhat leathery with scabrous surfaces and entire to serrate margins. The specific epithet *reticulata* comes from the reticulate or netlike pattern of prominent venation on the leaf underside (Lanner 1983). Twigs and leaves are frequently infested by insect galls, but vigor is not seriously affected (Hayward 1948). The small, green, apetalous, polygamo-monoecious flowers number from one to several in the leaf axils. Pea-sized fruits are fleshy, reddish-orange to purple globose drupes, each with a single large seed. Some authorities consider the highly variable netleaf hackberry to be a variety of sugarberry (*C. laevigata* Willd.) (Natural Resources Conservation Service 2003, Stephens 1973). Others recognize many intergrading forms, and it is possible that future distribution maps of *C. reticulata*, if the name is retained, will not resemble those available today.

Range.—Netleaf hackberry is found east of the Cascade and Sierra Nevada Mountains from central Washington south to northern Mexico and east to central Kansas, Texas, and Oklahoma (Lanner 1983, Little 1976).

Ecology.—At elevations ranging from 100 to 2,000 m, netleaf hackberry grows in a variety of habitats including mountain shrub, deciduous riparian woodlands, live oak-mixed shrub and wash scrub communities, rocky ravines, and as scattered individuals in semi-desert grasslands, pinyon-juniper, and Joshua tree woodlands (Albee and others 1988, Brown 1982, Carmichael and others 1978, Plummer 1977). Populations can be small or highly localized, particularly at the northern latitudes (Daubenmire 1970), or they can comprise the dominant vegetation matrix. On the Edwards Plateau of Texas, netleaf hackberry grows as an overstory codominant in many riparian woodlands (Van Auken and others 1979). A hackberry association was presented by Dick-Peddie and Hubbard (1977) for the mixed deciduous series of their riparian classification scheme for New Mexico, and several ecologists have recognized it as a vegetation type on the lower Snake and Salmon Rivers in Idaho and Oregon (Huschle 1975, Tisdale 1986), where warm canyons are adequate for its existence. At northern latitudes stands are often associated with rock (DeBolt and McCune 1995), which provides extra moisture and some protection from wildfire.

Reproduction.—Wind-pollinated, nonshowy flowers appear in spring, just before or as the leaves unfold, depending on latitude. Fruits ripen from September to November and persist on the trees until midwinter. They are dispersed by birds, rodents, and other small mammals. Netleaf hackberry exhibits low germination percentages (37 percent) and high seed dormancy (Bonner 1974). Seeds are hard and thick-walled, probably the major impediment to rapid germination. Germination is epigeal. Dormancy can be overcome with stratification at 5 ^{o}C in moist sand or other suitable media for 120 days (Bonner 1974). Mechanical scarification enhances germination after 45 days (DeBolt 1992). Netleaf hackberry can reproduce vegetatively by sprouting from the root crown, stem base, or lateral roots. It can also be propagated by cuttings (Bonner 1974).

Growth and Management.—Seedlings establish from animal-, gravity-, or water-dispersed propagules in sites free of herbaceous competition, often in rocky areas or in the duff of an existing stand. Plummer (1977) found netleaf hackberry useful in stabilizing disturbed areas in pinyon-juniper and mountain brush types of Utah. In Texas and Arizona, it is increasingly being used for riparian restoration and wildlife plantings. It currently receives limited use in artificial plantings in the northern portion of its range, though once established, young plants are hardy and persistent. Netleaf hackberry is generally slow-growing, but plants may live for 300 to 400 years (DeBolt and McCune 1995).

Benefits.—Netleaf hackberry provides cover and food for a host of wildlife species. Its fruits are particularly important for birds during winter (Hayward 1948, Lanner 1983), and its leaves and twigs are browsed by bighorn sheep, mule deer, whitetail deer, elk, and occasionally by livestock. It could be used more widely for domestic landscaping as it requires little maintenance and is drought tolerant. Its hard wood is still used today on a limited basis for tool handles and firewood.

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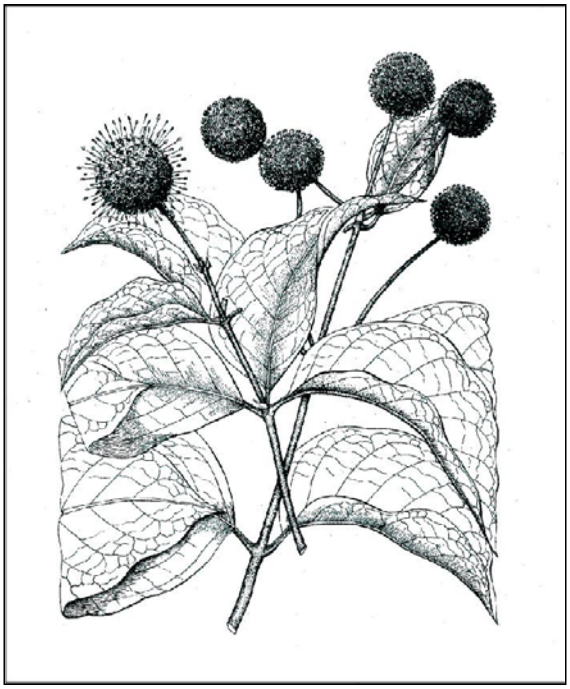
Cephalanthus occidentalis L. buttonbush

RUBIACEAE

Synonyms: *Cephalanthus berlandieri* Wernh.

Kristina Connor



General Description.—Buttonbush, also known as buttonball, button willow, common buttonbush, honey-bells, globe-flower, and riverbush, is a deciduous, wetland shrub or small tree that can reach 6 m in height but generally averages 1 to 3 m tall. The trunk base is often swollen (Snyder 1991). Branches are generally green when young but darken upon maturity and have conspicuous, raised lenticels (Brown and Kirkman 1990). The short-petioled glossy green leaves are elliptic or lanceolate-oblong; they are mostly opposite but, on the same plant, can occur in whorls of three or four. Leaves range in size from 7 to 18 cm in length and are 4 to 10 cm wide.

Range.—Buttonbush is common along stream and pond borders, in swamps, floodplains and other riparian areas throughout the eastern half of the United States. It occurs naturally in southern Nova Scotia, New Brunswick, Quebec, and Ontario as well as through the eastern half of the Great Plains States; scattered populations and varieties are found in Arizona, New Mexico, southern California, and Texas. It also grows in Mexico, Cuba, Central America, and in the West Indies (Little 1979). Recognized varieties are *C. occidentalis* L. var. *californicus* Benth., *C. occidentalis* var. *pubescens* Raf., and *C. occidentalis* var. *angustifolius* Dippel.

Ecology.—Buttonbush is a wetland species that cannot tolerate drought. It commonly grows in thickets in areas that have intermittent flooding. The open, rangy plant is not particularly attractive and is seldom found in cultivation today, although Van Dersal (1938) and Vines (1960) reported that it was cultivated as early as 1735 as a honey plant. The creamy white summer flowers of buttonbush attract butterflies, honeybees, and hummingbirds. While it is common in natural environments, its habitat is threatened in California and it grows poorly along manmade waterways (Holstein 1984). Faber-Langendoen and Maycock (1989) state that buttonbush abundance increases with increasing depth of water and light levels, while Holstein (1984) suggests distribution may be limited by mean July temperatures of 20 ^{o}C. It is classified as a pioneer species and grows best in wet areas that receive full sun. It is able to tolerate some salinity that might result from hurricane storm surges but will not survive long-term exposure to salt water (McCarron and others 1998).

Reproduction.—The perfect, creamy white terminal and axillary flowers of buttonbush occur in dense spherical heads 2 to 3.5 cm in diameter. The flower balls stand on stalks that are 5 cm long. The fragrant individual flowers have corollas 6 to 10 mm long, with pubescent lobes, and four stamens that extend 5 to 8 mm beyond the corollas. Flowers are produced over a long period, from late spring, throughout the summer months, and into early autumn. Flowers are thought to be self-incompatible (Imbert and Richards 1993). The long-stemmed fruits are clusters of achenes. The hard nutlets are 4 to 7 mm long and turn reddish-brown when mature (August to November). Fruit balls may persist throughout the winter. Bonner (1974a) reported an average of 295,000 seeds/kg. Seeds are high in carbohydrates (Bonner 1974b).

Longevity of seeds in storage is unknown but they are thought to be orthodox. Thus, if seeds are dried to a moisture content of 12 percent or less, they can be stored under refrigeration for long periods (Roberts 1973). Germination is epigeal, cotyledons forced above ground, and no pretreatment is required. DuBerry (1963) and Bonner (1974a) reported germinations from 78 to 86 percent while Vines (1960) reported a low germination percentage. Seeds may be transported by animals, birds, or by water. Buttonbush may also be propagated from tip cuttings in the spring or mature-wood cuttings in the winter.

Growth and Management.—Buttonbush is a fast growing but short-lived shrub. It can be used as a landscape shrub border but if not planted in moist soil, it must be watered frequently. It must also be pruned to maintain a good form. In nature, buttonbush occurs in dense thickets. It will resprout after fire (Vogl 1973, Wade and others 1980). It has no reported pest problems but is moderately sensitive to herbicides. Thickets can be reduced by cutting.

Benefits.—Buttonbush seeds are an important food for water birds but can be toxic to other animals (Snyder 1991). Dense buttonbush thickets provide a safe nesting ground for many wetland birds. Buttonbush also serves as a source of honey for butterflies, bees, and hummingbirds. A decoction of the inner bark was used by Native Americans as an emetic. The bark was also used as a substitute for quinine. The wilted leaves, which contain bitter glycosides, cephalin and cephalanthin (ACES 2001), are reportedly toxic to some animals, especially cattle that eat them when other foliage is scarce. However, buttonbush leaves are eaten by deer (Bramble and Goddard 1943), apparently with no ill effects. Other plant parts are less toxic.

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***Cercocarpus intricatus* Wats.** littleleaf mountain-mahogany
ROSACEAE

Synonyms: *Cercocarpus ledifolius* var. *intricatus* (Wats.) Jones
Cercocarpus arizonicus Jones

Stanley G. Kitchen

General Description.—Littleleaf mountain-mahogany, also known as little leaf cercocarpus and dwarf mountain-mahogany, is a long-lived, unarmed, intricately branched and occasionally tree-like, evergreen shrub. Height of mature plants varies from 0.5 to 2.5 m. Mature bark is smooth and light gray. Dark brown heartwood is dense and extremely hard. Persistent leaves are 3 to 18 mm long, 0.8 to 1.4 mm wide (oblong to linear) and leathery with strongly revolute margins (Welsh and others 1987). Leaf pubescence varies from glabrous to villous. Perfect, apetalous flowers, 3 to 9 mm long, occur singularly or in small clusters arising primarily from short spur branchlets on second-year growth. Hard, light brown fruits are cylindrical achenes, approximately 1 mm wide and 4 to 10 mm long with a persistent twisted or spiraling tail (style) 1 to 3 cm long (Welsh and others 1987). Fruit body and especially the tail are covered with short (1 mm) hairs that extend from the axis when dry and facilitate wind dispersal.

Taxonomy.—The evolutionary process by which Littleleaf mountain-mahogany segregated from curlleaf mountain-mahogany (*C. ledifolius* Nutt. var. *ledifolius*) appears to still be in progress with intermediates between the species widespread (Stutz 1990). The shorter and more compact littleleaf mountain-mahogany is more drought tolerant, has fewer stamens and shorter tails on fruits than does curlleaf mountain-mahogany (Stutz 1990). Although hybridization occurs between the two species, littleleaf mountain-mahogany appears to exhibit much greater reproductive isolation from true mountain mahogany (*C. montanus* Raf.) than does its ancestral species (Stutz 1990). Walker and Turley (1999) cited examples of hybrids between littleleaf and true mountain-mahoganies, suggesting that a lack of hybridization may be due, at least in part, to limited interspecies contact.

Range.—Littleleaf mountain-mahogany is found throughout most of Nevada and Utah and in parts of eastern California, northern Arizona, and extreme western Colorado at elevation of 900 to 3,000 m (Davis 1990). Limited populations have also been reported for New Mexico and Wyoming (NatureServe Explorer 2002).

Ecology.—Within desert shrub, pinyon-juniper, and mountain brush communities, littleleaf mountain mahogany is typically found rooted in cracks and crevices of exposed sedimentary and metamorphic rocks; commonly limestone, dolomite, and quartzite in the Great Basin and sandstone in the Colorado Plateau (Davis 1990). It is also found in shallow, poorly developed soils derived from these substrates. It grows best in full sun. Soil pH of littleleaf mountain-mahogany habitat is neutral to slightly basic, (Fairchild and Brotherson 1980). Annual precipitation is 200 to 500 mm. Although undocumented, it is believed that this species possesses nitrogen fixing root nodules similar to those reported for close relatives (Davis 1990). Littleleaf mountain-mahogany is browsed heavily by wild ungulates and domestic sheep when it can be reached.

Reproduction.—Flowering occurs from mid-May to late June (Walker and Turley 1999). Fruits ripen and disperse in July and August. Years of abundant seed production are rare. A high percentage of empty fruits is common. Plummer and others (1968) reported 112,000 cleaned seeds (fruits with tails removed) per kg. Seed dispersal is by wind.

Growth and Management.—Although information on seed germination for this species is lacking in the literature, primary dormancy at seed dispersal is probably similar to that of curlleaf mountain-mahogany. Kitchen and Meyer (1990) observed almost no germination for this species without prechill (1 ^{o}C). They reported germination of six seed collections after 6 weeks of prechill ranged from 53 to 96 percent of viable. Seedling growth rate is slow, and plants require 10 to 30 years to reach maturity. Management alternatives for littleleaf mountain-mahogany are limited due to the nature of the sites it occupies.

Benefits.—Littleleaf mountain-mahogany provides cover and year-round forage on harsh landscapes. It is of particular value to native ungulates that depend on rugged escape terrain such as mule deer (*Ococolius hemionus*), bighorn sheep (*Ovis Canadensis*), and mountain goat (*Oreamnos americanus*).

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***Cercocarpus ledifolius* Nutt.** curl-leaf mountain mahogany

ROSACEAE

Synonyms: None

Christopher Ross

General Description.—Curl-leaf mountain mahogany is a large-sized shrub to small or medium tree. Young stems are smooth and gray, becoming rough and brown in mature specimens, and often scaly in older trees. The evergreen leaves are narrowly lanceolate, often revolute, about 1 to 1.5 cm long with a 1- to 3-mm petiole. They are densely white-wooly underneath. (Lis 1993). The trees are extremely long lived in the absence of external sources of mortality and are often by far the oldest members of the communities in which they occur (Ross 1999).

Range.—Curl-leaf ountain mahogany is widely distributed in North America, from Montana to Baja California and from near the Pacific Coast in southwestern Oregon to the Bighorn Mountains in Wyoming and near Chadron, Nebraska. It occurs at elevations of 610 to 1,372 m in the north, and to 3,000 m or higher in the south (USDA USFS 1937, Martin 1950).

Ecology.—Curl-leaf mountain mahogany occurs in a variety of plant associations, including sagebrush, pinyon/juniper, scrub oak/mountain brush, aspen, ponderosa, jeffrey and other pines, and spruce/fir (Martin 1950, Ross 1999). It occurs on a wide variety of soils (Davis and Brotherson 1991), including decomposed granite and limestone, altered andesites (Billings 1976) and others. Curl-leaf mountain mahogany often occurs in rock outcrops and talus slopes with no apparent soil development. In pine and spruce/fir forests it may eventually be overshadowed by tall trees and shaded out. It often forms dense, closed canopy stands that permit little understory or interspecific competition. Sapsuckers and other woodpeckers may attack intermediate age class trees, girdling the stems and causing extensive stand mortality in some cases (Ross 1999). Other predators include the bark beetle *Renoci's heterodoxus* (Kraft 1960) and the leaf defoliater *Anacamtodes clivinavia profanata* (Furniss and Barr 1969). A variety of other insects also attack the species at times.

Reproduction.—Flowers are one to three per inflorescence, axillary, and more or less sessile, with a straight stigma and 15 to 25 stamens. Fruits are unusual for a member of the rose family, 4 to 8 mm long, hard, with a 2.4 to 3.5 cm plume style (Lis 1993). Seed production is episodic but may be very heavy at times, with the seeds forming drifts beneath trees. Seed predation by insects in fall may be nearly complete at times (Dealy 1975). Reproduction is sporadic, occurring usually on bare mineral soil, including fresh road cuts, but very uncommon in established plant communities. The increase in cheatgrass (*Bromus tectorum* L.) and other annuals over its range has apparently reduced reproduction in many areas (Ross 1999). Under established stands, germination is common but the seedlings usually damp off and die (Ross 1999). Episodic regeneration and mortality, especially from fire and sapsuckers, may create even-aged stands with almost no diversity of age class.

Fire Effects.—Although curl-leaf mountain mahogany is sometimes referred to as a weak resprouter after fire, this is very uncommon. In the western Great Basin, it is invariably killed by fire regardless of intensity, and never resprouts. Even very light burns that do no apparent damage to mature trees result in full mortality within 1 year. Closed mature stands may have insufficient understory to carry fire, so that the fire and resulting mortality are confined to the edges of the stands. Regeneration by seed may occur after fire if the soil is not colonized by other species. In some cases, the resulting stands occupy essentially the same area as the burned stand. Historic fire lines and burns are often clearly demarcated by the sharp boundaries of living stands. The wood is rarely consumed by fire and often persists for decades after, offering precise information about past distribution and age classes. With changes in fire intensity and return interval, usually related to increases in exotic annuals, curl-leaf mountain mahogany in many areas is decreasing and is increasingly restricted to higher elevations, steeper slopes, and cooler aspects (Ross 1999).

Growth and Management.—Although curl-leaf mountain mahogany is very long lived and eventually assumes a tree form, young specimens grow quickly as multistemmed shrubs. Stands are typically composed of a single age class, perhaps with younger specimens on the edges. It may be readily grown from seed for transplanting, although young transplants are attractive to rodents, lagomorphs, and large game. Seed collection is easily done, although the hairy styles are a strong respiratory and skin irritant. Management has focused on increasing the forage production of old, browsed stands via clipping and pruning (Davis and Brotherson 1991), although this may result in tree mortality (Garrison 1953, Thompson 1970).

Benefits.—Curl-leaf mountain mahogany has found extensive use in the past as a fuel and charcoal source. The very hard, beautiful wood has been used for lathe work and parts for musical instruments (Ross 1999). Living stands provide significant blue grouse nesting habitat (Stauffer and Petersen 1986). It is one of the few species that meet protein requirements for wintering deer (Welch and McArthur 1979) and is heavily favored by bighorn sheep in summer (Rominger et al. 1988). Where present in even small amounts in sagebrush, curl-leaf mountain mahogany allows greater wildlife diversity and abundance than would otherwise occur (Furniss et al. 1988). It is also used increasingly as a commercial, residential, and highway landscaping species.

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***Cercocarpus montanus* Raf.** true mountain-mahogany
ROSACEAE

Synonyms: *Cercocarpus betuloides* Nutt. in T. & G.
Cercocarpus betulifolius Nutt. ex Hook.
Cercocarpus parvifolius Nutt.
Cercocarpus flabellifolius Rydb.

Stanley G. Kitchen

General Description.—True mountain-mahogany, also known as mountain cercocarpus, birchleaf cercocarpus, birchleaf mountain-mahogany, alderleaf mountain-mahogany, blackbrush, deerbush, tallowbrush, and lintisco (Spanish), is a long-lived, unarmed, mostly deciduous shrub, with few to many ascending stems generally 1 to 4 m tall and 0.5 to 5 cm in diameter at the base. Mature bark is smooth and light gray. Stout tap and lateral roots penetrate deep into available soil and rock crevices. Leaves are simple and alternate. Leaf length varies from 6 to 44 mm. Leaf blade shape is oblanceolate to roundish with shallow forward-pointing teeth on the terminal margin. The upper surface is glabrous while the lower surface is generally pubescent (Welsh and others 1987). Perfect, apetalous flowers, 10 to 17 mm long, occur singularly or in small clusters arising from axiles or on short spur branchlets along upper portions of 2-year-old stems. Hard, pale green to light brown fruits are pubescent, cylindrical achenes, approximately 1 to 2 mm wide and 8 to 15 mm long with a persistent twisted or spiraled style or tail 3 to 10 cm in length. The numerous 1 to 2 mm long hairs present on this appendage extend almost perpendicular to the style axis when dry and facilitate wind dispersal. Because of the reflective nature of these hairs, abundant seed crops give plants a frosted look in sunlight.

Taxonomy.—Nine varieties of true mountain mahogany are recognized of which var. *montanus* Raf. is most widespread (Marshall 1995, NatureServe Explorer 2002). Varieties with southwestern United States distributions include vars. *argenteus* (Rydb) F.L. Martin, *glaber* (S. Wats.) F.L. Martin, and the evergreen *paucidentatus* (S. Wats) F.L. Martin. Closely related species of the Southwest and Mexico include: *C. mexicanus* Hendrickson, *C. rzedowski* Hendrickson, and *C. fothergilloides* Kunth, suggesting a southern North American origin (Stutz 1990). Coastal California has varieties with restricted distributions including the critically imperiled (S1) Santa Catalina mountain-mahogany or *C. montanus traskiae* (Eastw.) F.L. Martin, which is sometimes treated as a separate species, and the vulnerable (S3) Island mountain-mahogany or *C. montanus blancheae* (Schneid.) F.L. Martin (NatureServe Explorer 2002). True mountain-mahogany is known to hybridize with other mountain-mahogany species where populations are in contact (Stutz 1990, Walker and Turley 1999). Hybrids derived from crosses with the more tree-like and evergreen curlleaf mountain mahogany (*Cercocarpus ledifolius* var. *intermontanus* N. Holmgren) are evergreen, intermediate in stature and leaf shape, and usually sterile. In contrast, hybrids formed with *C. ledifolius* Nutt. spp. *ledifolius*, are quite fertile and backcross with parent populations (Stutz 1990).

Range.—True mountain-mahogany, like other members of the genus, is endemic to dry coastal and interior foothills and mountains of the Western United States and Mexico (Marshall 1995, Stutz 1990). In the United States, it is centrally located in Colorado, Utah, and Wyoming and to lesser degrees in South Dakota, Nebraska, Kansas, Oklahoma, Texas, New Mexico, Arizona, Nevada, California, Oregon, Idaho and Montana (Davis 1990, NatureServe Explorer 2002). Within its range it grows at elevations of 1,000 and 3,000 m (Davis 1990).

Ecology.—True mountain-mahogany grows in solid, sometimes extensive stands, and in mixtures in sagebrush and mountain shrublands and pinyon-juniper woodlands. This species is also found in openings of ponderosa pine, mixed conifer, and aspen forests. It does best in full sun. Annual precipitation ranges from 250 to 600 mm. Soils are well drained, near-neutral to slightly basic, and deep to absent (rock crevices). Nitrogen fixation in root nodules and ectomycorrhizal facilitation of phosphorus uptake (Hoeppel and Wollum 1971) are probably critical for the success of this species on infertile soils. Plants often appear hedged from heavy winter use by wildlife. Regeneration by crown sprouting is best after early season fires (Marshall 1995). Ferguson (1983) suggested that the ability to sprout following fire might be ecotype dependent. Stand regeneration by seed is slow.

Reproduction.—Anthesis for this wind pollinated species occurs between April and early July depending on elevation, latitude, and aspect. Fruits ripen and disperse from July to October. A unique pattern of resource partitioning is commonly observed in which branches with few seeds and long leader growth occur concurrently with branches sporting many fruits and little leader development (Walker and Turley 1999). Abundant fruit production may occur at intervals of 1 to 10 years (Plummer and others 1968). A high percentage of nonviable (empty) fruit is common for this species and the genus *Cercocarpus* in general. Means of 90,000 and 130,000 cleaned seeds per kg (fruits with tails removed) have been reported in the literature (Kitchen and others 1989, Deitschman and others 1974). Primary seed dispersal is by wind. However, seeds are also gathered and likely cached by rodents. The possible significance of rodents as secondary dispersers of mountain-mahogany seeds is unknown.

Growth and Management.—Although within-plant flowering and fruit maturation are well synchronized, some within-population asynchrony is expected. Ripened fruits are easily dislodged and collected by striking or shaking branches over hand-held hoppers. Optimal season for harvest varies from June to September. During harvest and handling, fruit hairs dislodge and can cause considerable discomfort to eyes and skin, revealing the motivation for the cowboy moniker, “hell feathers” (Plummer and others 1968). Commercially available seed is typically cleaned to 95 percent purity and 85 percent viability. Seeds have been warehouse-stored for 7 years without significant loss in viability (Stevens and others 1981). Although primary dormancy is apparently absent for some collections of true mountain-mahogany seed (Deitschman and others 1974), moist chilling (stratification) treatments of 2 to 12 weeks are typically required to break dormancy (Kitchen and Meyer 1990). In one study, seeds germinated in chilling (2 ^{o}C) between 7 and 15 weeks of treatment (Kitchen and Meyer 1990). A germination inhibitor may play a role in germination regulation (Moore 1963). Laboratory viability evaluations using standard TZ (tetrazolium chloride) tests can be problematic due to difficulty in extracting undamaged embryos from fruits (Kitchen and others 1989). Seeds are used in restoration plantings of highly disturbed sites (e.g. surfacing mines) and for wildlife habitat improvement. Seedling vigor is fair and growth rate is slow to moderate. Plants reach maturity in 5 to 15 years. Plants are tolerant of moderate to heavy use by browsers (Turley 2000) and shoots of true mountain-mahogany provide adequate nutrition as winter forage for wildlife. Productivity decreases when plants are protected from herbivory over extended periods (Waugh 1990). Decadent stands can be rejuvenated using light to moderate top removal techniques such as one-way chaining (Davis 1990). Both containerized and bare-root stock (1 and 2 year old) is available from select nurseries.

Benefits.—True mountain mahogany is an important, often dominant shrub in many parts of the Western United States. It provides valuable winter forage for wildlife. It also provides protection for, and increases the fertility of, naturally occurring and human-caused (e.g. mine spoils) infertile soils.

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***Cereus greggii* Engelmann** night-blooming *cereus*
CACTACEAE

Synonyms: *Peniocereus greggii* (Engelm.) Britt. & Rose
Cereus greggii Engelmann var. *roseiflorus* Kuntze
Cereus pottsii Salm-Dyck

Juanita A. R. Ladyman

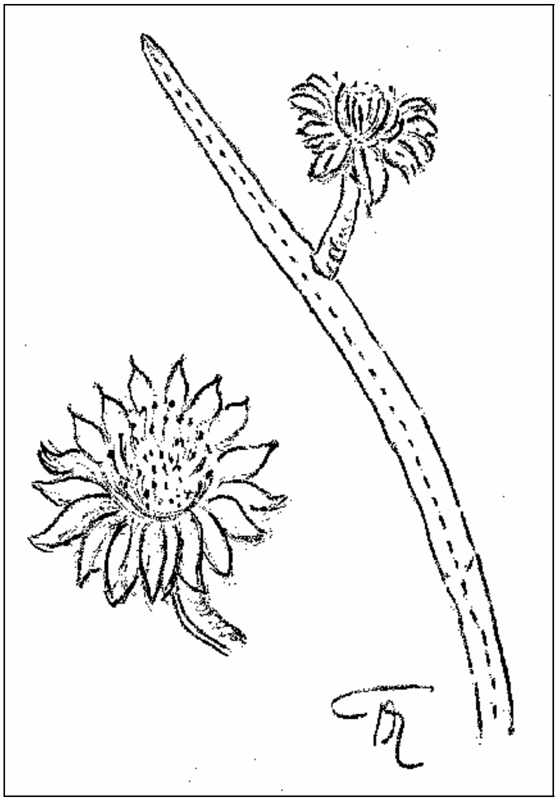

Illustration credit: Tonia Masaood

General Description.—The common names for *Cereus greggii* are night-blooming cereus, Texas night-blooming cereus, Arizona queen-of-the-night, reina-de-la-noche, sweet-potato cactus, and deer horn cactus. It is a perennial, succulent shrub (Vines 1960). Night-blooming cereus is a Federal Species of Concern and is listed as endangered by the State of New Mexico (Sivinski and Lightfoot 1995, NMRPTC 2002). It is threatened by illegal collection throughout its range. Although this plant is cryptic and may be more common than verified documentation suggests, many occurrences of night-blooming cereus are known to have been extirpated due to collection pressures, and its range-wide abundance is believed to be declining. Night-blooming cereus has erect or sprawling stems that may grow to 2.4 m in length but are typically less than 1.5 m. The gray-brown stems are four to five ribbed and approximately 1.25 cm in diameter. There are 11 to 13 dark spines that tend to be swollen at the base, per areole. The lower spines may have some white coloration. The flower is particularly remarkable, having waxy white, pointed "petals" with numerous white to yellow-tipped stamens. It is fragrant and up to 5 cm in diameter and 15 cm long. The orange-red, oblong fruit is up to 7.6 cm long and 3.8 cm in diameter with short spines. The root is a fleshy taproot and typically weighs 2.3 to 6.8 kg (Weniger 1991, Earle 1963, Vines 1960). In old plants it may be up to 0.6 m in diameter and weigh 125 lbs (Weniger 1991). In 1919 a specimen with purplish flowers was collected in Organ, New Mexico, but since then only plants with white flowers have been recorded (Weniger 1969). There are two varieties of night-blooming cereus, *Cereus greggii* var. *greggii* and *Cereus greggii* var. *transmontanus.* Variety *transmontanus* differs from the typical variety in that the flowers are larger, approximately 7.5 cm in diameter, and the hypanthium is particularly spiny, and the spines generally 1.5 to 3.0 cm long (Benson 1982, Martin and Hutchins 1980). The hypanthium is the cup-like enlargement of the floral axis below the calyx that surrounds the ovary. The hypanthium of variety *greggii* is covered by minute, inconspicuous spines and the flowers are smaller. These varieties are in need of further study (NMNPPAC 1984). Some sources (Natural Resources Conservation Service 2003) maintain that the synonym, *Peniocereus greggii* (Engelm.) Britt. & Rose is the correct name. Night-blooming cereus provides an interesting evolutionary link. It appears to possess anatomical characteristics that are relictual from its nonsucculent, woody, Pereskia-like ancestor (Mauseth and others 1998).

Range.—Night-blooming cereus grows in southern New Mexico, southeastern Arizona, western Texas, eastern Chihuahua, northeastern Durango, northern Zacatecas, and Coahuila, Mexico (Kearney and others 1960, Powell 1998, Vines 1960). Benson (1982) defined the range of variety *transmontanus* as the Arizona and Sonoran Desert that possibly also includes Hildalgo County in New Mexico, and that of variety *greggii* as the Chihuahuan Desert of New Mexico, western Texas and Mexico.

Ecology.—Night-blooming Cereus grows in dry alluvial soils at elevations between 370 and 1,500 m. Again, the varieties are distinguished by variety *transmontanus* growing at the lower end of the elevation range (300 to 1,050 m) and variety *greggii* growing above 1200 m (Benson 1982). Night-blooming cereus generally grows in slightly broken to level terrain in desert grassland or Chihuahuan desert scrub. Typically it grows in sandy to silty gravelly soils on upper to mid bajadas among, depending upon the desert region, creosotebush (*Larrea tridentata*), mesquite (*Prosopsis glandulosa*), paloverde (*Cercidium* species), and knife-leaf condalia (*Condalia* species). It is also commonly associated with Ocotillo (*Fouquieria splendens*), tarbush (*Flourensia cernua*) and dropseed (*Sporobolus* species). Habitat alteration such as that caused by the high impact trampling of heavy grazing is suspected to reduce population size (NMNPPAC 1984).

Reproduction.—As the common name suggests, night-blooming cereus blooms only at night. Just after dark the flowers open in a series of "jerks" (Benson 1982). Individual flowers only bloom for one night. The total flowering period of plants within a population is also brief and generally all flowers bloom within a 2-day period. However, in unusual circumstances, flowers on different individuals within a population may bloom periodically over a period of almost one month. Flowering occurs in late May into July depending on geographic area (Earle 1963, Epple 1995, Kearney and others 1960). The fragrance of the flowers is pleasant, and humans can detect the perfume of the flowers up to 30 m away from the plant (Benson 1982, Epple 1995, Vines 1960). Flowers are pollinated principally by hawk moths (ASDM 2002) and possibly other night feeding insects (Epple 1995) that search for nectar. The flowers are not self-fertile and must be cross-pollinated. Therefore the hawk moths (Sphingidae) must fly hundreds of yards between the sparsely distributed plants (ASDM 2002). In areas where pesticides are heavily used for agriculture, the hawkmoth populations are devastated, and most of the flowers on plants in adjacent natural habitat fail to fruit (ASDM 2002).

Growth and Management.—The stems generally grow up through, and later become supported by, shrubs. It is likely that the shrubs provide protection and a suitable microclimate for germination and subsequent plant development. Any activity that reduces shrub cover is a threat to night-blooming cereus. Therefore, fire is a potential hazard, although the direct effect of fire on night-blooming cereus is not well documented. The substantial tuberous root may provide the plant the means to recover if the above-ground stems are killed, and therefore, it is likely that individual plants can tolerate light fires that do not decimate the shrubs with which they are associated (Thomas 1991). More severe fires that scorch and heat the soil are likely to be more detrimental. Herbivores such as white-throated woodrats (packrats) and cactus borers (*Cactobrosis fernaldialis*) eat the stems, but new stems soon sprout from the tuberous root (ASDM 2002). Many populations throughout its range have been extirpated due to private and commercial collection, and the time required for population re-establishment is not known. However, although slow growing, it is easily propagated by short stem cuttings and from seed. Seeds of many cacti species, including *Cereus* species, are subject to physiological dormancy. For example, seeds of *Cereus griseus* were dormant at maturity but germinated after 8 weeks in a dry environment (Baskin and Baskin 2001). *Cereus griseus* seeds have an absolute light requirement for germination (Baskin and Baskin 2001). If the plant is dug up for transplantation it is actually difficult to keep alive (Weniger 1969). Apparently the root is susceptible to fungus. Damp soil has to be avoided, but even if root rot is prevented, the plant tends to decline over a few years if kept in a pot or in a greenhouse (Weniger 1969).

Benefits.—Night-blooming Cereus plants have commercial value especially among cactus collectors (Epple 1995). Not only is it an aesthetically desirable cactus, but it has considerable medicinal value. The root is generally believed to be the organ that has medicinal properties (Moerman 1998, Moore 1989, Powell 1998). However, the stems also have the same properties although "more feebly" (Moerman 1998, Moore 1989, Powell 1998). Active ingredients include penicerol, viperidone, desoxy viperidone, viperidinone, β-sitosterol and, most likely, caffeine (Moore 1989). It is likely that night-blooming cereus is not unique in its medicinal value as other species of *Cereus* contain similar active ingredients (Ecdybase 2002). The commercial toll on this species has not been established, but wild-harvested material is available on the Internet (Pacific West Botanicals 2002). It is called “pain in the heart” by the Death Valley Shoshones (Moore 1989). This tribe presumably uses it in a manner similar to Native Americans of Nevada who ingest an infusion of the roots as a cardiac stimulant (Moerman 1998). Other Native Americans have used a decoction of the roots for diabetes, the seedpods mixed with deer fat as a salve for sores, and the cut slices of root as an externally applied cure for chest colds (Moerman 1998, Vines 1960). The fruits, flowers, young stalks, and roots have been eaten for food (Moerman 1998). This use of the root may account for the common name “sweet potato cactus.” Chewing the raw root has been reported to quench thirst. Birds eat the seed and contribute to seed dispersal (Vines 1960).

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Cestrum diurnum L. day jasmine
SOLANACEAE

Synonyms: _Cestrum fastigiatum_ Jacq.
Cestrum diurnum L. var. _fastigiatum_ (Jacq.) Stehlé in Fournet
Cestrum diurnum portoricense O.E. Schulz in Urban

John K. Francis

General Description.—Day jasmine is a single or multistemmed shrub or rarely a small tree that is also known as day cestrum, wild jasmine, ink-bush, Chinese inkberry (English), dama de día, rufiana, galán de día, and saúco tintóreo (Spanish) (Little and others 1974). The bark of day jasmine is nearly smooth and gray. The inner bark is yellow-brown and slightly bitter. The twigs are slender, greenish gray, and sometimes drooping (Liogier 1995, Little and others 1974). The leaves of day jasmine are oblong or oblong-elliptic, and shiny green to yellow green, and somewhat membranous. They are about 15 by 6.5 cm and have petioles about 2.5 cm long. The small, white flowers are grouped in panicles attached at the bases of the last leaves in each branch. These develop into elliptical, purplish-black berries about 6.5 mm long (Howard 1989, Liogier 1995, Little and others 1974).

Range.—Day jasmine is native to the Bahamas, Cuba, Jamaica, Hispaniola, and the Cayman Islands (Little and others 1974). It has been introduced as an ornamental into most of tropical and subtropical America. The species has escaped from cultivation in at least Florida, southern Texas, Hawaii, Puerto Rico, Guam, and American Samoa (Florida Exotic Plants Council 2001, Institute of Pacific Islands Forestry 2001).

Ecology.—Day jasmine grows in gardens, roadsides, fencerows, pastures, vacant lots, and abandoned farmland in Puerto Rico (Liogier 1995). The species is particularly associated with pasture fencerows because its seeds are deposited there by birds, vegetative competition is controlled by grazing, and day jasmine is rarely eaten by cattle. There is no mention in the literature of the types of natural forest stands where day jasmine grows within its native range. However, because the species is intolerant of heavy shade and quickly disappears when overtopped by forest, it can be inferred that day jasmine is an opportunist that invades disturbed areas and quickly completes its life cycle ahead of encroaching forest. The species may grow as individual plants or in thickets. Day jasmine will grow in areas receiving from about 800 to 3000 mm of precipitation, but most aggressively colonizes areas that receive from about 1400 to 2400 mm of precipitation. It tolerates soils of all textures, apparently from all parent materials, but is most common in limestone areas (Florida Exotic Plants Council 2001). Day jasmine does not prosper on exposed subsoil nor grow on swampy ground. The plant is salt tolerant if not exposed to heavy salt spray or overwash from storms (Florida Exotic Plants Council 2001).

Reproduction.—Day jasmine flowers and fruits year-round (Florida Exotic Plants Council 2001). The fruits from a Puerto Rican collection were sweet and slightly bitter with little other flavor and weighed (fresh) an average of 0.208 $\pm$ 0.010 g/fruit. The seeds weighed an average of 0.0021$\pm$ 0.0005 g/seed (air dry). The fruits are much more variable in size (CV = 49) than the seeds (CV = 25). There are from four to 14 seeds/fruit (Florida Exotic Plants Council 2001). Day jasmine seeds are dispersed by frugiverous birds (Neal 1965, Little and others 1974). Seventy-nine percent of the seeds from the Puerto Rican collection cited above germinated between 7 and 30 days after sowing.

Growth and Management.—Day jasmine rarely reaches more than 4.5 m in height and 8 cm in trunk diameter (Little and others 1974). Early growth is relatively fast and life spans are relatively short (5 to 20 years). Although seeds are still sold by regional seed houses and ornamental seedlings are offered by nurseries, nothing is published about propagation and management. With a plant so aggressive, few nursery and planting problems seem likely. Because the species is a weed in many situations, control may be desirable. In the absence of control guidelines, cutting followed by herbicide treatment of the sprouts is suggested.

Benefits.—Day jasmine has long been planted as an ornamental for its pleasing appearance, moderate size, ease of establishment, and fragrant flowers. The plant has the drawback of being poisonous to livestock. The leaves contain a calcinogenic glycoside called 1,25-dihydroxycholecalciferol that leads to a vitamin D toxicity that results in elevated serum calcium and deposition of calcium in soft tissues. Fifteen to 30 percent of day jasmine leaves in an animal's diet is sufficient to cause symptoms (Animal Science at Cornell University 2001). However, the fruits of day jasmine are one of the three foods that make up the bulk of the diet of the endangered plain pigeon (*Columba inornata*) in Puerto Rico (Island Resource Foundation 2001).

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Cestrum laurifolium L'Hér. dama de noche
SOLANACEAE

Synonyms: *Cestrum citrifolium* Ritz in Hoffm.
Cestrum alaternoides Poir. in Lam.
Cestrum lambertii Dunal in DC.

John K. Francis

General Description.—Dama de noche, also known as candlewood, torch, galán de monte, bois-flambeau, and citronnier, is an evergreen shrub usually 1 to 2 m in height but sometimes reaching 4 m. Dama de noche is a Puerto Rican name meaning lady of the night. It has one or a small number of stems arising from the root crown or low on the main stem. The plant tends to root shallowly with stout lateral roots that are hard and woody with a corky or fleshy bark. The stems and branches are slender with gray bark and grow vertically for 1 to 2 m and then curve horizontally. The alternate, glabrous leaves are shiny green on the upper surface, narrowly elliptic to obovate, with a short petiole and blades that are 4 to 15 cm long. The inflorescences are short axillary racemes with three to five yellow or greenish-yellow, five-lobed, tubular flowers 10 to 20 mm long. The fruits are purple to black, ovoid to subglobose berries, 6 to 10 mm long, with a persistent calyx. There are one to three or more black seeds per fruit with an ivory spot on the ventral side (author's observation, Howard 1989, Liogier 1995).

Range.—Dama de noche is native to Cuba, Hispaniola, Puerto Rico, the Virgin Islands, the Lesser Antilles, and Trinidad (Grisebach 1963, Howard 1989, Liogier 1995).

Ecology.—Dama de noche is most common in areas underlain by limestone rocks but also grows in areas of igneous rocks. The soils are well drained, often rocky with a wide range of textures. In Puerto Rico, it may be found from a little above sea level to about 500 m in elevation and in areas that receive from about 900 to 2200 mm of annual precipitation. Dama de noche has an intermediate tolerance of shade. It usually grows in the understory of medium- to low-density forest. The species grows and fruits best when small openings allow broken overhead sunlight to enter. Dama de noche does not invade disturbed areas quickly and so is mainly found in middle and late secondary forests and remnant forests. It can be quite common but does not form dense stands.

Reproduction.—Dama de noche is a good fruit and seed producer and may yield a few to 100 or more fruits per season. Flowering and fruiting seem to be synchronized, at least within a given area. Fruits were observed ripening in a forest in the north of Puerto Rico during the dry season (March). A collection of fruits from that area averaged 0.290 ± 0.012 g/fruit. Air-dried seeds separated from them averaged 0.0169 ± 0.0004 g/seed or 59,200 seeds/kg. Sown on commercial potting mix, 93 percent germinated between 14 and 60 days after sowing. Seeds are apparently dispersed by birds, and seedlings are well scattered and not abundant. Plants resprout when cut or damaged.

Growth and Management.—Dama de noche appears to have a moderate growth rate, probably not exceeding 1 m of height growth per year. No nursery, planting, or management experience has been published. Protection of forests from fires and development is recommended to encourage the formation and development of natural stands.

Benefits.—Dama de noche contributes to the biodiversity of the forests where it grows, helps protect the soil, and furnishes food and cover for wildlife. The stems are generally too small to use for fuel.

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Liogier, H.A. 1995. Descriptive flora of Puerto Rico and adjacent islands. Vol. 4. Editorial de la Universidad de Puerto Rico, San Juan, PR. 617 p.

***Chamaebatiaria millefolium* (Torr.) Maxim.** fern bush
ROSACEAE

Synonyms: *Spiraea millefolium* Torr.
Sorbaria millefolium Focke
Basilima millefolium Greene
Chamaebatiaria glutinosa Rydb.
Spiraea glutinosa Fedde

Nancy L. Shaw

Drawing source: Hitchcock and others 1961

General Description.—Fern bush or desert sweet, the single species in its genus, is an upright, multistemmed, sweetly aromatic shrub 0.3 to 2 m tall. Bark of young branches is brown, becoming smooth and gray with age. Leaves are leathery, alternate, simple, twice pinnately divided, stipulate, and clustered near the branch tips. Foliage and young branches are viscid and pubescent with simple and stellate, pointed and glandular-capitate hairs. Southern populations are evergreen (Phillips 1949), while northern populations are largely deciduous, retaining a few leaves though winter and initiating new leaf growth in early spring. The profuse, terminal, leafy-bracteate panicles are 5 to 20 cm long and produce abundant flowers that are showy, creamy white, and insect-pollinated. Flowers are complete, regular, and five-merous. Follicles are pubescent and coriaceous. Seeds are yellowish to brownish and linear to narrowly fusiform. Germination is epigeal (Hickmann 1993, Hitchcock and others 1961, Welsh and others 1987). Chromosome number is x = n = 9 (McArthur and Sanderson 1985). Variability within the species appears low and hybridization with other species has not been reported.

Range.—Fern bush is endemic to the Great Basin, Colorado Plateau, and surrounding areas. It occurs east of the Cascade and Sierra Nevada Mountains from central Oregon eastward into Wyoming and south to southeastern California, Nevada, Utah, northern Arizona, and northern New Mexico (Hitchcock and others 1961, Phillips 1949, Welsh and others 1987).

Ecology.—Fern bush grows in fissures in rock outcrops and cliffs and on well-drained soils of dry, rocky, gravelly canyons and mountain slopes at elevations ranging from 900 to 3,400 m (Hickman 1993). It is often an early successional species on cinder cones and basalt lava flows, but it also grows on soils derived from limestone and granite (Eggler 1941, Everett 1957, Merkle 1952). Fern bush occurs in isolated populations or as an associated species in *Artemisia* spp., *Pinus* spp.-*Juniperus* spp., northern *Juniperus*, mountain brush, *Populus tremuloides* Michx., *Pinus flexilis* James, *P. ponderosa* Dougl., *Picea* spp. A.--*Abies* spp., *Pinus longaveva* D. Bailey, and chaparrel communities (Hickman 1993, Welsh and others 1987).

Reproduction.—Plants flower from June to September (Hitchcock and others 1961, Phillips 1949) with irrigation prolonging the flowering season (Shaw and Hurd 2001). Seeds ripen in August to October. The follicles are hand collected. They open as they dry, and seeds are extracted by screening. Shaw and Hurd (2001) found an average of about 3.7 million seeds/kg for two seed lots grown under irrigation. Fresh seeds are nondormant while stored seeds require a 1- to

3-month prechill (Phillips 1949, Shaw and Hurd 2001). The optimum temperature for germination of southwestern populations is 18 to 26 °C (Phillips 1949).

Growth and Management.—Seedlings establish from shallow seeding on well-drained soils where vegetative competition is limited (Shaw and Hurd 2001). Fall seeding or artificial prechilling is required for seeds of northern populations. Seedlings develop rapidly if adequate water is available. Bareroot seedlings can be lifted following one growing season. Irrigated plants begin flowering during the second year (Shaw and Hurd 2001). Unlike its namesake genus, *Chamaebatia* Benth., fern bush is not nodulated by nitrogen-fixing actinomycetes (McArthur and Sanderson 1985). Fern bush is a rare host of *Phoradendron juniperinum* A. Gray, the juniper mistletoe (Hawksworth and Mathiasen 1978).

Benefits.—Fern bush provides cover for many organisms. It is sometimes browsed by mule deer (*Odocoilus hemionus* Rafinesque), sheep (*Ovis* spp.), and goats (*Capra hircus*), but it receives little use by cattle (*Bos* spp.). First cultivated in 1878 (Rehder 1940), fern bush is a valued ornamental due to its showy flowers, long flowering period, and fernlike foliage (Hitchcock and others 1961, Phillips 1949). Mass plantings, xeriscapes, screens, hedges, and specimen plants thrive in full sun (Phillips 1949). Native Americans used a tea made from its leaves for treatment of stomachaches (Mozingo 1987). Plants produce cyanic acids in their tissue (Fikensher and others 1981).

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***Chenopodium oahuense* (Meyen) Aellen**. 'aheahea
CHENOPODIACEAE

Synonyms*:* *Atriplex oahuensis* Meyen,
Chenopodium oahuense var *discosperma* Fosb.,
Chenopodium pekeloi Degener, I. Degener & Aellen,
Chenopodium sandwicheum Moq.

Randy S. Senock and Sarah A. Taylor

General Description.—*Chenopodium oahuense*, known most commonly as 'aheahea or 'aweoweo, is a nonscented to lightly scented shrub that sometimes takes on the form of a small tree. Plants may be erect, ascending or prostrate, branched, and total height 0.5 to 2 m. Older branches turn gray and woody with age, while younger tissue remains mealy pubescent, thickened and somewhat fleshy. Leaves are rhombic to broadly deltate, 2 to 4.2 cm long, and 1.3 to 2.5 cm wide, with both surfaces pubescent, the upper surface less so and greener. Leaves three-lobed, teeth rounded to obtuse, base truncate to cuneate, petioles 1.3 to 2.5 cm long (Wagner and others 1990). The leaves are strongly scented when crushed (Lamb 1981). Flowers in small, dense clusters grouped into terminal, almost leafless panicles. A calyx nearly 1 mm long, entirely surrounding the fruit at maturity. Seeds are light to dark brown and may be horizontal or sometimes vertical, about 0.8 mm in diameter, the surface covered with short, blunt, rounded projections (Wagner and others 1990).

Range.—While the genus is pantropical in distribution, this species is indigenous to Hawaii. ‘Aheahea occurs on Laysan, French Frigate Shoals, Necker, Nihoa, Lisianski, and all of the main Hawaiian Islands except Kaho‘olawe (Wagner and others 1990).

Ecology.—‘Aheahea is dispersed across the full range of dryland habitats in Hawaii, from coastal to subalpine. It appears primarily as a shrub but has been found on Mauna Kea on the island of Hawaii 3.5 to 4.5 m tall (Lamb 1981). ‘Aheahea behaves as a colonizer on old lava flows following site disturbance. In many dry upper elevation shrublands on the island of Hawaii, ‘aheahea dominates woody plant density and may be found sharing habitat with native naio, *Myoporum sandwicense* Gray, and mamani, *Sophora chrysophylla* (Salisb.) Seem, trees (Lamb 1981). The US Army has documented 'aheahea as being the most widespread woody plant species across their 108,000 acre Pohakuloa Training Area. Following wildfire in that same area, ‘aheahea reestablishment was delayed for approximately 1 year. Within 4 years, however, it had exceeded its preburn density approximately 15-fold (Sherry and others 1999). 'Aheahea appears well adapted to tolerate drought by dying-back during periods of low moisture and then rapidly growing during periods of higher available moisture.

Reproduction.—Seed production is extremely high for this species. The inflorescence is a large terminal panicle composed of many small, dense glomerules of flowers. ‘Aheahea peak reproductive events appear correlated with favorable environmental conditions such as prolonged periods of available moisture. However, plants can be found in flower nearly any time of year. Chromosome number 2n = 36 (Wagner and others 1990).

Growth and Management.—‘Aheahea grows rapidly and remains fleshy during the first several months of growth. In later stages, branches are brittle and easily damaged. However larger, older individuals become single-stemmed and develop thickened woody branches. ‘Aheahea has been used sparingly as an ornamental in native and xeriscape gardens. The parent plant produces hundreds of seeds, which are easily propagated.

'Aheahea prefers partial to full sun with light watering. The species may have potential in native habitat restoration as a nurse species or to enhance microclimatic understory conditions in favor of woody plant establishment.

Benefits.—The leaves and plant tips are used for greens, and may be eaten like spinach, wrapped in ti [*Cordyline fruticosa* (L.) A. Chev.] leaves and cooked on hot coals. Hawaiians used the plant to make a poultice for minor wounds during battle. Leaves were pounded or crushed and applied like rubbing alcohol, the healing effect due to the presence of chlorophyll in the leaf (Ching 2002). Hawaiians also used the dark red bark pounded in conjunction with other ingredients to create a concoction that would enhance and beautify the skin of a newborn baby when ingested by a pregnant or nursing mother (Anonymous 1996). Two limbs of the shrub wood were connected to create a "makua mano," or shark hook, and in this fashion, 'aheahea was used to catch sharks (Ching 2002). The native shrub is also of great importance to a certain rare beetle, *Rhyncogonus biformis*, that lives on Necker Island. The beetle is nocturnal and emerges at night where it feeds soley on the leaves of the 'aheahea (Kawaharada 2002).

Detrimental Effects.—The flower heads are host plants for *Nysius nemorivagus*, a white Lygaeid bug that can become a nuisance pest for certain agricultural crops such as cabbage, cucumbers, potatoes and all types of squash (Kessing and others 1993).

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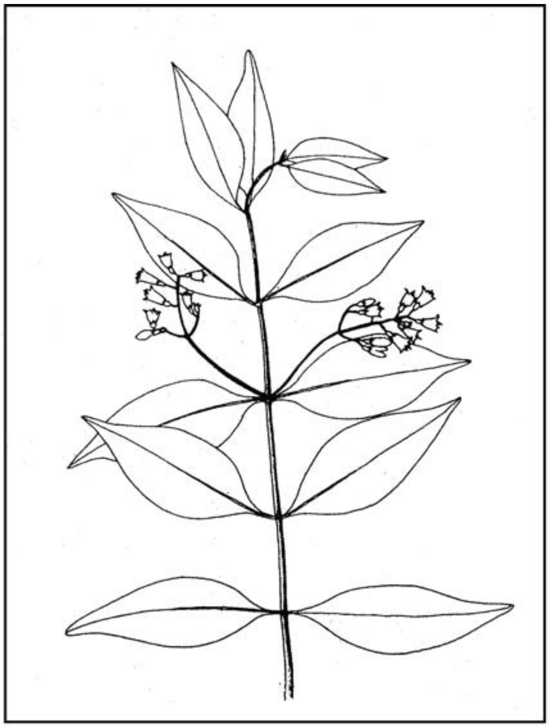
***Chiococca alba* (L.) A.S. Hitchc.** West Indian snow-berry
RUBIACEAE

Synonyms: *Lonicera alba* L.
Chiococca racemosa L.

John K. Francis



General Description.—West Indian snow-berry, is also known as David's root, bejuco de berac, buenda, liane des sorciers and several other common names (Howard 1989). It is one of the most common woody plants in Puerto Rican moist forests. The species grows as a scrambling shrub or woody vine that often climbs taller vegetation and may reach 6 m of extension (Acevedo-Rodríguez and Woodbury 1985). The slender, green stems and branches are four-angled to round in cross section. Opposite branching occurs at the nodes where one or two shoots develop. A vertical shoot at each node commonly ascends from prostrate stems. The root system consists of shallow laterals and abundant fine roots. West Indian snow-berry has opposite, thin to coriaceous, dark green leaves that are ovate or oblong and pointed at the tip and pointed to rounded at the base. The petioles are 2 to 10 mm long and tiny lobbed stipules are present (Liogier 1997).

Range.—West Indian snow-berry grows naturally in Florida, the Bahamas, through the Greater and Lesser Antilles, in Mexico, Central America, and northern South America. The species is not known to have naturalized outside its native range.

Ecology.—West Indian snow-berry grows in moist and dry forests from near sea level to 700 m or more in all types of topography. It will grow on soils of all textures derived from both sedimentary and igneous parent materials including ultramafic rocks (serpentine). Very poorly drained and highly saline conditions are not tolerated. The species may be found in remnant forests in both natural openings and the understory. It invades brushy pastures and roadsides and appears early in the reforestation process. It is intermediate in tolerance to shade. West Indian snow-berry competes well with weeds and brush, but does not prosper in dense grass swards. The species does not appear to be seriously affected by any insect or disease.

Reproduction.—West Indian snow-berry flowers in Puerto Rico from June through October and yields ripe fruits from June through December (Acevedo-Rodriguez and Woodbury 1985). The small white, cream, or yellow flowers are borne in racemes that arise from the leaf axils. The globose but slightly flattened fruits are white and vary in size (4 to 8 mm) and weight (by a factor of 3) in the same inflorescence. The fruits are sweet with little other flavor. The average fruit weight from a Puerto Rico collection was 0.117 $\pm$ 0.003 g. The dark brown seeds, which averaged about two per fruit, weighed 0.004 $\pm$ 0.000 g. Germination is epigeal. For the above sample, germination was 48 percent and occurred between 33 and 59 days after sowing. Stems root when they come in contact with the soil, which results in interconnected patches and many independent plants. Asexual reproduction by air layers and rooted cuttings should be easy. Long distance dispersal appears to be principally done by birds.

Growth and Management.—West Indian snow-berry plants under moderate canopy openings grow up to 0.5 m per year in each of its many stems.

Plants develop slowly in the nursery, requiring 3 months to grow large enough to prick into pots and about an additional year to reach outplanting size. Seedlings and sections of older plants can be dug up in the forest and transplanted successfully (Workman 1980). Once established, West Indian snow-berry needs little maintenance.

Benefits.—West Indian snow-berry is used to a limited extent as an ornamental in naturalistic landscaping (Workman 1980) and is sometimes cultivated as a flowering vine in greenhouses (Bailey 1941). Being very common and widespread, the species contributes to the biodiversity of many Neotropical forests. It is grazed by cattle, goats and certainly wild ruminants and produces fruits that are eaten by birds and other animals. The roots of West Indian snow-berry are used as a purgative, diuretic, vomitive, and antidiarrhetic in herbal medicine (Liogier 1990).

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***Chromolaena geraniifolia* (Urban) King & H.E. Robins.** geranium-leaf eupatorium
ASTERACEAE

Synonyms: *Osmia geraniifolia* (Urban) Britt. & Wilson
Eupatorium geraniifolium Urban

John K. Francis

General Description.—Geranium-leaf eupatorium, a name assigned by the author in the absence of a local common name, is an evergreen shrub up to 2 m in height and 1 cm in stem diameter. The plant usually has several stems arising from the root crown. The root system is composed of fibrous lateral and fine roots. Geranium-leaf eupatorium produces relatively few branches. The foliage, which has a chrysanthemum-like odor, tends to be concentrated near the branch ends. The opposite leaves, which have a short petiole, are densely pubescent, 2 to 6 cm long by 1.5 to 5 cm broad, and deeply lobed or coarsely toothed. Inflorescences are small terminal corymbs of oblong-cylindrical heads. The corolla of the small flowers is blue. The fruits are dark-colored achenes, 4 to 5 mm long with a pappus 4 mm long (author's observation, Liogier 1997).

Range.—Geranium-leaf eupatorium is endemic to Puerto Rico. It occurs mainly in mountainous areas of the central part of the island (Liogier 1997). It is not known to have been planted or naturalized elsewhere.

Ecology.—Geranium-leaf eupatorium can be locally common in scattered populations. It may be found on a wide variety of soils but most frequently is found on well-drained, medium-textured, often rocky soils that develop over igneous, sedimentary, and metamorphic (including ultramafic) rocks. The species is most common in areas of volcanic rock. Geranium-leaf eupatorium grows on sites that receive from about 1200 to about 3000 mm of mean annual precipitation at elevations of 400 to 1,000 m (Liogier 1997). The species is moderately intolerant of shade; it grows well in openings and under the canopy of low basal-area forest. Geranium-leaf eupatorium occurs in remnant and middle- to late-secondary forests, old road cuts and fills, bluffs, and unstable slopes. It grows as scattered individual plants and in small clumps under favorable conditions.

Reproduction.—Geranium-leaf eupatorium was observed in bloom in March by the author. It flowers and fruits abundantly. Seeds collected near Cayey, Puerto Rico, averaged 0.00033 g/seed or 31 million seeds/kg. These seeds were sown on moist filter paper and yielded 67 percent germination between 7 and 24 days after sowing. The seeds are dispersed by the wind. Seedlings and successful natural reproduction are not common.

Growth and Management.—Individual stems of geranium-leaf eupatorium live about 5 years. Plants live much longer because of sprouting that replaces senescent stems. No management guidelines have been published. Planting is probably the best way of establishing new populations, and natural reproduction probably can be encouraged by creating openings with scattered patches of bare soil in forests near seed sources.

Benefits.—Geranium-leaf eupatorium is a pretty plant and contributes to the aesthetic appeal of the forest. It helps stabilize the soil and furnishes cover for wildlife.

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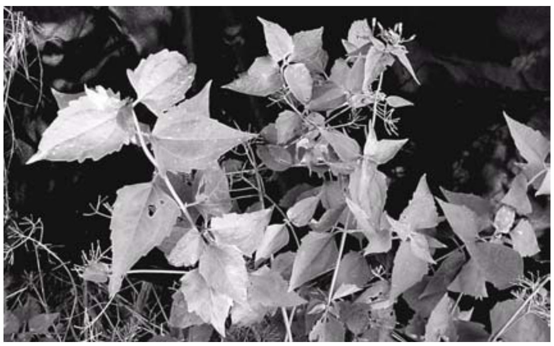
***Chromolaena odorata* (L.) King & H.E. Robins.** Christmas bush
ASTERACEAE

Synonyms: *Eupatorium odoratum* L.
Eupatorium conyzoides Vahl
Eupatorium brachiatum Sw. ex Wikstr.
Eupatorium atriplicifolium Vahl
Osmia odorata (L.) Schultz-Bip.

John K. Francis



General Description.—Christmas bush, also known as bitter bush, Siam weed, baby tea, cariaquillo, Santa María, and fleurit-Noël, is a scrambling shrub (Howard 1989, Liogier 1997). It may reach 1 m or more as a free standing shrub and 4 m or more when climbing into trees or shrubs. Stems reach 2 cm in diameter. The plants are maintained by a system of abundant, yellowish, fine lateral roots. Multiple sprouts arise from the root crown and lower stems. The individual branches are long with relatively few branches. Foliage occurs only on recent growth. The opposite, three-nerved leaves are deltoid to ovate-lanciolate, usually with a dentate margin and a long pointed tip. The leaves are aromatic when crushed. The inflorescences are corymbs of cylindrical heads located on the terminals of lateral branches. There are 15 to 25 tubular florets per head, white, lavender, pink, or blue in color. The seeds are a brownish gray to black achene that is 4 mm long with a pale brown pappus 5 or 6 mm long (Howard 1989, Liogier 1997).

Range.—Christmas bush is native from Florida through the West Indies and from Texas through Central and South America to Argentina (Howard 1989, Liogier 1997). It has been accidentally or deliberately introduced and has naturalized throughout much of the tropics, including Guam and Hawaii (Pacific Island Ecosystems at Risk 2001).

Ecology.—Christmas bush grows from near sea level to over 1,000 m in elevation (Binggeli 1999). It thrives on all types of well-drained soil and can grow on soils relatively low in fertility. Disturbance is required before a site can be colonized (Pacific Island Ecosystems at Risk 2001). Once established, Christmas bush competes aggressively with herbs, grass, and shrubs in open areas. In its native range, it is frequently seen on roadsides, riverbanks, vacant lots, abandoned farmland, and neglected pastures. Christmas bush has found a particular niche in the slash-and-burn agriculture cycle. In Borneo, Christmas bush and other perennial grasses and shrubs invade within 3 years of abandonment and are gradually replaced by trees (Ohtsuka 1999). The species is not shade-tolerant and will not grow under a closed forest stand. It is also intolerant of frost (Binggeli 1999) and is limited by drought (below about 900 mm of mean annual precipitation).

Reproduction.—Christmas bush blooms annually and is an abundant producer of seeds. Flowering and fruiting begins after plants are 1 year old (Binggeli 1999). The flowers are pollinated by insects. The small fruits mature in about a month (Binggeli 1999). One collection of seeds in Puerto Rico averaged 2,670,000 seeds/kg but did not germinate. A second collection averaged 1,560,000 seeds/kg and gave 11 percent germination between 3 and 120 days after sowing. Germination is epigeal. The seeds are wind-dispersed, and transport by animals is possible because of small hooks on the seeds. In India, it was observed that only about 1.4 percent of the first-year seedlings survived into the second year (Binggeli 1999). Stems root whenever they come in contact with the ground.

Growth and Management.—Individual stems last about 2 years and die back to or near the base and are replaced by new sprouts. Plants easily survive cutting and fire. The best current control method is mechanical or hand cutting followed by herbicide treatment. Partial control can be obtained through the use of aggressive cover crops. Relatively good biological control has been obtained with *Pareuchaetes pseudooinsulata* Rego Barros (Lepidoptera) in Guam and several other Pacific islands (Pacific Island Ecosystems at Risk 2001).

Detriments and Benefits.—Invasion of Christmas bush has been disastrous by seriously suppressing native species in disturbed forests and pastures in the tropics outside its native range. The shrub is reported to be highly allelopathic to nearby vegetation (Muniappan 1994), a fact that has been demonstrated in controlled studies (Sahid and Sugau 1993). Christmas bush reduces the diameter growth of teak in infested plantations (Daryono and Hamzah 1979). It was thought to be useful in the control of *Imperata* grass and for this reason was deliberately introduced into the Ivory Coast, but the results were disappointing (Binggeli 1999). Because of the abundance of dead leaves and dry shoots, Christmas bush stands are a fire hazard (Muniappan 1994). Cattle do not eat Christmas bush; however, it is browsed by white-tailed deer (Meyer and others 1984). In herbal medicine, leaf extracts with salt are used as a gargle for sore throats and colds. It is also used to scent aromatic baths (Liogier 1990). Extracts of Christmas bush have been shown to inhibit or kill *Neisseria gonorrhoeae* (the organism that causes gonorrhoea) *in vitro* (Caceres and others 1995) and to accelerate blood clotting (Triratana and others 1991). A satisfactory medium-density particleboard was prepared from Christmas bush stems (Kaleta and others 1999). During fallows between cultivation, Christmas bush adds copious amounts of organic matter to the soil and may reduce the populations of nematodes (M'Boob, 1991). It is also useful as mulch for row crops (Swennen and Wilson 1984).

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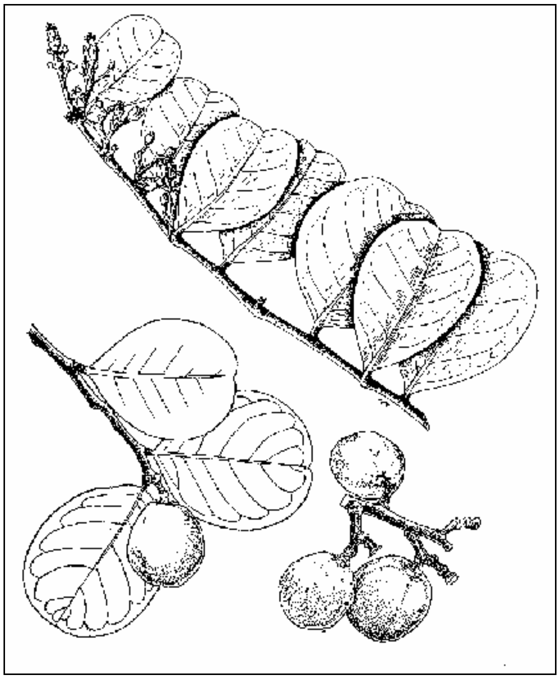
***Chrysobalanus icaco* L.** coco-plum

CHRYSOBALANACEAE

Synonyms: *Chrysobalanus pellocarpus* G.F.W. Meyer
C. icaco L. var. *genuinus* Stahlé & Quentin
C. icaco L. var. *pillocarpa* (G.F.W. Meyer) C. Martius

John K. Francis



General Description.—Coco-plum, also known as icaco, icaque ponne, pork-fat-apple, zicate, and many other common names, is a medium-sized coastal shrub or, rarely, a small tree. It generally has multiple brown or gray stems that are smooth to scaly. The twigs are green and hairless when young and turn reddish brown with raised lenticels. The shrub's habit may be creeping or erect. The branches support many shiny, dark-green, leathery, round, or elliptic leaves 3.8 to 8.2 cm in length and 2.5 to 5.7 cm in width. The under surfaces of the leaves are light green. The petiole is about 3 mm in length. The simple leaves are alternate in two rows, turned upward (Little and others 1974).

Range.—Coco-plum is native to coastal areas of southern Florida and the Bahamas through the Caribbean. It is also found along the coasts of Mexico, through Central America and South America, to Ecuador and northern Brazil. The range has been extended inland in those areas by disturbance and planting (Little and others 1974). *Chyrysobalanus orbicularis* Schum., *C. ellipticus* Soland. ex Sabine, and *C. atacarensis* A. Chev. from Africa were all once considered to be subspecies of coco-plum (Paradis 1987). Probably all the African references to *C. icacos* are really one of these species. There is disagreement among taxonomists as to whether varieties exist among coco-plumb (Howard 1988, Liogier 1985). At most, variation among populations is minor.

Ecology.—Coco-plum is a coastal species. It commonly grows as single plants or thickets on dunes and rocky headlands. It may also be found on shallow soils in moist areas up to a 450-m elevation in Puerto Rico (Little and others 1974). Although the species can survive a great deal of stress from storms, salt spray, and flooding, it is low in stature, relatively intolerant of shade, and only persists where competing vegetation is short. Scale insects and caterpillars sometimes damage natural and ornamental plants in Florida (Vargas-Simon and others 1997).

Reproduction.—The flower clusters (cymes) are shorter than the leaves and borne at the bases of the leaves near the ends of the branches. Several greenish-white flowers less than 1 cm in diameter compose the clusters. Coco-plum flowers and fruits nearly throughout the year. The white to purple fruits are drupes that resemble plumbs. Their thin flesh is spongy, whitish, and slightly sweet to almost tasteless when ripe. Immature fruits are astringent (Little and others 1974). The fleshiness of the mesocarp of fruits varies considerably across its range (Howard 1988). One large (2.5 m tall) coco-plum plant growing under a *Pinus caribaea* Morelet plantation in Puerto Rico yielded 760 ripe fruits in a single picking. Ripe fruits from another Puerto Rican collection weighed 4.36 $\pm$ 1.17 g (mean and standard deviation), and seeds averaged 1,790/kg in one Puerto Rican collection. This seed lot gave 89 percent germination beginning 34 days after sowing sample (Francis and Rodríguez 1993). No scarification or other seed treatment is needed.

Seed dispersion is presumed to be by gravity, water, birds, bats, domestic animals, and humans. Natural reproduction may be sparse to abundant. Artificial reproduction is usually by seeds with plants grown as potted seedlings. Apical and basal semiwoody, leafy cuttings treated with hormones will root in 6 to 8 weeks in mist bed conditions (Vargas-Simon and others 1997). The best treatment tested was Indol Acidic Acid (IAA) at 5,000 ppm applied to apical stem cuttings. Adventitious roots arose from the vascular cambium, and lateral roots arose from the paricycle.

Growth and Management.—Growth is slow in the nursery and the field, so new plantings of coco-plum must be protected from both herbaceous and woody competition.

Benefits.—The fruits are edible raw and can be made into preserves. Coco-plum seeds, which have a high oil content, are also edible. The wood is light brown, hard, and heavy (specific gravity 0.8) and is used for fuel and rustic construction (Little and others 1974). Various parts of the plant have been used in folk medicine. The species is known to have hypoglycemic effects (Costa 1977). It is a honey plant and furnishes food for wildlife. Coco-plum is used in the Eastern and Western Hemespheres as an ornamental. Another important benefit from the species is for dune and soil stabilization.

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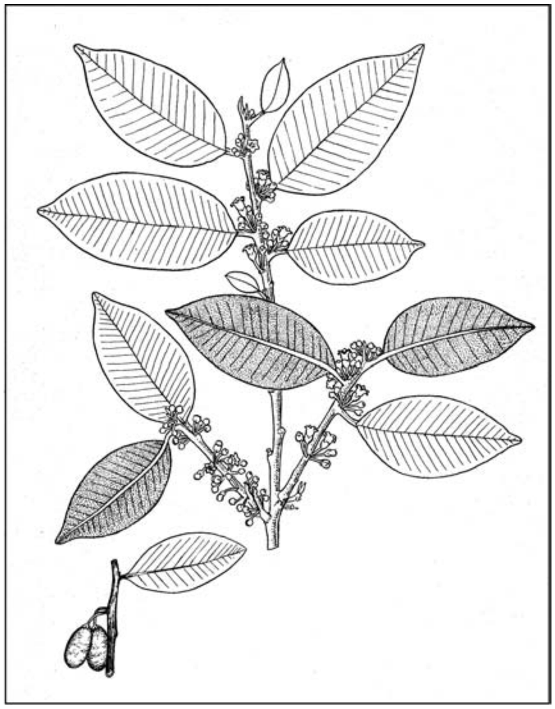
***Chrysophyllum oliviforme* L.** satinleaf

SAPOTACEAE

Synonyms: *Chrysophyllum microphyllum* Jacq.
Chrysophyllum monopyrenum Sw.
Cynodendron oliviforme (L.) Baehni

John K. Francis



General Description.—Satinleaf, also known as wild star-apple, damson plum, saffron-tree, caimitillo, caimitillo de perro, camitillo cimarró, teta de burra, macanabo, and caïmite marron, is a beautiful, evergreen shrub or small tree usually 3 to 5 m in height. Under favorable conditions, older individuals occasionally reach 10 m or more in height and 30 cm in diameter at breast height. The single or multiple stems have gray-brown bark with fissures and plates. Twigs are slender and rusty or reddish-brown. The alternate leaves are elliptic, ovate or oblong, 3 to 11 cm long and 2 to 5 cm broad, with shiny, dark-green, hairless upper surfaces and coppery under-surfaces owing to a dense covering of short hairs. The bell-shaped flowers are one to many on short pedicels in the leaf axils. The 3- to 5-mm, five-lobbed corolla is yellowish- or greenish-white. The fleshy fruits are dark-purple, blue, or black, elliptical, one-seeded berries 1 to 2 cm long. They have whitish flesh surrounded by a gummy or rubbery skin that secretes a white milky sap when cut. The fruits are sweet and edible. Satinleaf has 2n = 52 chromosomes (Gilman and Watson 1993, Liogier 1995, Little and Wadsworth 1964, Long and Lakela 1976, Nelson 1996).

Range.—Satinleaf is native to Florida, the Bahamas, the greater Antilles, and Belize (Liogier 1995). The species is planted in many tropical countries as an ornamental and has become naturalized in Hawaii and French Polynesia (Pacific Island Ecosystems at Risk 2002). It has been declared endangered in the wild in Florida (Crowley 2002).

Ecology.—Satinleaf grows on a wide variety of soils in all textures and in pH's from about 5 to 8, and has a moderate tolerance to salt (Institute of Food and Agricultural Sciences 2002). It grows on coastal sands and shallow clays over limestone in Puerto Rico, in pinelands and hammocks of the everglades and keys of Florida, and in low-elevation moist, secondary forests and *Eucalyptus* plantations in Florida (Little and Wadsworth 1964, Pacific Island Ecosystems at Risk 2002). Satinleaf occurs in remnant and middle secondary forests. When young, it demonstrates an intermediate tolerance to shade and can grow and develop in the understory of relatively low-density forests. To bear fruit, it must have increased light, as in intermediate and codominant crown positions. Satinleaf plants are severely damaged by temperatures of 0 °C and below. They are resistant to drought and storm damage (Gilman and Watson 1993).

Reproduction.—Puerto Rican satinleaf plants flower July to October and mature fruits in February (Little and Wadsworth 1964). They are reported to flower and fruit all year in Florida (Long and Lakela 1976). The flowers are insect pollinated. Seeds are dispersed by frugivorous birds (Pacific Island Ecosystems at Risk 2002). Seedlings are relatively common in suitable habitat in Puerto Rico. Seed weights and treatment information is not available. Misted hardwood cuttings and air layers, both treated with 0.3 percent IBA (indol-butyric-acid), were tested as means of propagating the species vegetatively. Thirty-five of 69 cuttings rooted in 7 months and one of 39 air layers rooted in 6 months (author's observation). Ornamental production is by seed and semihardwood cuttings under mist (Gilman and Watson 1993).

Growth and Management.—Growth is relatively slow at all stages, and the plants are relatively long-lived. Natural reproduction can probably be encouraged by disturbance under low-density secondary forests near seed sources.

Benefits.—Satinleaf contributes to the aesthetics of the forests where it grows, helps protect the soil, and furnishes food and cover for wildlife. It was listed as an important source of nectar for honeybees in the Dominican Republic (Marcano Fondeur 1973). The foliage is probably unpalatable to ungulates; at least the key deer *(Odocoilleus virginianus* ssp. *clavium*) will not eat it (Schaus and others 2002). The fruits are edible and sometimes used to make jelly (Little and Wadsworth 1964). In areas of infestation, satinleaf is usually heavily attacked by Mediterranean fruit fly (*Ceratitis capitata* (Wiedemann) (Department of Entomology and Nematology 2002). The wood, which has a specific gravity of 0.9, is hard, heavy, and strong. It is used for construction in Cuba (Little and Wadsworth 1964). Satinleaf has been extensively, but not intensively, planted as an ornamental in Florida, Hawaii, and elsewhere. It makes a pretty addition to natural landscaping, a good foundation plant, and an attractive lawn, street, and parking lot tree. Pruning may be necessary to maintain a single stem and to remove drooping branches (Gilman and Watson 1993).

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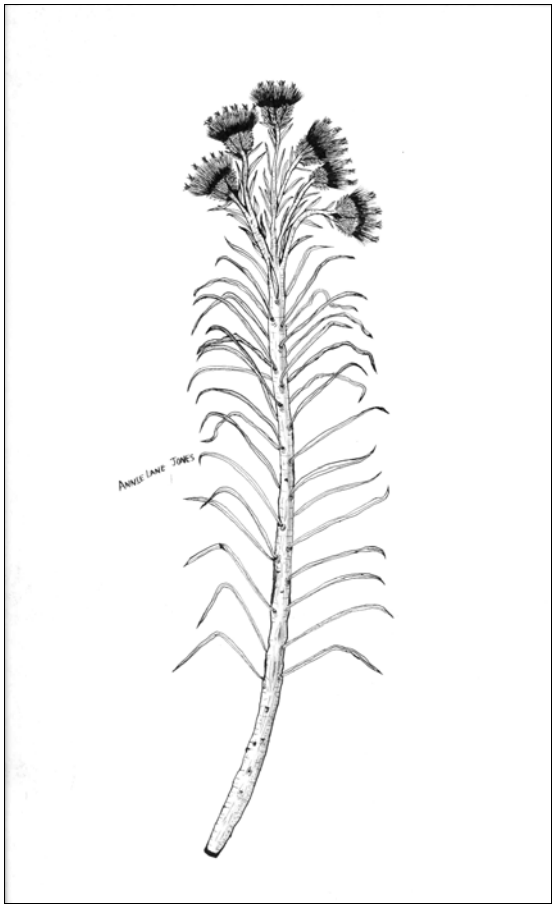
***Chrysothamnus nauseosus* (Pallas ex Pursh) Britt.** rubber rabbitbrush
ASTERACEAE

Synonyms: *Bigelovia nauseosa* Gray
Chrysocoma nauseosa Pallas ex Pursh
Ericameria nauseosa (Pallas ex Pursh) Nesom & Baird

E. Durant McArthur and Jeffrey R. Taylor



General Description.—Rubber rabbitbrush also know as common rabbitbrush is a shrub typically 0.3 to 2.0 m in height. Some types, however, are smaller while others exceed heights of 3.0 m. Usually several erect stems arise from the base and branch to create a rounded form. Branches are covered with a felt-like tomentum, permeated by a resinous gum, which can vary in color from green, yellow-green, gray-green, to white. Leaf shape can vary from filiform to broadly linear, and leaf length can range from 18 to 63 mm. Like branches, leaves are typically covered with tomentum. The flower heads are generally arranged into a cymose infloresence. Involucral bracts in each head may vary from glabrous to highly tomentose and number between 20 and 25. *Chrysothamnus nauseosus* is uniformly diploid, x = 9, 2n = 18 (Anderson 1966).

Taxonomy.—The International Plant Names Index (IPNI) recognizes 30 subspecies of *C. nauseosus* (IPNI. 2002). Some sytematists promote the transfer of rubber rabbitbrush to the genus *Ericameria* (Anderson 1995). Subspecies may vary by morphology, color, and secondary metabolic compounds. Each subspecies is likely the result of reproductive isolation inbreeding, although subspecific sympatry has been observed. Some of the more common subspecies include ssp. *albicaulis*, *hololeucus*, *consimilis*, *graveolens*, and *salicifolius* (McArthur and others 1979). White stem rubber rabbitbrush (*C. n.* ssp. *albicaulis* and *hololeucus*) vary from other subspecies by their dense white to grayish tomentum, the size and arrangement of involucral bracts (five distinct vertical ranks, 8 to 10 mm in length), and the corolla lobe length (1 to 2 mm in ssp. *albicaulis*, 0.5 to 1 mm in ssp. *hololeucus*). These two subspecies are segregated by elevation. Threadleaf rubber rabbitbrush (*C. n. consimilis*) is a tall form, up to 3.0 m, with green to yellow-green tomentum and thread-like leaves. Ecologically, spp. *consimilis* is more likely to be found in alkaline valley bottoms. Green rubber rabbitbrush (*C. n.* ssp. *graveolens*) has yellow-green to green stems and is less pubescent than other subspecies. Mountain rubber rabbitbrush (*C. n.* ssp. *salicifolius*) has larger leaves (4 to 8 cm long and 3 to 10 mm wide), less uniform involucaral bracts, and is one of the more palatable subspecies to livestock and big game.

Range.—Rubber rabbitbrush is common throughout the Intermountain West extending from British Colombia to Saskatchewan and south to western Texas, Sonora, Baja California, and eastern California (Anderson 1986). It inhabits plains, valley bottoms, and foothills and is often associated with sagebrush, pinyon-juniper, and ponderosa pine communities.

Ecology.—Rubber rabbitbrush establishes readily on disturbed areas and can often become the dominant vegetation on lands that have been disturbed by fire, insects, vehicles, or heavy grazing. The species spans a broad elevation gradient, extending from 150 to 2,700 m. with annual precipitation generally in the 250 to 350 mm range. This shrub grows well in sandy, gravelly, or clay-alkaline soils, depending on the subspecies or ecotype. Some subspecies have broader ecological amplitudes than others, allowing them to establish in a variety of habitats (McArthur and others 1979). Although it grows vigorously, it does not exclude or inhibit herbaceous species. On the contrary, production of herbaceous cover was greater where rubber rabbitbrush was present than when it was not present (Frischknecht 1963).

Reproduction.—Rubber rabbitbrush blooms from August to October. Seeds mature beginning in mid-October until late fall. In most conditions, rubber rabbitbrush is a heavy seed producer. Seed germination in rubber rabbitbrush is quite high, and seed viability remains relatively high (65 percent) for up to 3 year's storage under ordinary warehouse storage conditions (Stevens and others 1981). When exposed to cool night (4.7 ^{o}C) and warm day temperatures, seed germinates in about 2 days (Weber and others 1985). Under standardized single cool temperature conditions, however, seeds from lower elevations and latitudes germinate more quickly (2 weeks as compared to 4) than those from higher elevations and latitudes (McArthur and others 1987, Meyer and others 1989). Seed (achene) size in rubber rabbitbrush appears to be correlated to habitat; subspecies adapted to sandy sites have larger achenes (Meyer 1997). There are about 1,530 cleaned seeds per gram (McArthur and others 1979).

Growth and Management.—Once established, wind-disseminated achenes allow rubber rabbitbrush to spread easily and quickly (Meyer 1997, Young and others 1984). It is fast growing, reaching maturity in 2 to 4 years but relatively short-lived shrub, usually 5 to 20 years (personal observation). It can be aerially seeded. Rubber rabbitbrush can be troublesome on rangelands when it invades and occupies areas at high densities. It is a difficult to control because it is resistant to herbicides and has the ability to resprout from the crown (Cook and others 1965).

Benefits.—Rubber rabbitbrush can be an important structural and ecological component in stable and disturbed plant communities. Its ability to stabilize soil and reduce wind and water erosion preserves habitat for other shrubs, forbs, and grasses. This shrub is an excellent plant for erosion control because it has deep roots, produces heavy litter, and is able to establish on severe sites (Aldon and Pase 1981, McArthur and others 1995, USDA 1937). Rubber rabbitbrush is browsed by deer, pronghorn, and by domestic animals, but palatability varies greatly between subspecies and ecotypes. The white to grayish subspecies (*albicaulis*, *hololoeucus*, and *salicifolius*) are more palatable than the green subspecies (*gravelens* and *consimilis*) (Goodrich and others 1999 Hanks and others 1975). Unlike some forage shrubs, however, rubber rabbitbrush is quite resilient to browsing. In addition to food, *C. nauseosus* also provides cover for small mammals, birds, and newly born pronghorn (Yoakum 1986). In addition to its ecological importance, people have also recognized the chemical properties of *C. nauseosus.* Rubber rabbitbrush has been investigated as a possible source of rubber and other chemicals (Hall and Goodspeed 1919; Hegerhorst and others 1987). Some accessions, for example, produce up to 6 percent stem rubber and 20 percent resin. Finally, some forms have ornamental shrub potential (McArthur and others 1979, Weber and others 1985).

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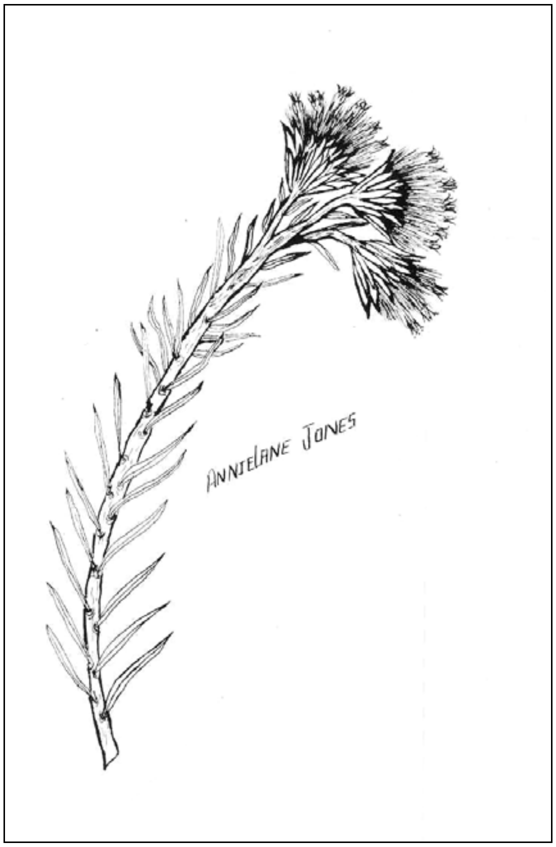
Chrysothamnus parryi (Gray) Greene Parry rabbitbrush
ASTERACEAE

Synonyms: *Bigelovia parryi* Gray
Ericameria parryi (Gray) G.L. Nesom & G.I. Baird
Linosyris parryi Gray

E. Durant McArthur and Jeffrey R. Taylor



General Description.—Parry rabbitbrush is a shrub, intermediate in height, growth habit, and stem and leaf tomentum between rubber rabbitbrush [*Chrysothamnus nauseosus* (Pallas ex Push) Britton] and low rabbitbrush (*Chrysothamnus viscidiflorus* Nutt.). It is usually short, being 20 to 60 cm tall, with numerous spreading to erect flexible branches. Branches are covered with a felt-like white to green tomentum. Leaves are narrowly linear to elliptic. Leaf dimensions range from 0.5 to 8 mm wide and 1 to 8 cm long. The leaf surface is somewhat viscid and leaf pubescence can vary from glabrous to tomentose. Flower heads are composed of four to twenty yellow disc flowers; heads are usually arranged in terminal racemes that sometimes form panicles. Corollas are tubular to funnelform and 8 to 11 mm long. Involucral bracts can vary in length (9 to 14 mm) and shape (acuminate to very attenuate) according to subspecies. Parry rabbitbrush is uniformly diploid n = 9, 2x = 18 (Anderson 1966).

Taxonomy.—Parry rabbitbrush is a diverse group with 12 subspecies (Anderson 1986, McArthur and Meyer 1987). Subspecies vary one from another by numerous characteristics including stature, growth habit, leaf shape, leaf size, involucral bract shape, number of flowers per head, pubescence, and habitat. Neesom and Baird (1993) recently suggested that Parry rabbitbrush would better be placed in *Ericameria* based on molecular genetic data. Anderson (1995) was not comfortable with this change. Notable subspecies include *asper*, *attenuatus*, *howardii*, *monocephalus*, *nevadensis,* and *parryi*.

Subspecies *asper* is a low shrub 15 cm or more high and inhabits mountainsides that border the deserts in western Nevada and eastern California (Anderson 1986, McArthur and others 1979). Leaves are covered with short-stalked resin glands and flower heads contain five to ten disc flowers.

Chrysothamnus parryi ssp. *attenuatus* has small leaves up to 4 mm in length. Stems are mostly erect and shrubs can grow as high as 60 cm. Flower heads contain five to seven disc flowers and bracts are ranked into five vertical rows. This subspecies is found in Utah, southwestern Colorado, and northwestern New Mexico (Anderson 1986, McArthur and others 1979).

Subspecies *howardii* is similar in size to subspecies *attenuatus*. The uppermost leaves usually extend beyond the uppermost heads of the inflorescence. Flower heads have five to seven pale yellow disc flowers and involucral bracts are vertically ranked with spreading tips. This subspecies is endemic to Utah, southern Wyoming, Colorado, New Mexico, and Nebraska (Anderson 1986, McArthur and others 1979).

In subspecies *monocephalus*, leaf shape can vary from linear-oblanceolate to spatulate. Like subspecies *howardii*, the upper leaves usually extend beyond the inflorescence. One unique characteristic is that flower heads occur singly or in pairs rather than forming racemes. Flower heads contain five or six disc flowers subtended by obscurely ranked involucral bracts. This subspecies occurs in high mountains between 790 and 3,400 m in eastern California and western Nevada.

Subspecies *nevadensis* is comprised of small shrubs up to 60 cm in height. Leaves are linear to linear-oblanceolate and covered with resin or gray tomentum. The uppermost leaves rarely extend beyond the inflorescence. Flower heads contain four to six yellow disk flowers and are subtended by ranked involucral bracts with slender recurved tips. Subspecies *nevadensis* occurs on dry mountainsides from eastern California to eastern Nevada, southwestern Utah, and Northern Arizona, being most common on the eastern slopes of the Sierra Nevada (Anderson 1986, McArthur and others 1979).

Subspecies *C. parryi* ssp. *parryi* consists of low shrubs with erect branches and can be as tall as 76 cm. The uppermost leaves usually extend beyond the inflorescence. Flower heads include 10 to 20 disc flowers and are subtended by obscurely ranked bracts with attenuate tips. This subspecies grows on dry hillsides and plains in central Nevada, southern Utah, south-central Wyoming, western Colorado, and northern New Mexico (Anderson 1986, McArthur and others 1979). Anderson (1970) made a case for this taxon being the most primitive of all *Chrysothamnus*.

Parry rabbitbrush in the form of *C. parryi* ssp. *attenuatus* has been implicated in the parentage of the putative stabilized hybrid species *C. nauseosus* ssp. *uintahensis* Anderson 1984).

Range.—The range of Parry rabbitbrush extends from California in the west, to western Nebraska in the east, and from Wyoming in the north, to New Mexico and Arizona in the south. Subspecies, however, may be more geographically restricted. Within its range, Parry rabbitbrush may be found at elevations between 790 and 3,400 m.

Ecology.—Parry rabbitbrush grows on dry, open foothills and mountains. Precipitation throughout its range generally exceeds 380 mm. Parry rabbitbrush tends to increase on overgrazed or otherwise disturbed areas. Populations are usually smaller and more scattered than those of more common species, such as rubber and low rabbitbrushes.

Reproduction.—Parry rabbitbrush flowers from July to September and seed matures in October and November. Achenes are 5 to 6 mm long and covered with long, shaggy, oppressed hairs. We presume there are about 1,600 cleaned achenes per gram and that they have good fertility as is the case for other *Chrysothamnus* species (Deitschmann and others 1974). Achenes are wind disseminated in late fall or winter. In addition to sexual reproduction, Parry rabbitbrush has been observed to spread through underground roots (Paulsen and Miller 1968, McArthur and others 1979). We are unaware of seed germination data.

Growth and Management.—Seed germinates in the early spring and seedlings become established during the following spring and summer. Plants generally mature within 5 years and typically live 15 to 20 years. Paulsen and Miller (1968) reported that, when necessary, Parry rabbitbrush can be controlled by the herbicide Tordon®.[1]

Benefits.—Although Parry rabbitbrush is a component of western uplands, it is spotty in distribution and usually sparse in population density. It has some importance as a browse source in those areas where it is locally abundant. Some subspecies of Parry rabbibrush, including *C. parryi* ssp. *asper* and *C. parryi* ssp. *monocephalus*, are particularly attractive plants and have horticultural potential as ornamentals.

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[1] Use of trade names does not imply endorsement of the U. S. Department of Agriculture

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***Chrysothamnus viscidiflorus* Nutt.** low rabbitbrush
ASTERACEAE

Synonyms: *Bigelovia douglasi* Gray
Chrysothamnus douglasi Clements & Clements
Crinitaria viscidiflora Hook.
Ericameria viscidiflora (Hook) L. C. Anderson

E. Durant McArthur and Jeffrey R. Taylor

General Description.—Low rabbitbrush, also known as yellowbrush, green rabbitbrush, little rabbitbrush, or Douglas rabbitbrush, is an erect shrub, with many branches stemming from a simple base. It is typically 0.3 to 1.1 m tall. Brittle, erect branches can be glaborous or puberulent with pale green or white bark. Leaves are often twisted. Leaf shape can vary between narrowly linear to oblong or lanceolate, with leaf length ranging from 1 to 6 cm. Leaves may be glaborous or pubescent, the degree of which may vary by subspecies. Flowerheads include five perfect, fertile disc flowers, which are arranged in compact terminal cymes. Each head includes approximately 15 involucral bracts that are arranged in poorly to well-defined vertical ranks. The bracts of some subspecies have a greenish to brownish thickened spot near their apex (McArthur and others 1979). Low rabbitbrush is the only species within the genus with frequent polyploidy; diploids, tetraploids, and hexaploids have been documented (x = 9, 2n = 18, 36, and 54, respectively) (Anderson 1966). In addition, occasional triploids and pentaploids are known (Anderson 1971).

Taxonomy.—This species includes five subspecies and several ecotypes within subspecies (Anderson 1980, McArthur and Meyer 1987). The most common subspecies include two glabrous subspecies, *viscidiflorus* and *axillaris*, and two pubescent subspecies *lanceolatus* and *puberlus*. Abrams and Ferris (1960) describe low rabbitbrush as a highly polymorphic species with several freely integrating subspecies with overlapping distributions. Stickyleaf low rabbitbrush or green rabbitbrush (ssp. *viscidiflorus*) is the largest subspecies of low rabbitbrush. Mature shrubs are generally more than 50 cm tall whereas mature shrubs of other subspecies are generally less than 50 cm tall. In addition, the leaves, stems, and inflorescences of ssp. *viscidiflorus* are viscid (sticky). Both mountain low rabbitbrush or yellowbrush (ssp. *lanceolatus*) and hairy low rabbitbrush (ssp. *puberlus*) are shorter at maturity than ssp. *viscidiflorus*, and both have finely pubescent stems. Mountain low rabbitbrush has gray or straw-colored stems, whereas hairy low rabbitbrush has yellow to green stems. All four of these subspecies are fairly widespread throughout the Great Basin. Some previously recognized subspecies, such as ssp. *elegans* and *pumulis*, have been consolidated; chromatographic work substantiates the consolidations (Anderson 1980; McArthur and others 1978). There is a difference of opinion on the taxonomic affinity of *C.*

viscidiflorus with *C. nauseosus* and *C. parryi* based on molecular genetic techniques (Nesom and Baird 1993; Anderson 1995)

Range.—Low rabbitbrush is one of the most widely distributed shrubs in Western North America (McArthur and others 1979). One reason for its broad distribution is the species' great ecological amplitude. It is found growing on dry, open areas from British Columbia and Montana, south to New Mexico, Arizona, and eastern California.

Ecology.—Due to its adaptability, low rabbitbrush grows in a variety of habitats. Plants generally, however, inhabit drier sites, such as foothills, mountains, dry plains, and valleys. Annual precipitation within its range varies between 250 and 535 mm, with notable exceptions at higher elevations. Anderson (1986) has shown that polyploid races, in subspecies where polypoidy occurs (ssp. *lanceolatus*, *puberulus*, and *viscidiflorus*), are adapted to lower and drier sites than their diploid counterparts. Interestingly, Anderson has also observed a correlation within certain subspecies between plant stature and leaf size with altitude and precipitation (personal communication). In addition to its ability to tolerate xeric conditions, some variants of low rabbitbrush can grow well in areas with poor or disturbed soils. Low rabbitbrush can be found at elevations ranging from 790 to 3,400 m. It is commonly associated with big sagebrush (*Artemisia tridentata*), broom snakeweed (*Gutierrezia sarothrae*), and other rabbitbrushes *Chrysothamnus* sp.), although it can be associated with shadscale (*Atriplex confertifolia*), winterfat (*Ceratoides lanata)*, fourwing saltbush (*Atriplex canescens)*, greasewood (*Sarcobatus vermiculatus*), and occasionally pinyon (*Pinus* sp.) and juniper (*Juniperus* sp.). Goodrich and others (2001) note that *C. viscidiflorus* does not commonly overtop associated herbaceous vegetation. Elevation tends to partition the subspecies; mountain low rabbitbrush (ssp. *lanceolatus*) especially and stickyleaf low rabbitbrush (ssp. *viscidiflorus*) grow well at higher elevations, while hairy low rabbitbrush (ssp. *puberlus*) does best on lower desert foothills.

Reproduction.—Shrubs flower from August through October; seed matures from October until December. Like other members of the genus, low rabbitbrush seeds (or achenes) are wind disseminated. Meyer (1996) found that germination rates at 15 ^{o}C for ssp. *lanceolatus* and *viscidiflorus* were 37 and 58 percent, respectively. Seeds from plants adapted to higher elevations (where seeds ripen earlier in the year) are more dormant than those collected from lower elevations and may be more chill responsive (Meyer 1996). There are about 1,720 cleaned seeds per gram (Deitschman and others 1974).

Growth and Management.—Seedlings emerge in spring and grow quickly. After a period of growth and establishment, shrubs often produce seed after their second growing season (Meyer 1996). Low rabbitbrush can dominate rangelands that are grazed heavily or cleared. This species has a strong tendency to sprout from the base (Wasser 1982), which may make it more difficult to remove and difficult to control with herbicides (Cook and others 1965). Fall is the preferred time to seed; seed can be drilled or broadcast and should remain within the top 3 mm of the soil surface. Seeds can be harvested by hand and by vacuum harvesting techniques.

Benefits.—Low rabbitbrush is an important native component of Western North American shrublands. It can provide important browse to both game and livestock, especially during late fall and winter months after more desirable forage has been consumed. As a forage shrub, the palatability of low rabbitbrush varies significantly among subspecies, varieties, locality, and season. Some subspecies, e.g., ssp. *lanceolatus*, may be used heavily by domestic livestock and wildlife, whereas others are consumed little, if at all (USDA 1937, Goodrich and others 2001). In addition to its value as a browse species, low rabbitbrush has successfully been used to revegetate depleted rangelands and other disturbed sites (Plummer 1977).

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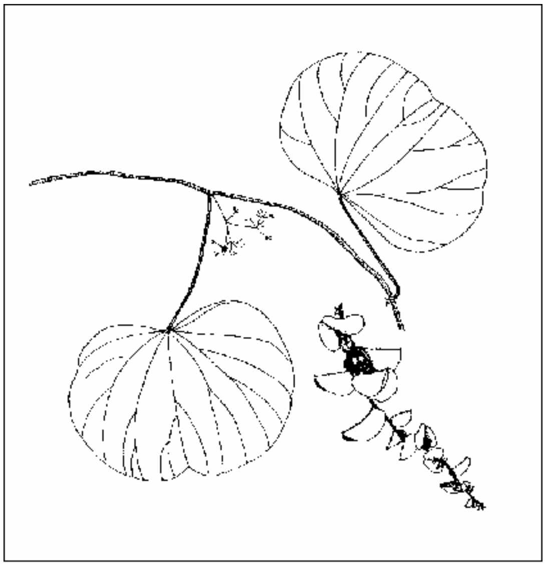
***Cissampelos pareira* L.** velvet leaf

MENISPERMACEAE

Synonyms: *Cissampelos caapeba* L.
Cissampelos microcarpa DC.

John K. Francis



General Description.—Velvet leaf is also known as abuta, pareira, alcotá, bejuco de mona, oreja de raton, hierba de peso, curarina, liane amère, liane-cordé, and liane molle. It is a shrubby climber (or liana) that reaches 3 to 6 m along the ground or into the crowns of trees. The stem is woody, flexible, and slender (to 1 cm), and twines for support. The pith and rays of the stem cross section resemble a wagon wheel with spokes; annual rings are not visible. The root system consists of flexible, light-brown lateral roots with sinkers and moderately abundant fine roots. There are relatively few branches. Alternate leaves are usually softly pubescent on both surfaces. The petioles are 3 to 7 cm long. Venation is palmate in widely oval or nearly round 4- to 10-cm blades. The small staminate and pistillate inflorescences (cymes) are borne in leaf axils. The fruits are juicy red, red-orange, or yellow, hairy drupes 4 to 5 mm in diameter. Each fruit is partially covered by a rounded bract. The seeds have a croissant shape (Acevedo-Rodríguez 1985, Howard 1988, Liogier 1985, Stevens and others 2001). The species' chromosome number is 2n = 24 (Long and Lakela 1976).

Range.—Velvet leaf is native from Mexico to Argentina and Peru on the New World mainland and in the West Indies (Instituto Botánico Darwinian 2002, Secretaría de Medio Ambiente y Recursos Naturales 2002, Stevens and others 2001). It is native to Florida, although rare or possibly locally extinct (Nelson 1996). It is also found throughout tropical Asia and Africa (Long and Lakela 1976, Parrotta 2001), although it is not clear whether it is native or naturalized there.

Ecology.—Velvet leaf is a "good site" species. It usually does not grow on exposed clay subsoils, compacted soils, excessively drained, or very poorly drained soils. The species occurs on a wide variety of soil textures, pH levels, and on soils derived from most parent materials including limestone and ultramafic rocks (serpentine). In Puerto Rico, velvet leaf grows in areas that receive from 750 to about 2400 mm of annual precipitation at elevations from near sea level to about 1,500 m (Stevens and others 2001). Velvet leaf may be found on roadsides, fencerows, river banks, hammocks, brushy pastures, and secondary and remnant forests. It is moderately intolerant of shade and does not grow under the closed canopy of high forest. Openings, and therefore disturbance, appear necessary for the maintenance of the species.

Reproduction.—Velvet leaf flowers and fruits all year in the Americas (Acevedo-Rodríguez 1985, Stevens and others 2001). In India it flowers between July and October and fruits from October to December (Parrotta 2001). Fruits collected in Puerto Rico weighed an average of 0.1925 $\pm$ 0.0008 g/fruit. Seeds from them averaged 0.0109 g/fruit (air-dried). When planted in commercial potting mix without pretreatment, 26 percent of the seeds germinated between 28 and 61 days after sowing (author's observation). Birds presumably disperse the seeds. Fruit and seed production are generally moderate, and seedlings are rarely abundant. Stems layer (root) wherever they contact the soil.

Growth and Management.—No information is available on the growth rate of seedlings. Growth of sprouts is rapid (at least 3 m in the first year). Individual stems are not long-lived, but by sprouting and layering, plants or clones may last many years. The creation of small forest openings and protection against heavy grazing are probably good strategies to promote natural establishment of new plants.

Benefits.—Velvet leaf adds to biodiversity and biomass, helps stabilize the soil, and furnishes food and cover for wildlife. A major interest in the species arises from the natural medicinal benefits of the plant's chemical contents. Known as the "midwife's herb," it has been used for centuries by native peoples of South America to treat menstrual cramps, prevent threatened miscarriage, control uterine hemorrhages, and ease childbirth and postpartum pain (Rain-tree 2002). The list of other natural medicinal applications to which the herb is applied is large: urinary infections, kidney stones, arthritis, snakebite, cough, dysentery, piles, ulcers, pain, indigestion, colic, skin irritations, stings, intestinal worms, and wounds (Parrotta 2001, Rain-tree 2002). Ground tissues and preparations of velvet leaf are sold throughout the world in markets, shops, and mail-order companies. The physiological effects are apparently derived from a number of alkaloids found in the tissues of the plant (International BioPark Foundation 2002, Morita and others 1993a, Morita and others 1993b).

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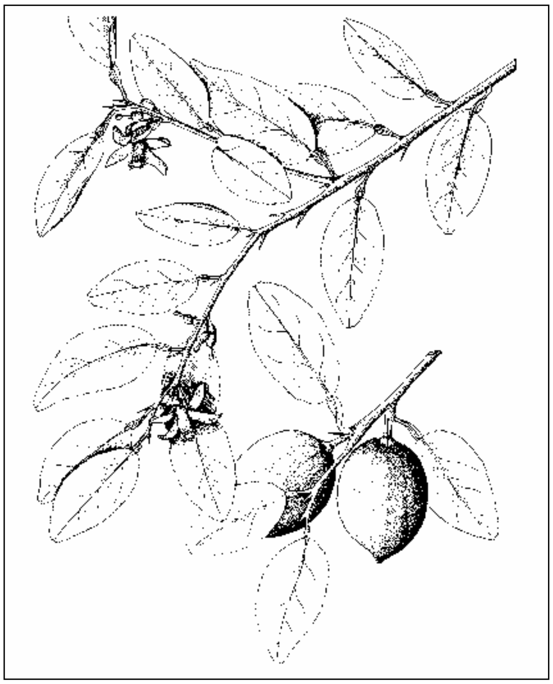
***Citrus aurantiifolia* (Christm.) Swingle** Key lime

RUTACEAE

Synonyms: *Limonia aurantifolia* Christm.
Limon spinosum Mill.
Citrus limonia Osbeck
Citrus lima Luman
Citrus spinosissima G.F.W. Meyer
Citrus acida Roxb.

John K. Francis



General Description.—Key lime is the name used most often to refer to a primitive race of *Citrus arantiifolia* cultivated and naturalized in the West Indies. It is also referred to as Mexican lime, West Indian lime, lima, limón criollo, limón agria, limón boba, and citron (Little and Wadsworth 1964). Key lime is an evergreen, spiny shrub or small tree to 6 m in height. The plant has single or multiple stems and irregular branches covered with smoothish brown to gray bark. The twigs are quadrangular (when young), green, and bare sharp axillary spines 3 to 17 mm long. The leaves are yellow-green to dark green, with 5- to 28-mm winged petioles and elliptic to oval leathery 4- to 13-cm long blades with edges that have minute rounded teeth. The crushed foliage has a strong, distinct, spicy (citrus) odor and taste. The four- to five-petaled white flowers occur in few-flowered axillary clusters. The fruits (hesperidiums) are ellipsoidal, 3 to 5 cm in diameter, have juicy, greenish-yellow flesh, and are yellow at maturity. They contain a few white, pointed seeds about 1 cm long (Liogier 1988, Little and Wadsworth 1964).

Range.—Key lime is believed to be native of eastern Malaysia. It was introduced to the Asian mainland early in historical times and carried by Arab traders to the Middle East and eventually came to Europe during the Crusades (Burkill 1997). The species was introduced to the West Indies by Columbus during his second voyage (Ehler 2002). Key lime has been planted throughout the tropics and has naturalized in at least Puerto Rico, the Virgin Islands (Little and Wadsworth 1964), and the Florida Keys (Nelson 1996).

Ecology.—Key lime is most competitive in areas that receive from about 700 to 1000 mm of mean annual precipitation. It tolerates drought better than any of the other citrus fruit species (Morton 1987). If planted, it will grow but becomes increasingly susceptible to disease in areas that receive up to about 2000 mm of annual precipitation. Most well-drained soils are suitable, particularly those rich in calcium (Morton 1987). Elevations below 900 m are best (Secritaría del Medio Ambiente y Recursos Naturales 2002). Key lime is intolerant of shade and will not survive long under a closed forest canopy. Cattle grazing encourages it somewhat by eliminating some of the competition without damaging it. Plants are top-killed by fires and hard frosts, but will sprout and survive if the disturbance is not repeated frequently. Naturally reproduced trees may be seen on roadsides, fencerows, abandoned farms, secondary forests, and coastal hammocks.

Reproduction.—Key lime flowers in late spring and fruits in fall to spring in Florida (Nelson 1996). In Puerto Rico, it flowers in spring to early summer and fruits in summer and fall (Little and Wadsworth 1964). The fruits ripen and fall from the trees 5 to 6 months after flowering (Morton 1987). Fruits in one collection in Puerto Rico ranged from 3.0 to 4.5 cm in diameter and weighed from 19 to 51 g. Air-dried seeds separated from them averaged 0.0702 $\pm$ 0.0037 g/seed or 14,000 seeds/kg. Placed on moist blotter paper, 84 percent germinated between 15 and 49 day after sowing. Germination is epygeal. Many of the seeds are polyembryonic. Seedlings begin to fruit in 3 to 6 years (Morton 1987). In the West Indies, the seeds are mainly dispersed by gravity and humans. There are undoubtedly animal vectors in the original native habitat. Key lime can be air-layered using indol buteric acid (IBA) with a high degree of success (Morton 1987).

Growth and Management.—Growth of Key lime is slow, less than 0.5 m/year. Plants may live for 25 years or more. Although the species is not managed in the wild, existing trees are usually protected by local inhabitants, whenever possible. Plantations are established using potted material that is set at 7.5- by 7.5-m spacing. Pruning is usually not necessary (Morton 1987).

Benefits.—Key lime has been under cultivation or semicultivation for thousands of years. Improved horticultural varieties, which have bigger, generally seedless fruits and thornless plants, now dominate the local and international fruit markets. The unimproved type is still managed commercially and is the basis for a juice and lime oil industry (Morton 1987). It is also planted for a dooryard fruit tree, and fruits are harvested from the wild. The principal use is still for food, refreshing drinks, tasty disserts, and for seasoning meats, vegetables, salads, sauces, and casseroles (Ehler 2002, Katzer 2002). The wild type is superior in flavor to the improved varieties because it has a stronger flavor and a higher acid content (Ehler 2002). The pericarp (rind) contains 7 percent essential oil with principal constituants, citral, limonene, and fenchon as well as terpineol, bisabolene, and other terpenoids (Katzer 2002). Key lime is used to treat a huge number of ailments (Burkill 1997, Liogier 1990). The author recommends a tea prepared from juice, fruit rind, or leaves as an expectorant and to relieve catarrh brought on by colds and flu. The fresh fruits and bottled juice are an excellent source of vitamin C and were once relied upon to prevent scurvy. Essential oils of Key lime and some other citrus fruits cause phytophotodermatosis in sensitive individuals (Bruneton 1999). The wood is hard and heavy, but is used for little other than fuel. It is a good honey plant. With pruning, the plant can be used for a living fence post (Little and Wadsworth 1964) and can be formed into a hedge (Burkill 1997).

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***Clematis orientalis* L.** oriental virginsbower

RANUNCULACEAE

Synonyms: *Clematis aurea* A. Nels. & J.F. Macbr.
Viticella orientalis (L.) W.A. Weber

John K. Francis

General Description.—Oriental virginsbower, also known as orange peel or orange peel clematis, is a deciduous, sometimes suffruticose vine or scrambling shrub. The multiple stems may reach 8 m in length and as much as 7 cm in thickness. Stems are covered with longitudinally fissured gray-brown bark. Inner bark is green. Vines cling to rocks and other plants by twining as they climb. The roots are weak and flexible. Fine roots are tan or orange-tan. The leaves are pinnately compound with three to seven coarsely-toothed to entire, ovate to linear-lanceolate leaflets 1 to 5 cm long. The foliage has a gray-green color. Axillary cymes, which may have one to many flowers, are borne on the current season's growth. Four yellow, yellow-orange, or yellowish-green sepals give the flowers their color. Flowers have a delicate fragrance. The feather-like style, 3 to 10 cm long, remains attached to the achene and functions as a wing. There are 2n = 16, 32 chromosomes (Plants for a Future 2003, Welsh and others 1987, Wu and others 2001).

Range.—Oriental virginsbower is native from Turkey through Asia to the Korean Peninsula and south to Iran and Northwest India (Griffiths 1994). The species has been widely planted as an ornamental and has naturalized and escaped in Idaho, Nevada, Utah, Colorado, and New Mexico (Natural Resources Conservation Service 2003) and probably other places in the world. There are two varieties, *orientalis* and *robusta,* separated on the basis of pedicel length and thickness (Wu and others 2001).

Ecology.—Oriental virginsbower grows in shrublands, riverbanks, gullies, sand depressions, and riparian forests in hot, dry valleys and desert and semidesert areas. In Utah, oriental virginsbower is mostly found along rivers, creeks, and intermittent streams at the mouth of canyons. It is not present in cooler sites farther up the canyons. It requires well-drained soils, but is not particular about soil texture, and tolerates acid and alkaline soils from a wide range of parent materials. It does well on chalky soils (Plants for a Future 2003). The species inhabits sites with elevations between 400 and 3,800 m (Wu and others 2001). It is hardy to about –15 °C (Plants For a Future 2003) and presumably survives from roots after top damage. Oriental virginsbower will climb taller vegetation, fences, and rocks, but forms mounds and mats when objects to climb are not available.

Reproduction.—Oriental virginsbower flowers between August and October. Both flowers and fruits are often present on the plant at the same time. The flowers are pollinated by bees and flies (Plants for a Future 2003). A group of air-dried seeds collected in Utah averaged 911 seeds/g. Oriental virginsbower seeds are dispersed by the wind. Seedlings are not abundant. It reproduces vegetatively by sprouting from the root crown and by layering.

Growth and Management.—Growth of oriental virginsbower is rapid, at least 1 m/year from sprouts or existing stems. Although the risk of environmental damage is not severe, because it is an alien, the species should not be used in environmental restoration plantings. No specific recommendations for control are available, but the general procedure of cutting plants and spot spraying the sprouts with broadleaf herbicide would probably be effective. The use of potted seedlings or rooted cuttings for ornamentals is recommended. They should be outplanted in the spring after the frost danger has passed. Pruning should take place in the spring (Plants for a Future 2003).

Benefits.—Oriental virginsbower is planted as an ornamental and ground cover. Plants escaped into the wild help protect the soil, furnish cover for wildlife, and add beauty to the landscape, especially during the fall when it produces flower and seed heads. Oriental virginsbower is used in landscaping as a flowering ground cover. Infusions are used as a gargle for sore and ulcerated throats and to treat dog bites (Plants for a future 2003).

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***Clibadium erosum* (Sw.) DC.** carruzo
ASTERACEAE

Synonyms: *Trixis erosa* Sw.

John K. Francis

General Description.—Carruzo, also known as jackass breadnut, cachimbo, tuchima, turma de toro, bois énivrant, and medsinnyé benní, is a shrub or small tree up to 6 m in height and 10 cm in basal stem diameter. These plants have a single stem from the ground, unless damaged, and are much branched in the crown. The trunk bark is gray to greenish brown, smooth to slightly fissured. The white wood is soft to medium in hardness, brittle, without annual rings, and has a 3-mm pith. The plant often breaks at forked stems. Carruzo plants are supported by a root system of tan, flexible laterals and may or may not retain a taproot. The twigs are ringed at the nodes by opposite, three-lobbed leaf scars and densely pubescent. The leaves are broadly ovate, with long, 2- to 8.5-cm petioles, coarsely and finely incised-dentate, and have an elongated tip. The inflorescences are many-branched clusters (corymbs) containing many heads with white to rose-purple flowers. Several black, 2- by 1.5-mm, seed-like fruits (akenes) are produced per flower (Howard 1989, Liogier 1997, Little and Wadsworth 1964).

Range.—Carruzo is native to Puerto Rico, St. Martin, Saba, St. Kitts, Nevis, Montserrat, Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent, Costa Rica, and Panama (Howard 1989, Missouri Botanical Garden 2003). The species is not known to have been planted or naturalized elsewhere.

Ecology.—Carruzo is a species of moist and wet mountains. It grows at elevations above about 400 m in Puerto Rico and it is reported from 800 and 1,300 to 1,500 m in Costa Rica (Instituto Nacional de Biodiversidad 1997, Missouri Botanic Garden 2003). Mean annual rainfall of its habitat in Puerto Rico ranges from 2000 to over 4000 mm/year. The soils are mostly clayey, derived from a variety of rock types, anaerobic in their subsoils, and have pH's between 5 and 6. Because the species is light-demanding, it grows mainly in disturbed areas (Little and Wadsworth 1964) such as roadsides, cuts and fills, landslides, tree-tip mounds, logged areas, plantations, fields, and abandoned construction sites. Once established, carruzo competes aggressively with grass, herbs, and shrubs of equal or lesser height. Overtopped, it soon dies.

Reproduction.—Carruzo flowers and fruits nearly throughout the year, at least in Puerto Rico (Little and Wadsworth 1964). Fruits are produced in great numbers. A group of akenes harvested in Puerto Rico averaged 0.001867 g/fruit or 536,000 fruits/kg. The author could not germinate the hard akenes on moist blotter paper. Some sort of pretreatment is probably necessary. Fruits can be collected in quantity by hand. Means of dispersal is unknown. Seedlings are common on disturbed ground near seed sources. Carruzo shrubs will sprout if disturbed and will layer if intact stems come in contact with the ground.

Growth and Management.—Carruzo grows rapidly, adding 1 to 1.5 m/year to its height. It begins flowering and fruiting after about 1 year and probably lives 2 to 5 years. There is no published record of planting or propagation techniques. Because it grows rapidly and thickly in disturbed areas, carruzo sometimes becomes weedy in fields, plantations, and along roads.

Stands along roads are routinely controlled by mowing.

Benefits.—Carruzo helps protect the soil in disturbed areas, serves as a nurse species for later successional species, and provides cover and possibly food for wildlife.

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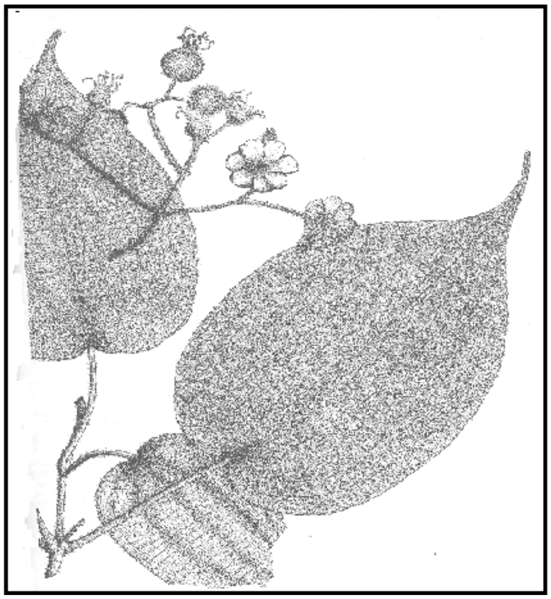
Clidemia cymosa **(Wendl. ex Spreng.) Alain** camasey peludo
MELASTOMATACEAE

Synonyms: *Heterotrichum cymosum* (Wendl.) Urban
Melastoma cymosa Wendl. in Spring.
Heterotrichum eggersii Cogn.

John K. Francis



General Description.—Camasey peludo, which means hairy melastome, is also known locally as camasey colorado, camasey de paloma, pelúa, and terciopelo. It is a medium to large shrub to 4.5 m in height and 7.5 cm in trunk diameter. Shrubs 1.5 to 2.5 m in height are typical. The stems may be single or multiple. The bark is thin, gray-brown, and smooth or slightly fissured. There are relatively few branches. The twigs are red or orange near the tips due to a thick covering of reddish hairs, greenish below, becoming brown as they grow older. The young leaves are bright red or orange. As the leaves approach full size, the color fades to green on the upper surface with reddish accents at the edges and other areas where hairs are concentrated and yellow-green on the lower surface. The leaves are ovate with a cordate base and an elongated tip and have seven veins radiating from the base. The petioles are 4 to 9 cm long and the blades are 8 to 18 cm long and 7 to 12 cm broad. The 1.9-cm, white or pinkish flowers are grouped in terminal panicles. The purple berries that develop are about 12 mm in diameter. They are juicy and edible with a delightful flavor somewhat like blueberries. Each berry contains up to hundreds of tiny, light brown seeds (Liogier 1995, Little and Wadsworth 1964).

Range.—Camasey peludo is endemic to Puerto Rico (Liogier 1995). It grows mainly in the Luquillo Mountains, the Cordillera Central, and moist foothills in the eastern, northern, and western districts (Little and Wadsworth 1964).

Ecology.—Camasey peludo is common and widespread but never abundant. It is confined to disturbed, open areas, such as roadsides, landslides, recently abandoned fields, and large tree-fall gaps. Camasey peludo grows in areas receiving from about 1600 to over 3000 mm of annual precipitation on soils derived from igneous and sedimentary rocks. These upland soils are mostly highly weathered clays with slow internal drainage. The species grows from a few meters above sea level to nearly 1,000 m in elevation. Camasey peludo are occasionally attacked (sometimes lethally) by white flies (Aleyrodidae) and mealy bugs (Pseudocoddidae, author's observation). *Cyrtopeltis modesta* Distant (Hemiptera), *Paurocephala heterotrichii* Caldwell (Homoptera), and *Bleparomastix ebulealis* Guenée (Lepidoptera) have also been observed attacking camasey paludo (Martorell 1975).

Reproduction.—Camasey peludo flowers and fruits nearly throughout the year (Little and Wadsworth 1964). A collection of fruits averaged 1.298 $\pm$ 0.046 g/fruit and ranged from 0.650 to 1.998 g/fruit. Seeds separated from them averaged 98 million seeds/kg (air dry). Sown on moist filter paper, 85 percent germinated between 11 and 49 days after sowing. No data on nursery management of seedlings is available. Forty-four branches of camasey peludo were air layered by girdling and treating with 0.3 percent IBA in talcum, then covered with commercial potting mix and wrapped with aluminum foil. Eighty-nine percent rooted. However, IBA-treated cuttings placed in a mist bed entirely failed to root and grow. Natural layering is common.

Growth and Management.—Camasey peludo plants are relatively short-lived, lasting about 3 to 6 years. Resprouting and layering may enable them to persist somewhat longer. There is no reported planting or management experience for this species. Plants cloned by layering should be used for planting until methods of growing the plants from seed are developed. Natural reproduction in areas of abundant rainfall may be encouraged by cultivation or scalping to expose a bare seedbed during wet portions of the year.

Benefits.—Camasey peludo is an attractive roadside plant and should be encouraged whenever possible. Its beauty also suggests real potential as an ornamental, although its life is short and it has a tendency to unsightly decline in its last year. The fruit, currently almost unknown to the public, is very tasty and deserves attention. The fruits are a food source for birds. The light-brown, moderately hard wood has a specific gravity of 0.6 but is not used because of the poor form and small size of the plants (Little and Wadsworth 1964).

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***Clidemia hirta* (L.) D. Don** Koster's curse
MELASTOMATACEAE

Synonyms: *Melastoma hirta* L.
Clidemia crenata DC.
Melastoma elegans Aublet
Clidemia elegans (Aublet) D. Don

John K. Francis

General Description.—Koster's curse (a Hawaiian name) is also known as clidemia, soap bush, camasey, camasey peludo, nigua, kak mél, bon bon mél, canot-macaque, and bonbon bleu. It is a weak upright or scrambling shrub that varies in mature size from less than 1 m to 5 m in height, depending on habitat. Koster's curse is supported by shallow lateral roots and abundant fine roots. There are usually multiple stems arising as sprouts from the rootstalk and base of the principal stem, especially in older and disturbed plants, resulting in dense shrubs. The branches and twigs are slender. The 5- to 18-cm, opposite leaves have a short petiole, five to seven principal nerves radiating from the base, an ovate blade with a serrated to entire edge, usually subcordate base and pointed tip. The whole plant is covered with brown hairs. Inflorescences are branched axillary cymes with five-merous white flowers. The fruits are ellipsoidal, purple-to-black berries 6 to 8 mm long with a flavor similar to blueberries, but weaker. Each fruit contains over 100, 0.5- to 0.7-mm-long, coffee-colored seeds (author's observation, Howard 1989, Liogier 1995, Smith 1992, Stevens and others 2001).

Range.—Koster's curse is native to the Greater and Lesser Antilles, southern Mexico, Central America, and South America as far south as Northern Argentina and Bolivia (Howard 1989, Liogier 1995, Stevens and others 2001). It has naturalized in Hawaii, American Samoa, many of the Pacific and Indian Ocean islands, Australia, Southern Asia, Sri Lanka, India, and East Africa (Binggeli 1997, Pacific Island Ecosystems at Risk 2002).

Ecology.—In its native range, Koster's curse colonizes disturbed habitat—landslides, river banks, burned areas, tree tip mounds, pastures, old fields, plantations, fence rows, and roadsides. It occurs as scattered plants, occasionally as thickets, which flourish for a few years and succumb to competition or disease and insects. It tolerates a wide range of soil properties as long as moisture is adequate. Annual rainfall ranges from about 1200 to 4000 mm. Elevation may vary from near sea level to 1,500 m. The species grows well in full sun but is moderately tolerant of shade. In some non-native habitat in the absence of the usual insects, fungi, and fast-growing competitors, Koster's curse forms dense and tall, monotypic thickets under forest canopies that shade out virtually all vegetation below them (Binggeli 1997, Smith 1992).

Reproduction.—Koster's curse flowers and fruits year-round in continuously moist habitat. After dry seasons or droughts, in which it may defoliate or die back, it recovers and begins flowering again. A large plant may produce more than 500 fruits/year (Smith 1992). A collection of fresh fruits from Puerto Rico weighed an average of 0.2171 $\pm$ 0.0081 g/fruit. Air-dried seeds separated from them averaged 0.00383 g/seed or 260,000 seeds/kg (author's observation). The seeds are dispersed by birds, feral pigs, other animals, and humans. The seeds can remain viable in the soil for up to 4 years. The stems root on contact with moist soil; even detached leaves have been observed to root (Smith 1992).

Growth and Management.—Koster's curse grows slowly in the first months and faster thereafter. It often dominates at the end of the first year (Binggeli 1997). Individual stems live 2 or 3 years in Puerto Rico, although plants may live longer by sprouting. There is little motivation to encourage Koster's curse and often a need to control it. Single-pass mowing is usually ineffective. Spraying with broadleaf herbicides is the most widely used control method, supplemented by hand pulling (Rubber Research Institute of Malaya 1973). At best, such measures are temporary. Some success has been achieved with biocontrol by the introduction of *Liothrips urichi*, a thrips (Binggeli 1997). A number of other natural controls are being studied (State of Hawaii Department of Agriculture 2002).

Benefits and Detriments.—Desired or not, Koster's curse helps revegetate disturbed areas and provides a reliable food source for wildlife. The species is used in Brazil to treat *Leishmania braziliensis* skin infections (Franca and others 1996). On the other hand, Koster's curse is a serious threat to understory plant species in fragile tropical island ecosystems (Pacific Island Ecosystems at Risk 2002). It is a serious weed in tropical plantations such as rubber (*Hevea brasiliensis* Muell. Arg.). Sheep have been shown to control most weeds in plantations but will not eat Koster's curse (Chee and Faiz 2002). Goats suffer toxicity from hydrolysable tannin when fed the plant (Murdiati and others 1990).

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Coccoloba krugii Lindau wild-grape
POLYGONACEAE

Synonyms: none

John K. Francis

General Description.—Wild-grape, also known as white wood, crabwood, and bow-pigeon, is an evergreen shrub or small tree 1.5 to 6 m in height and stem diameters up to 10 cm. The plant is supported by an extensive lateral root system of black roots. Older plants usually have multiple stems arising from the root crown. The smooth or slightly fissured bark is gray. A dense, branchy crown is formed of trident or bifurcate branches and slender twigs. Leaves have a reddish petiole 5 to 6 mm-long, and reddish midvein. The blades are coriaceous, entire, ovate to suborbicular, and 2 to 6 cm long. This species is dioecious (male and female flowers on different trees). The flower clusters are terminal spikes. Flowers are tiny, greenish-white, five-merous, and nearly stalkless. The fruits are fleshy and black, ovoid and somewhat triangular in cross section, 4 to 5 mm long, and have a mildly sweet flavor somewhat like grapes. The fruit juice stains skin and clothing. Each fruit contains one dark brown akene (Howard 1988, Liogier 1985, Little and others 1974).

Range.—Wild-grape is native to the Bahamas, Jamaica, Hispaniola, Puerto Rico, the Virgin Islands, St. Martin, Anguilla, Barbuda, and Antigua. A natural hybrid, *Coccoloba krugii* x *uvifera,* with features intermediate between the two parents is found in Puerto Rico, the Virgin Islands, Anguilla, and Barbuda (Howard 1988, Liogier 1985, Little and others 1974).

Ecology.—Wild-grape grows on well-drained to excessively drained, mostly slightly acid to mildly alkaline soils in the whole range of soil textures. It is found in Puerto Rico and the Virgin Islands from near sea level to 125 m in elevation (Little and others 1974) in areas that receive from 750 to 950 mm of annual precipitation. Wild-grape is intolerant of shade. Because it grows slowly, in order to compete it must grow on difficult sites such as beach strands, dry coastal forests, shallow rocky headlands, hillsides, and ridges. The species is mostly found in remnant forests and sometimes highly disturbed galleries. Wild-grape may occur as individual plants, in groups, or in thickets.

Reproduction.—Wild-grape flowers in the fall and bears fruits during the winter (Little and others 1974). A collection of fruits from Puerto Rico averaged 0.0985 $\pm$ 0.0021 g/fruit. Air-dried seeds separated from them weighed an average of 0.0148 $\pm$ 0.003 g/seed or 68,000 seeds/kg. However, sowing them in commercial potting mix with no pretreatment resulted in only 5 percent germination. The seeds are dispersed by birds, iguanas, and possibly mammals. Seedlings are not common. Plants sprout when cut or burned.

Growth and Management.—Growth of wild-grape is slow, perhaps 10 to 20 cm of height per year. Plants are relatively long-lived and may renew themselves by coppicing and continue clonally through more than one generation of crowns. No management experience has been published. Planting any slow-growing species in wildlands is a challenge; protection of remnant forests is probably the best approach to promoting wild-grape.

Benefits.—Wild-grape wood is heavy and hard and useful for at least fuel. The fruits are edible and tasty, though small. The fruits are counted among the food sources of the endangered Anegada iguana (*Cyclura pinguis*) (International Reptile Conservation Foundation 2002).

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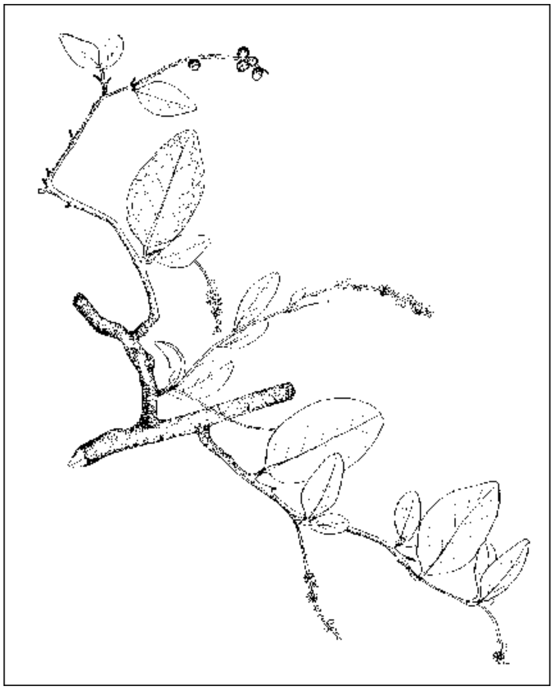
Coccoloba microstachya Willd. pockhout

POLYGONACEAE

Synonyms: *Coccoloba parvifolia* Poir. in Lam.
Coccoloba klotzschiana Meisn. in DC.
Coccoloba microstachya var. *ovalifolia* Miesn. in DC.
Coccoloba microstachya var. *lanceolata* Meins. in DC.
Coccoloba microstachya var. *rotundifolia* Urb. ex Lindau
Coccoloba microstachya var. *obtusifolia* Lindau

John K. Francis



General Description.—Pockhout, a name used in the Virgin Islands, is known as uvillo, uverillo, and negra loca in Puerto Rico and Hispaniola. It is an evergreen or semideciduous shrub or small tree usually 2 to 6 m in height and 2 to 7 cm in diameter at breast height. It is limby and twiggy with a contorted form and often develops multiple stems from suckers on the lower stem. The wood is light brown and hard. The plants are supported by a weak taproot and many, extensive, reddish-brown, tough and flexible lateral roots. The fine roots have clearly visible mycorrhizal sheaths. The stem bark is gray, smooth, becoming deeply furrowed into plates in old individuals. The twigs are brown to gray, smooth with lenticels. The light-green, alternate leaves have short petioles, 3 to 6 mm long, have broadly elliptic to ovate-lanceolate blades 3.5 to 7 cm long, entire edges and generally rounded at both ends. Inflorescences are terminal spikes. Male and female flowers are borne on different shrubs (dioecious). The flowers are greenish white and tiny. The egg-shaped fruits are sessile, 6 mm long, nearly black or dark brown when ripe, and contain one blackish seed (Liogier 1985, Little and others 1974).

Range.—Pockhout is native to Hispaniola, Puerto Rico and its offshore islands, and the Virgin Islands (Liogier 1985). Little and others (1974) also list Anguilla as having a population. The species in not known to have been planted or naturalized elsewhere.

Ecology.—Pockhout grows on a wide variety of well- to excessively-drained soils over sedimentary (especially limestone), igneous, and metamorphic (especially ultramaphic) rocks. The sites are usually hill tops, ridges, or upper slopes with shallow and rocky soils. In Puerto Rico, this habitat varies from 750 to about 1700 mm of mean annual precipitation at elevations from near sea level to 760 m. The species is normally dispersed throughout the secondary forest and does not form pure thickets (Weaver and others 1999). Pockhout is moderately intolerant of shade. It grows in intermediate and codominant positions in open, low forests as well as dominating in more difficult sites.

Reproduction.—Pockhout flowers during the summer and fruits during the winter (Little and others 1974). Fruit and seed production can be relatively heavy in open-grown trees. Fresh fruits collected in Puerto Rico averaged 0.0517 $\pm$ 0.0075 g/fruit. Air-dried seeds separated from them averaged 70,400 seeds/kg. Sown without pretreatment on moist filter paper, 98 percent germinated beginning 16 days after sowing (Francis and Rodríguez 1993). Seedlings are uncommon.

Growth and Management.—Pockhout is slow growing and long lived. No published planting or management experience is known to the author.

Benefits.—Pockhout contributes to the biodiversity of secondary and remnant forests, helps protect the soil, and furnishes food and cover for wildlife. The wood is good for fuel.

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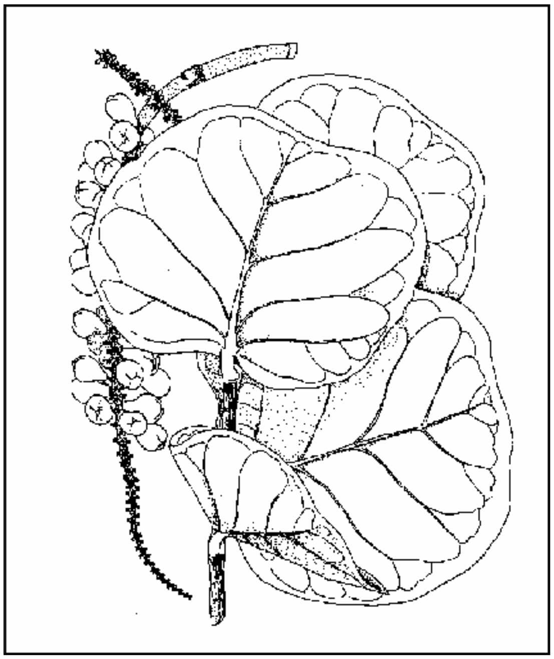
***Coccoloba uvifera* (L.) L.** seagrape

POLYGONACEAE

Synonyms: *Coccolobis uvifera* Jacq.
Polygonum uvifera L.

John A. Parrotta



General Description.—Seagrape, also known as seaside grape, bay grape, uva de playa, uvero, raisin de la mer, and several other common names, is a large, low-branching shrub or small tree with thick, smooth branches and a stout trunk. It is a coastal, tropical species easily recognized by its large, thick, nearly circular leaves and long, grapelike clusters of edible, purple fruits.

Range.—Seagrape is widely distributed along the Atlantic, Caribbean and Pacific coasts of the American tropics and subtropics between 25° N. and 10° S. latitudes (Parrotta 1994). It is believed to be native to southern Florida, the Bahamas, and the West Indies, and is currently naturalized on both coasts of Mexico from Sinaloa and Veracruz southward through Central America and South America to northern Peru and northeastern Brazil. It has been introduced as an ornamental and seashore windbreak species in Hawaii and several tropical countries in the Asia-Pacific region (National Research Council 1983).

Ecology.—Seagrape is one of the first species to colonize sandy and rocky shores within its natural range, and is rarely found at any great distance from sea coasts (Little and Wadsworth 1964, Adams 1972). It is a drought-hardy, salt-tolerant species that grows in areas receiving between 500 and 1500 mm of rainfall with a dry season of up to 8 months (Von Carlowitz 1986). Its best growth occurs on well-drained loamy sands that are slightly to moderately alkaline in reaction. It can, however, tolerate rocky, calcareous soils and soils derived from igneous rocks, provided they are freely drained (FAO 1982). A light-demanding species, seagrape often forms dense thickets on sand dunes, and is typically associated with a number of other shrub, vine and tree species. While most commonly found in dune shrub formations, it does occur farther inland in coastal woodland formations up to 150 m in elevation in the Caribbean and elsewhere in its tropical and subtropical American range (Stoffers, 1956, Craig 1984, Gooding 1974). Throughout its range, it is susceptible to attack by a number of defoliating insect species, as well as leaf, stem, and root pathogens, though none appear to pose a serious threat to the species (USDA 1960, Spaulding 1961, Chellman 1978, Martorell 1975, National Research Council 1983, Parrotta 1994).

Reproduction.— Flowering and fruiting in seagrape usually begins when trees are 6 to 8 years old. Its small (5 mm across), fragrant, greenish-white, male and female flowers, borne on separate trees, form terminal and lateral clusters 10 to 23 cm in length. Flowering and fruiting may occur throughout the year, although flowering is generally concentrated between January and August and fruiting between March and October in its native Caribbean range (Little and Wadsworth 1964, Parrotta 1994). The flowers are pollinated by bees and other insects. The elliptic or egg-shaped fruits, measuring about 2 cm in diameter, are grouped in clusters resembling bunches of grapes. The fruits ripen approximately 2 months after flowering. The ripe, purple fruits contain a single, hard, elliptic seed about 1 cm long surrounded by an edible, tartly sweet pulp and a thin, fleshy covering. Fresh seed weights range from 1,000 to 1,400 seeds/kg, based on collections in Puerto Rico (Parrotta 1994). The fruits are consumed by a variety of birds that help to disperse the seeds. Natural reproduction is generally good on open coastal sites, although seedlings do not tolerate shading or competition from grasses and herbs. In the nursery, seagrape can be propagated from seed in light-textured, well-drained soils; no pretreatment is required to break seed dormancy. Seeds should be sown on or near the soil surface. Germination takes place between 18 and 50 days after sowing, and seedlings reach plantable size (15 cm tall) 4 to 5 months after sowing. It can also be propagated vegetatively by air-layering, ground-layering, and grafting, though mature wood cuttings are most commonly used to produce rooted cuttings for mass propagation of selected cultivars (FAO 1982, Parrotta 1994).

Growth and Management.—Growth rates in seagrape are strongly influenced by wind exposure; on exposed sites, heights typically increase from the windward to leeward edges of stands. On a less exposed coastal site with sandy soils receiving an annual rainfall of approximately 1500 mm in northeastern Puerto Rico, average heights of 0.9 and 2.9 m were recorded for 1- and 3-year-old plantings (Parrotta 1994). No information is available on growth rates of older trees. Under optimal conditions seagrape can attain a height of 8 to 18 m and a stem diameter of 45 to 60 cm (Record and Hess 1943). Being shade-intolerant and susceptible to competition from grasses, herbs and other woody species, planted stands should be regularly weeded until they are taller than competing vegetation.

Benefits.—Throughout its range, the wood is used as firewood and for making charcoal. The reddish- to dark-brown heartwood, distinguished from the light-brown sapwood in larger trees, is hard, close-grained, and used in turning and occasionally for furniture, inlay work and cabinetry (Gooding 1974). The edible fruits can be eaten raw, used in preserves, or fermented like grapes to make wine. The flowers yield abundant nectar, and the resulting honey is of good quality, light amber in color, with a spicy flavor (National Research Council 1983). The astringent red sap exuded from the cut bark, known commercially as West Indian or Jamaican kino, was formerly used for tanning and dyeing (Little and Wadsworth 1964, Uphof 1968). The astingent roots and bark have been used in traditional medicine in Puerto Rico and elsewhere in the Caribbean (Liogier 1990). Seagrape's tolerance of saline soils and sea spray has made it an excellent and popular choice for ornamental plantings and coastal windbreaks. It prunes well and makes an attractive hedge.

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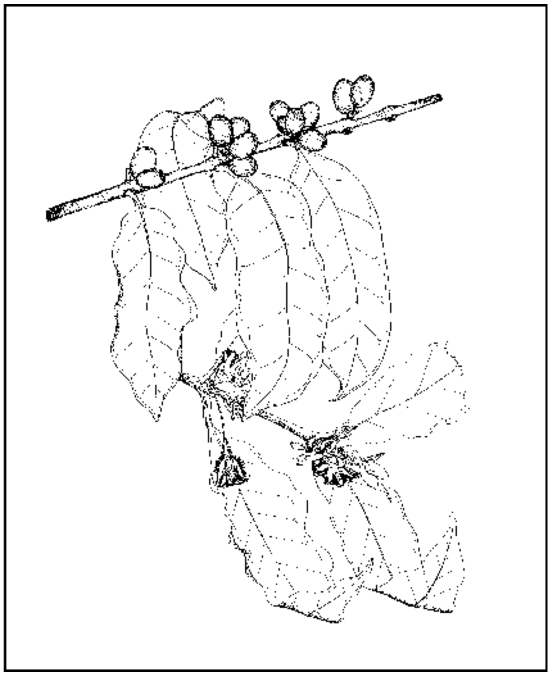
Coffea arabica L. coffee
RUBIACEAE

Synonyms: _Coffea vulgaris_ Moench
Coffea laurifolis Salisb.
Coffea moka Hort. ex Heynh.

John K. Francis



General Description.—Coffee, also known as café, is an upright, evergreen shrub or small tree up to 5 m in height and 7 cm in diameter at breast height. The plant may grow with a single stem, but often develops multiple stems by branching at the base or on the lower stem. The bark is light gray, thin, and becomes fissured and rough when old. The wood is light-colored, hard, heavy, and tough. The root system consists of a short, stout central root, secondary roots radiating at all angles, and abundant fine "feeder" roots. The glabrous, shiny, dark-green, opposite leaves have petioles 4 to 12 mm long and ovate to elliptic blades 7 to 20 cm long, with entire edges, and pointed at both ends. The fragrant, white flowers are in axillary clusters of two to nine. The 1.0- to 1.8-cm drupes are ovoid, fleshy, green turning red and finally blue-black. The fruits usually contain two greenish seeds, 8 to 12 mm long, that are rounded and flattened on one site with a medial groove. Coffee is an allotetraploid with 2n = 44 chromosomes (Bailey 1941, Howard 1989, Liogier 1997, Little and Wadsworth 1964, Wrigley 1988).

Range.—The original native population of coffee was in the highlands of Ethiopia with possible disjunct populations in nearby highland areas of Sudan and Kenya. All of those areas have been altered and under semicultivation for many years (Charrier and Berthaud 1985). Coffee was first cultivated by Arabs during the 14th century and introduced into the New World and much of the rest of the tropics during the 17th century (Smith 1985, Wrigley 1988). Today it is cultivated throughout the moist subtropics and high-altitude, moist tropics and has naturalized in many of these areas including Puerto Rico, the Virgin Islands (Little and Wadsworth 1964), Guam, and Samoa (Pacific Island Ecosystems at Risk 2002).

Ecology.—The native range of coffee lies at 1,370 to 1,830 m in elevation (Wrigley 1988). In higher latitudes, altitude becomes less critical. Optimum temperatures range from 15 to 24 °C. Growth is impaired above 25 °C. Frosts destroy both leaves and fruits (Willson 1985). The species requires a minimum of 1200 to 1500 mm of annual precipitation. Precipitation in excess of 2500 to 3000 mm begins to be detrimental (Wrigley 1988). Although the species tolerates soil pH's from 4 to 8, pH's of 5.2 to 6.2 are preferred. Good drainage is essential, and soil textures lighter than clays are best (Willson 1985). Coffee is tolerant of shade and usually grows in the forest understory. This environment is simulated when coffee is grown under _Inga vera_ Willd. and other shade species. Also, it will grow well and is often cultivated in full sun. There are a number of serious pests and diseases of coffee in plantations; the effects appear to be negligible in dispersed naturalized populations.

Reproduction.—Coffee usually flowers and fruits once per season, but in some areas it flowers twice. In Puerto Rico, flowering occurs January to April (Barrett 1925). It is reported to flower from February through May in Nicaragua (Stevens and others 2001). The flowers are insect pollinated (Wrigley 1988). The fruits take from 6½ to 7 months to mature (Bailey 1941). Seeds of the varieties naturalized in Puerto Rico vary from 0.139 to 0.147 g/seed (Barrett 1925). Seeds 8 weeks old germinate (95 percent in 32 days) better than fresh seed (Wrigley 1988). However, coffee seeds stored more than 21 weeks at ambient temperature begin to rapidly lose their viability (Harrer 1963). The seeds are dispersed by birds, and seedlings can be abundant. Artificial propagation is usually by seed, but the species can be reproduced by budding and cuttings (Center for New Crops and Plants Products 1996).

Growth and Management.—Coffee has a moderate growth rate. Plants begin bearing in 3 to 4 years and are in full fruit production in 6 to 8 years. Coffee plants may live over 100 years (Center for New Crops and Plants Products 1996). Nursery plants are maintained in containers under shade for 6 to 12 months before outplanting (Wrigley 1988). Also, plantations are established by direct seeding into prepared seed spots (Center for New Crops and Plants Products 1996). Weed control is necessary in the first years after plantation establishment. Naturalized and escaped coffee is usually not common enough or does not grow fast enough to warrant control.

Benefits.—As an exotic species in New World forests, coffee has had a gentle impact on biodiversity and contributes to wildlife food and cover, and soil stability. The wood is used mainly for fuel in the New World but is turned into chairs and other types of furniture in Africa (Cheney 1925). Coffee is a good honey plant and yields a light-colored honey (Little and Wadsworth 1964). Coffee berries, edible and slightly sweet, are eaten occasionally by children and field workers. The fruit pulp, which is removed during processing, is sometimes fed to livestock but more often is composted for fertilizer and mulch (Center for New Crops and Plants Products 1996). Coffee seeds have been chewed as a stimulant in East Africa from ancient times (Center for New Crops and Plants Products 1996). The hot drink "coffee" is brewed from the roasted and ground seeds (or "beans") and is one of the world's most popular beverages. It is used to flavor candies, liquors, and pastries. Probably the principal reason for its popularity is the addictive stimulant alkaloid, caffeine (1,3,7-trimethylxanthine), 1.1 to 1.3 percent in the beans, but varying greatly in the beverage due to different brewing practices. The alkaloid is present in the leaf at 0.30 percent, twig, 0.04 percent, stem 0.01 percent, and central root, 0.01 percent. Other alkaloids, xanthine, guanine, and trigonelline, which have stimulant and diuretic properties, are also present (Burkill 1997). Caffeine protects vegetative plant parts from insect and fungal attack and inhibits the growth of plants and bacteria near germinating seeds (Steiman 1997). Purified caffeine is widely sold as a medicinal stimulant, dietary aid, and headache remedy. Leaf poultices are used to treat sores in Trinidad, and root sap or root infusions are drunk to relieve scorpion stings (Burkill 1997). Coffee is also employed in folk medicine to treat asthma, flu, headache, jaundice, nephrosis, malaria, sores, and vertigo (Center for New Crops and Plants Products 1996).

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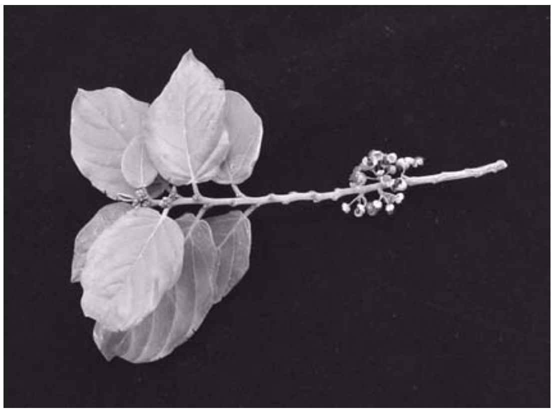
***Colubrina arborescens* (P. Mill.) Sarg.** coffee colubrina
RHAMNACEAE

Synonyms: *Colubrina colubrina* (Jacq.) Millsp.
Colubrina ferruginosa Brongn.
Rhamnus colubrinus Jacq.
Ceanothus arborescens Mill.
Ceanothus colubrina (Jacq.) Lam.

John K. Francis



General Description.—Coffee colubrina, also known as greenheart, wild coffee, snakebark, blackbead tree, abeyelo, corazón de paloma, bijáguara, cascalata, sonzonate, and bois de fer, is an evergreen or semideciduous shrub or small tree. It grows as a shrub with multiple stems 3 to 6 m in height in dry areas on beach fronts, deep sands, and porous limestone with little soil, and as a tree to 25 m in height on moist sites and fertile soils. Bark on trunks is gray or brown, smoothish, fissured, or platy. Inner bark is pink, brown, or reddish-brown. The roots are dark brown with reddish inner bark and are somewhat brittle. The twigs, flower clusters, young leaves, petioles, and underside of older leaves are covered with a rusty pubescence. Leaves, which grow alternately in two rows on twigs, are papery to leathery, ovate to elliptic, 5 to 18 cm long, pointed at the tip and rounded at the base, and have prominent, curved veins. The tiny yellow or yellow-green flowers grow in short-stalked cymes in the leaf axils. Fruits are globose capsules 6 to 10 mm in diameter that split into three parts and release globose, 3- to 3.5-mm, hard, black seeds (Liogier 1990, Little and Wadsworth 1964, Sargent 1923).

Range.—Coffee colubrina is native to southern Florida, the Bahamas, the West Indies, and from southern Mexico to Panama (Liogier 1994, Little and Wadsworth 1964, Stevens and others 2001). Although the species is planted as an ornamental, it is not known to have become naturalized outside its native range.

Ecology.—Coffee colubrina grows in a wide variety of well-drained soils in its native range, including soils of all textures, pHs ranging from about 5.0 to 8.0, and soils derived from sedimentary (including limestone), igneous, and metamorphic (including ultramaphic) rocks. The species grows in areas of Puerto Rico that receive from about 750 to 2500 mm of mean annual precipitation at altitudes from near sea level to about 600 m. Although the species is evergreen in moist sites, in dry areas, especially in excessively drained sites, it defoliates in response to prolonged drought. Coffee colubrina grows on hammocks in Florida (Nelson 1996) that have sandy soils (Gilman 1999), and in beach strand vegetation, coastal sands, dry to moist foothills and mountains in remnant and secondary forests in the West Indies (author's observation). The species tolerates salt spray and moderate amounts of salt in the soil (Gilman 1999). Coffee colubrina is moderately intolerant; it grows in full sun and partial shade of low forest or broken high forest.

Reproduction.—Coffee colubrina is reported to bloom from spring to fall in Puerto Rico (Little and Wadsworth 1964) and throughout the year in Florida (Long and Lakela 1976). The flowers are insect pollinated. Seeds collected by the author in Puerto Rico averaged 70,400 seeds/kg (air-dried). Besides minor movement by gravity, wind, and water, the fruits pop open when dry and fling the seeds a short distance (Gilman 1999).

Growth and Management.—Growth is slow in dry forest areas and generally moderate in moist, fertile soils. Four experimental plantings of coffee colubrina were made in Puerto Rico. Complete mortality occurred in the two drier, poorer sites, but the trees grew 1 m/year in height for the first few years on the better sites (Francis 1998). Mortality probably occurred on the drier sites because they were overcome by faster-growing competition. To ensure quick establishment, planting of containerized stock for ornamental and wildland plantings is recommended. Protection from weeds, vines, and faster-growing trees for 2 or more years is imperative. Ornamental plants can be forced into tree shape by continual pruning of the lower branches (Gillman 1999).

Benefits.—Coffee colubrina helps protect the soil, contributes to the aesthetics of the forest, and furnishes food and cover for wildlife. The plant attracts abundant insects including bees, wasps, butterflies, and diurnal moths, which in turn provide food for warblers (*Dendroica* spp.), gnatchtchers (*Polioptila* spp.), kingbirds (*Tyrannus* spp.), and vireos (*Vireo* spp.) (Florida Fish and Wildlife Conservation Commission 2003). The species is considered a honey plant, furnishing both nectar and pollen to honeybees (*Apis mellifera* L.) May through September in the Dominican Republic (Rivas-Laureano 2003). Coffee colubrina is planted as a shade tree and ornamental in Florida, Guatemala, Nicaragua, and El Salvador (Little and Wadsworth 1964, Stevens and others 2001). It is recommended for planting in parking lot islands, in large containers, and small lawns, and for borders, screens, and hedges, as well as for reclamation plantings (Gilman 1999). A tea made from the leaves and the wood is used as a remedy for rheumatism. Extracts are also used for antiseptic baths (Liogier 1990). The shiny black seeds are used in necklaces in Jamaica. The wood is hard and heavy with a specific gravity of 0.7. The sapwood is ivory or light brown, and the heartwood is yellowish brown. Because it is resistant to decay, it is used for fence posts and was formerly used for marine pilings (Little and Wadsworth 1964).

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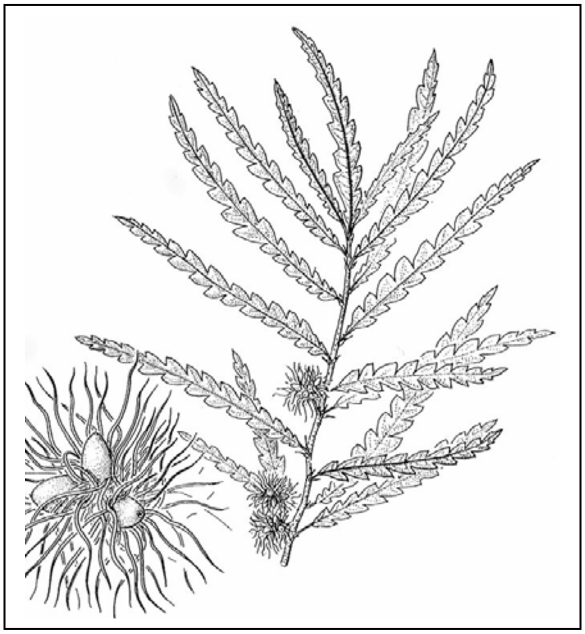
***Comptonia peregrina* (L.) Coult.** sweet fern
MYRICACEAE

Synonyms: *Comptonia asplenifolia* L.
Myrica asplenifolia (L.) Ait.

Paula M. Pijut



General Description.—Sweet fern is a densely branched, deciduous, rhizomatous shrub that grows 0.5 to 1.5 m tall and 1.2 to 2.5 m wide or more (Dirr 1998, Gleason and Cronquist 1991). Sweet fern is a dioecious or seldom monoecious (Gleason and Cronquist 1991), actinorhizal nitrogen-fixing shrub (Del Tredici 1996, Ziegler and Huser 1963) with fern-like leaves and stems that are aromatic when crushed. Leaves are alternate, oblong-linear, deeply pinnately lobed, stipulate, dark green, pubescent, 5 to 12 cm long, 1 to 1.5 cm wide, with petioles 0.3 to 0.6 cm long (Dirr 1998, Gleason and Cronquist 1991, Hall and others 1976). Stems are green, yellowish, or reddish-brown when young, turning reddish-purple or coppery-brown with age. Buds are globular, minute, solitary, and sessile, with two to four exposed scales (Dirr 1998). The flowers are inconspicuous. Staminate catkins are olive green, cylindrical, clustered (usually three to four) on the tip of the previous year's wood, 1.5 to 4 cm long, and drooping (Gleason and Cronquist 1991, Hall and others 1976). Pistillate catkins are dark red at the beginning of anthesis, subglobose at maturity, up to 0.7 cm long, with the ovary surrounded by eight persistent bracts (Gleason and Cronquist 1991, Hall and others 1976). The fruit is an ovoid nut, olive-brown, 3 to 5 mm long, enclosed in a burr-like cluster of bracts (Dirr 1998, Gleason and Cronquist 1991). The chromosome number of sweet fern is 2n = 32 (Gleason and Cronquist 1991). Two varieties are recognized: var. *asplenifolia* (L.) Fernald and var. *tomentosa* A.Chev. (Krüssmann 1984, Missouri Botanical Garden 2002).

Range.—Sweet fern occurs from Nova Scotia to North Carolina, western South Carolina, and northern Georgia, and west to Saskatchewan, Minnesota, Illinois, and Tennessee (Gleason and Cronquist 1991). *Comptonia peregrina* var. *asplenifolia* occurs only from Long Island, New York, to Virginia (Hall and others 1976). In Canada, sweet fern is found in all three Maritime Provinces, Ontario, and certain parts of Quebec (Hall and others 1976).

Ecology.—Sweet fern prefers well-drained, dry, acid, sandy or gravely soils with full exposure to the sun (Del Tredici 1996, Schwintzer 1989, Snyder 1993). These sites include dry piney woods, exposed mountain slopes, abandoned pastures, barrens, highway embankments, gravel pits, weathered mine tailings, and cut-over forested land (Del Tredici 1996). Sweet fern is shade intolerant, adaptable to infertile soils, fixes nitrogen in a symbiotic association with *Frankia*, a filamentous bacterium (actinomycete) (Callaham and others 1978), has cluster roots that aid in phosphorus uptake (Hurd and Schwintzer 1997), and is a pioneer colonizer of sites disturbed by fire, logging, clear-cutting, and road construction (Del Tredici 1996, Lynham and others 1998, Snyder 1993). Sweet fern is drought and salt tolerant. Sweet fern colonizes areas via lateral roots that form endogenous root buds from which shoot sprouts are readily formed (Louis and Torrey 1991). The shrub is a serious weed problem in the commercial lowbush blueberry fields in Canada and New England (Hall and others 1976, Snyder

1993). The nymphs of the Saratoga spittlebug (*Aphrophora saratogensis* Fitch.) feed on sweet fern but do not cause serious damage (Johnson and Lyon 1991). Sweet fern is susceptible to attack by *Botryosphaeria dothidea* (Moug.:Fr.) Ces. & DeNot. (causing dieback) and *Gymnosporangium ellisii* (Berk.) Ellis (alternate host for aecia stage) (Sinclair and others 1987). Sweet fern is the alternate host of the fungus, *Cronartium comptoniae* Arth., that causes sweet fern blister rust on hard pines (Farr and others 1989, Sinclair and others 1987). The fungus is not seriously harmful to sweet fern, but it can reduce the growth and even cause death of susceptible pines, such as jack (*Pinus banksiana* Lamb.), pitch (*P. rigida* Mill.), shortleaf (*P. echinata* Mill.), and loblolly (*P. taeda* L.) (Del Tredici 1996, Snyder 1993).

Reproduction.—Sweet fern flowers are small, inconspicuous, wind-pollinated, and shed large amounts of pollen (Hall and others 1976). In the United States the shrub blossoms in April or early May with fruit maturation by fall. In Canada, sweet fern blossoms mid-May to mid-June with fruit maturation from July through September (Hall and others 1976). Hall and others (1976) determined the mean number of staminate catkins per shoot based on 42 shoots to be 6.43 ± 0.48 (SE) and for the pistillate catkins 0.60 ± 0.01 (SE). The fruit of sweet fern is borne in a bur-like cluster of bracts containing on average 5.52 ± 0.43 (SE) nuts per bur (Hall and others 1976). The pericarp is composed of a thin, fleshy outer layer and a hard, thick inner layer (Del Tredici and Torrey 1976). Seeds do not germinate readily but can remain viable (for as long as 70 years) buried in the soil (Del Tredici 1977). Sweet fern seeds are in deep primary dormancy when they are shed from the plant and become incorporated into the soil (Dow and Schwintzer 1999). They enter seasonal cycles of secondary dormancy over time in which dormancy is induced during the summer. The seeds are then released from this dormancy by chilling during the winter. However, most buried seeds still require exposure to strong daily temperature fluctuations before they germinate (Dow and Schwintzer 1999). Strong temperature fluctuations indicate that shade cover has been removed, which stimulates the seeds to germinate in an open situation favorable for seedling establishment. Fresh seed will germinate (80 percent) after scarification and treatment with 500 mg/l gibberellic acid (GA_3) for 24 hours (Del Tredici and Torrey 1976). Sweet fern propagates itself vegetatively via lateral roots that form endogenous root buds from which shoot sprouts are readily formed (Louis and Torrey 1991). These sprouts can spread extensively over large areas forming thickets. Juvenile stems (7.6 cm or less in length) root when treated with 3 g/l indole-3-butyric acid and placed under mist (Dirr 1998). Root pieces (10 cm long x 0.2 cm wide, or 5 cm x 1.3 cm) dug in late winter or early spring, placed horizontally at a depth of 1.3 cm in a mixture of fine sand and sphagnum peat, will develop shoots and additional roots (Dirr 1998). Sweet fern can be grown in containers and successfully transplanted (Dirr 1998). Micropropagation of sweet fern has been achieved by the induction of root buds in excised root culture (Louis and Torrey 1991).

Growth and Management.—Sweet fern is a slow to medium growing shrub that develops a broad, flat-topped to rounded habit as it spreads and colonizes (Dirr 1998). It is hardy in zones two to six (USDA Plant Hardiness) and is sexually mature in 2 to 3 years (Snyder 1993). Burning and disking following logging will stimulate the growth of sweet fern (Snyder 1993). Sweet fern is used for erosion control, low maintenance plantings along highway embankments, and as naturalistic plantings under power company rights-of-way (Del Tredici 1996, Snyder 1993). Sweet fern can become weedy in pastures, old fields, and open woods, but can be controlled with herbicides, such as dicamba, 2,4-D, and glyphosate (Hall and others 1976, Heyd and others 1987, Snyder 1993).

Benefits.—Sweet fern is planted as a landscape plant because of its fern-like, aromatic foliage and stems. Because it fixes nitrogen, sweet fern is useful for rehabilitation of disturbed sites. Sweet fern has limited use as a food source and cover for wildlife. The fruits are consumed by flickers, moose and deer browse sweet fern, and prairie chickens and sharp-tailed grouse use it for nesting cover (Snyder 1993). The leaves can be used for potpourri and tea (Stokes 1981). The chemical betulin occurs in the leaves, root, and stem of sweet fern, and its biological activities have been described (Duke 1996).

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***Conocarpus erectus* L.** button mangrove

COMBRETACEAE

Synonyms: *Conocarpus procumbens* L.
Conocarpus erectus var. *procumbens* (L.) DC.
Conocarpus erectus var. *sericeus* DC.
Conocarpus sericeus Jiménez
Conocarpus supinus Crantz
Terminalia erecta (L.) Baill.

John K. Francis

General Description.—Button mangrove is also known as buttonwood, sea mulberry, botoncillo, mangle prieto, mangle negro, palétuvier, and mangue. The species is usually a shrub 1.5 to 4 m in height but can become a tree up to 20 m or more in height. The root system consists mainly of laterals and fine roots that are dark brown, weak and brittle, and have a corky bark. The plant usually has an erect trunk or multiple trunks, but it may assume a prostrate form and have limbs that layer and become new individuals. The bark is gray or brown, furrowed, fibrous, and moderately thin (about 8 mm). The inner bark is dark cream in color. Stemwood (specific gravity of 1.0) is hard, heavy, and strong. Branches are brittle. The twigs are slender, yellow-green, angled, flattened, or winged. The spirally arranged, elliptic to lanceolate leaves are cartaceous to somewhat fleshy, 2 to 10 cm long, with petioles 3 to 9 mm long. Inflorescences are terminal or axillary panicles of tiny greenish-white flowers grouped in spheroidal heads 3 to 5 mm in diameter. The thin, dry, 5- to 15-mm, two-winged seeds are densely packed into globose clusters (Howard 1989, Liogier 1994, Little and Wadsworth 1964, Nelson 1996, Pennington and Sarukhan 1968, Stevens and others 2001).

Range.—Button mangrove is native to Bermuda, both coasts of southern Florida, the Bahamas, the West Indies, both coasts of Mexico, Central America, South America (through Ecuador and Brazil), and the Galapagos Islands. It is also native to coastal areas of Tropical West Africa (Howard 1989, Little and Wadsworth 1964). The species has been planted widely as an ornamental and has naturalized in at least Hawaii (Pacific Island Ecosystems at Risk 2002).

Ecology.—Button mangrove is intolerant of shade. It is almost always open-grown or in codominant stands. It will tolerate competition by plants of similar size but will not grow under the canopy of taller trees. The species grows above the high tide line, along beaches and just landward of *Laguncularia racemosa* (L.) Gaertn. and other mangroves. The soils in these situations are usually sandy or marly but sometimes loamy or clayey. Button mangrove is particularly adaptable as an ornamental because it tolerates compacted soil, air pollution, poor drainage, and drought (Gilman and Watson 1993). It also tolerates salt water overwash from storm surges and heavy salt spray. The species grows, although much less commonly, on the lower floodplains of rivers and in upland forests. Herbarium samples have been collected at elevations of 745 m in Costa Rica (Instituto Nacional de Biodiversidad 2002).

Reproduction.—Button mangrove blooms throughout the year in México (Pennington and Sarukhan 1968) and from March to September in Florida (Nelson 1996). Tomlinson (1986) maintains that this species is dioecious. It is a consistent and abundant seed producer throughout most of its range. The fruit heads may contain from 35 to 56 fruits each (Masís and others 1999). Seeds collected in Puerto Rico averaged 250,000 seeds/kg. Seeds from this collection began germinating on moist filter paper in 9 days but were only 12 percent viable (Francis and Rodríguez 1993). The seeds are dispersed by water (Pacific Island Ecosystems at Risk 2002). Button mangrove can be propagated by partially burying large stakes in moist ground for living fence posts (Little and Wadsworth 1964).

Growth and Management.—Button mangrove has a medium growth rate (Gilman and Watson 1993) and may live for several decades. Information is not available on wildland plantation establishment. The planting of potted or containerized seedlings seems the safest approach. The species is not aggressive or invasive and only requires control when land is converted to other uses.

Benefits.—Button mangrove provides food and cover for wildlife (various species of crabs and insects). It protects the soil during storm surges and helps "fix" dunes (Popp and others 1989). Both button mangrove and silver buttonwood (*C. erectus* var. *sericeus* Griseb.) are widely planted as ornamentals in yards, parking lots, streets and parks (Gilman and Watson 1993, Nelson 1996). It can be trained to form hedges. Potted plants are used to form bonsai (Gilman and Watson 1993). Button mangrove wood is reported to be ideal for smoking fish and meat (Gilman and Watson 1993). The wood is durable but susceptible to dry-wood termites [*Cryptotermes brevis* (Walker)] and is used to make railroad ties, posts, for turnery, boat building, fuel, and charcoal. The bark and leaves have been used in tannery (Little and Wadsworth 1964). Bark from Belize contains 18 percent tannin (Burkill 1985). Extracts of the bark are used to treat bleeding gums, vaginal bleeding, colic, and skin ulcers (Liogier 1990).

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***Corchorus hirsutus* L.** jack-switch

TILIACEAE

Synonyms: none

John K. Francis

General Description.—Jack-switch, also known as wooly corchorus, mallet, cadillo, and malvavisco, is an upright woody to semiprostrate shrub usually about 1 m in height but sometimes reaching 2 m and 1.5 cm in basal diameter. It usually has a single main stem and a somewhat sparse, open crown. Plants examined by the author had a deep taproot and fine lateral roots at all levels. All parts except older branches and stems are densely pale scruffy tomentulose with stellate hairs. The alternate leaves are ovate to oblong-lanceolate, 2 to 6 cm long, have crenate to serrate margins and obtuse to acute tips, and have petioles 2 to 7 mm long. The leaves, which have a gray-green color, tend to wilt rather than defoliate during dry seasons. Yellow flowers occur in groups of two to eight on axillary peduncles opposite the leaves. The four-chambered capsules are ellipsoidal, about 12 mm long, and contain a number of 1.5- to 2-mm black seeds (Britton and Millspaugh 1962, Howard 1989, Liogier 1994).

Range.—Jack-switch is native throughout the West Indies and has been reported from Mexico through Central and South America and in northeastern Africa (Britton and Millspaugh 1962, Howard 1989, Liogier 1994). Herbarium specimens exist for Bolivia and Paraguay (Missouri Botanical Garden 2002). The species is present as an exotic in the southern tip of Florida (Institute of Systematic Botany 2002).

Ecology.—Jack-switch is intolerant of shade and grows in open areas or openings in low forest. It cannot endure severe competition. The species usually grows near the coast or inland on dry, often excessively-drained sites. These are usually coastal sands or rocky ridges and hillsides over limestone, igneous, and metamorphic (including ultramaphic) rocks. Jack-switch occurs as scattered plants or as open stands with other species of similar size. Because cattle do not eat or rarely eat the foliage, the species benefits from over-grazing. It also invades eroded and physically disturbed soils.

Reproduction.—Jack-switch blooms continuously, except during periods of drought. The species is insect pollinated (Marcano-Fondeur 1973). Capsules collected in Puerto Rico averaged 28.0 seeds/capsule. Air-dried seeds from that collection averaged 1.109 million seeds/kg. Sown without pretreatment on the surface of wet peat, 10 percent germinated over a 4-month period (author's observation). Dispersal undoubtedly occurs by wind and water; specialized means of seed dispersal are unknown. Seedlings in wildland sites in Puerto Rico vary from common to rare. Plants apparently do not renew themselves by resprouting after stem death. Reaction to fire is unknown.

Growth and Management.—Jack-switch plants have a moderate to slow growth rate and live about 5 years. Mechanical soil disturbance near seed sources and heavy grazing would probably lead to natural establishment of the shrubs. Jack-switch is seldom common enough to warrant control, but if needed, mowing may be sufficient.

Benefits.—Jack-switch furnishes cover for wildlife and helps protect the soil. The plant is attractive enough to be used as an ornamental in natural landscaping, although that use is not yet reported. It is a honey plant (Marcano-Fondeur 1973). The leaves are cooked and eaten, and made into tea in St. Croix, U.S. Virgin Islands. Branches were formerly used to make brooms (Garland 2002).

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***Cordia lima* (Desv.) Roemer & J.A. Schultes** lija
BORAGINACEAE

Synonyms: *Varronia lima* Desv.
Cordia radula Spreng.
Cordia asperrima DC.

John K. Francis

General Description.—Lija, which means sandpaper in Spanish, is an evergreen, vine-like, arching shrub 1 to 2.5 m in height and 1 to 2 cm in basal diameter. Lija plants are supported by weak taproots, slender lateral roots, and abundant fine roots. The roots are dark brown. Older plants usually have a number of stems that grow vertically for 1 to 2 m and then arch horizontally. Supported on other vegetation without twining or tendrils, they sometimes extend 4 m or more laterally. The relatively few branches and twigs are slender. The leaves are 2 to 6 cm long, stiff and almost woody, ovate or elliptic, with toothed edges and a rough texture imparted by short, stiff hairs. The inflorescences are terminal or lateral glomerules of small white subsessile flowers. These produce globose one-seeded fruits (drupes) that are red when ripe and 4 to 5 mm in diameter. The fruits have a mild, pleasantly sweet flavor (author's observation, Grisebach 1963, Liogier 1995).

Range.—Lija is native to Hispaniola, Puerto Rico, and the Bahamas (Grisebach 1963, Liogier 1995). It is not known to have been planted or naturalized elsewhere.

Ecology.—Lija grows in dry to moist habitat (about 700 to 1800 mm of mean annual precipitation) at elevations from near sea level to at least 600 m. Colonized soils are variable in texture with pH's from about 5.0 to 7.5, well drained, and usually rocky, on ridges, hillsides, and in draws. Although the species grows over other rock types, it is most common in limestone and ultramafic (serpentine) areas. Lija is moderately intolerant of shade and competes well with herbs and brush. It grows under and at the edges of remnant forests and middle to late secondary low forests with relatively low basal areas. The species varies from uncommon to relatively common in Puerto Rico. Individual plants are usually widely scattered.

Reproduction.—A collection of fresh fruits from Puerto Rico averaged 0.261 $\pm$ 0.010 g/fruit. Air-dried seeds separated from them averaged 0.0515 $\pm$ 0.0013 g/seed or 19,000 seeds/kg. Placed to germinate on moist filter paper, 16 percent germinated within 6 months. Other germination tests are needed to determine whether this is low for the species. Pretreatments do not appear necessary. Apparently, the seeds are dispersed by birds. Seedlings in natural forests are uncommon. Established plants sprout when disturbed.

Growth and Management.— Lija is a slow-growing shrub. Adult plants add only 10 to 30 cm to their stem length annually. Individual stems appear to live 1 or 2 decades while plants, by sprouting, may live much longer. No planting or management experience has been published for the species. Protection from fire and development are probably all that is required in relatively undisturbed sites.

Benefits.—Lija contributes to the biodiversity in forests where it lives, helps protect the soil, and furnishes food and cover for wildlife. The fruits are tasty but too small and too infrequently found to justify collection.

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Cordia polycephala (Lam.) I.M. Johnston black sage
BORAGINACEAE

Synonyms: _Varronia polycephala_ Lam.
Varronia paniculata Wakström
Cordia wickstroemii Steudel
Cordia sulfurata Krause
Cordia ulmifolia Juss. ex Dumont
Lantana corymbosa L.

John K. Francis

General Description.—Black sage, also known as basora, palo de perico, saraguero, saragüero, Santa María (Spanish), petit mahot, and mahot fin (French), is a scrambling shrub or woody vine (Acevedo-Rodríguez 1985, Howard 1989, Liogier 1995). The single or multiple stems are gray, cylindrical, and strong with relatively few, slender branches. There may or may not be a weak taproot; the plants rely on shallow lateral root systems with abundant fine roots. Alternate scabrous leaves are ovate to lanciolate and 8 to 15 cm long. The leaves have a serrate margin and are dark green above and yellow green below. Whitish-green flowers are grouped in tightly packed cymes arising near the branch ends. The fruits (drupes) are red, globose, 2.5 to 5 cm in diameter, and have little flavor. The seed has an irregular surface (Acevedo-Rodríguez 1985, Howard 1989, Liogier 1995).

Range.—Black sage is native to Hispaniola, Puerto Rico, Vieques Island (Puerto Rico), the Virgin Islands, St. Barts, St. Kitts, Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent, Granada, and South America as far south as Bahia, Brazil (Centro Nordestino de Informações Sobre Plantas 2002, Howard 1989). It is not known to have been planted or naturalized elsewhere.

Ecology.—Black sage most frequently grows in abandoned fields and pastures, along roads, in early secondary forest, in open forest on difficult terrain, and in disturbed openings in old-growth forest. It occurs in areas receiving from 1000 to 2500 mm of annual precipitation, in soils of all textures and parent materials at elevations from near sea level to at least 600 m. The species does not occur in very poorly drained soils. Black sage is not among the early pioneers to colonize disturbed sites but enters with brush that follows the weed and grass stage. It competes well by scrambling across low vegetation and climbing into the crowns of other shrubs and low trees. It is moderately intolerant to shade and is able to grow under the canopy of low basal-area forest.

Reproduction.—As a population, black sage blooms and fruits all year, particularly during the summer (Acevedo-Rodríguez 1985). However, individual plants usually flower at one time and then rest for several months before flowering again. The fresh fruits in one Puerto Rican collection averaged 0.12 g/fruit. The fruits are consumed by birds that disperse the seeds. Seedlings are common but rarely abundant.

Growth and Management.—Black sage achieves 1 m or more of stem extension per year. Stems may grow to 1.5 cm of diameter and reach 5 m in height or extension from the point of rooting (Acevedo-Rodríguez 1985). One 1.5-cm stem was observed to have five growth rings. Black sage can live at least 5 years and perhaps much longer by sprouting, which it readily does when injured. No planting, management, or control experience has been published. In the absence of other control information, grubbing out individual plants or spot treating with broad-leaf herbicides is recommended.

Benefits.—Black sage helps protect the soil and furnishes food and cover for wildlife. The fruits are edible. It is a minor weed in pastures (Vélez and van Overbeek 1950).

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***Cornus sericea* L.** redosier dogwood
CORNACEAE

Synonyms: *Cornus stolonifera* Michx.

Paula M. Pijut

Illustration source: USDA—Forest Service Collection, Hunt Institute

General Description.—Redosier dogwood is a multi-stemmed, deciduous, stoloniferous shrub that grows 1 to 3 m tall and 3 m wide or more, often forming dense thickets. Leaves are opposite, simple, ovate to oblong-lanceolate, acuminate, rounded at the base, 5 to 12 cm long, 2.5 to 6.4 cm wide, with petioles 1.3 to 2.5 cm long (Dirr 1998, Gleason and Cronquist 1991). Leaves are medium to dark green in summer, purplish to reddish in the fall, distinctly glaucous beneath, with five to seven lateral vein pairs. Stems are slender, upright, bright red to dark blood red, appressed pubescence on younger stems, with prominent lenticels, and a white pith (Dirr 1998). Buds are valvate, appressed, and elongated. The inflorescence is a cyme (3.8 to 6.4 cm in diameter) with small (2 to 3 mm), white to cream-colored flowers (Gleason and Cronquist 1991). The fruit is a globose, white drupe (stone), 7 to 9 mm in diameter (Gleason and Cronquist 1991). The chromosome number of redosier dogwood is 2n = 22 (Gleason and Cronquist 1991). Two forms of *C. sericea* are recognized: f. *baileyi* (J.M. Coult and W.H. Evans) Fosberg and f. *stolonifera* (Michx.) Fosberg (Missouri Botanical Garden 2002).

Range.— Redosier dogwood occurs from Alaska to Newfoundland, south to Virginia in the east, to Kansas in the Great Plains, to northern Mexico, in the Rocky Mountains, and through California on the West Coast (Crane 1989).

Ecology.—Redosier dogwood is extremely adaptable to a wide range of soil and climatic conditions. It prefers rich, moist, poorly drained soils with high levels of mineral nutrients, and moderate to full sunlight (Crane 1989). These sites include swamps, low meadows, riparian zones, wetlands, floodplains, forest openings and understories. Redosier dogwood is suppressed in shade, a dominant understory shrub in the early successional willow and balsam poplar communities, not a primary invader of wet prairies and meadows (enters the stand later in succession), and enters a stand after fire (Crane 1989). It is tolerant of fluctuating water tables and extremely cold temperatures. Redosier dogwood can spread and form dense thickets (by layering) when stems touch the ground and roots form at the nodes. The larvae (instars) of the dogwood sawfly [*Macremphytus tarsatus* (Say)] feed on redosier dogwood causing defoliation (Johnson and Lyon 1991). *Pandemis pyrusana* Kearfott (leafroller) attacks redosier dogwood in British Columbia and California (Johnson and Lyon 1991). Redosier dogwood is susceptible to attack by *Discula destructiva* Redlin. *sp. nov.* (dogwood anthracnose), *Botryosphaeria dothidea* (Moug.:Fr.) Ces. & De Not. (canker and dieback), *Septoria cornicola* Desmaz. (leaf spot), and *Phyllactinia guttata* (Wallr.:Fr.) Lev. (powdery mildew) (Brown and others 1996, Jones and Benson 2001, Sinclair and others 1987). Tobacco ringspot virus has been detected in naturally infected redosier dogwood (Sinclair and others 1987). Mycoplasma-like organisms have been detected in witches-brooms of redosier dogwood (Sinclair and others 1987).

Reproduction.—Redosier dogwood flowers are small, self-sterile with obligate outcrossing, and are insect-pollinated (Crane 1989). In the United States the shrub blossoms from late May to June (June to August in the Northern United States) with fruit maturation by fall. The fruit is a drupe containing a single two-celled and usually two-seeded stone, but only one seed is fully developed (Brinkman 1974). Redosier dogwood seeds have a hard seed coat and dormant embryos (Crane 1989). Seeds do not germinate readily (can remain viable in seedbanks) and require cold stratification and sometimes scarification in order for germination to occur (Crane 1989). Fresh seed can be fall sown or stratified for 60 to 90 days at 5 ºC (Brinkman 1974). Acharya and others (1992) found that native (Alberta, Canada) redosier dogwood seed germination was strongly influenced by the population from which seeds were collected, and the yearly precipitation in those areas. Redosier dogwood propagates itself vegetatively via stolons (stems just on or under the ground) and by layering forming dense thickets. Plants are also produced from the roots, the bases of dying branches, and injured stems (Crane 1989). Cuttings (with leaves) root readily when treated with 1 g/l indole-3-butyric acid (Dirr 1998). Hardwood cuttings root (90 to 100 percent) when placed in the field in late winter without a rooting treatment (Dirr 1998). Redosier dogwood can be grown as bare-root, containerized, or balled-and-burlapped plants (Dirr 1998).

Growth and Management.—Redosier dogwood is a fast (vigorous) growing shrub that develops a loose, broad-spreading, rounded habit with horizontal branches at the base (Dirr 1998). It is hardy in zones 2 to 7 (USDA Plant Hardiness) and is sexually mature in 3 to 4 years (Crane 1989). Redosier dogwood generally increases following fire (Crane 1989). Coppicing stimulates new, vigorous stem growth. Pruning and burning redosier dogwood helps produce long straight stems. Redosier dogwood is used for soil stabilization, reclamation sites, residential landscape plantings, mass plantings along highway banks, parks, and golf courses (Crane 1989, Dirr 1998, Renault and others 2001). Redosier dogwood can be controlled by spraying with mixtures of 2, 4-D and dicamba (Crane 1989).

Benefits.—Redosier dogwood is planted as a landscape plant because of its bright red stems, which are especially beautiful contrasting against a snowy landscape. Because it is easy to establish and grows rapidly, redosier dogwood is useful for rehabilitation of disturbed sites. It is an excellent soil stabilizer along stream banks because of its thick, extensive root system (Crane 1989). Redosier dogwood is relatively tolerant to high salinity tailings waters produced as a result of oil and sand mining, making it useful for reclamation of sites (Renault and others 1999, 2001). The bark, stems, leaves, roots, and fruit of redosier dogwood were used by Native Americans for a variety of uses including basket weaving, dyes, and tonics (Stevens and Dozier 2002). Redosier dogwood thickets provide cover for birds and other small wildlife. It is an important food source and winter browse for deer, elk, moose, bear, cottontail rabbits, snowshoe hares, grouse, quail, and other small birds and mammals (Crane 1989).

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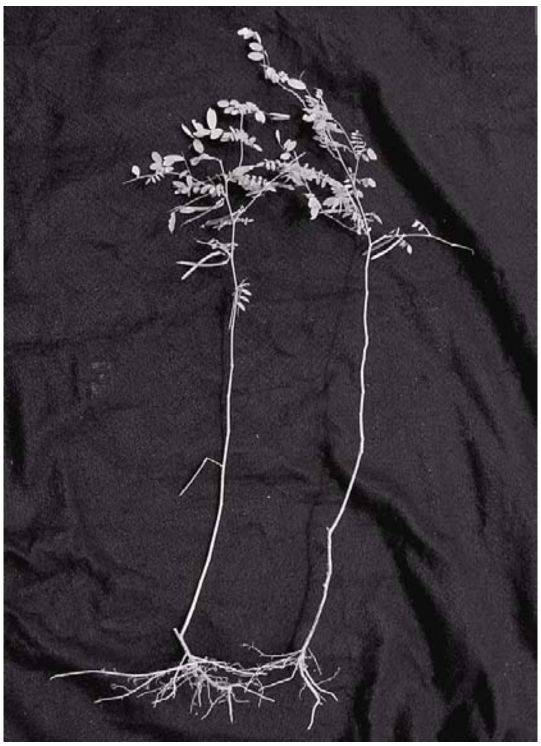
Coursetia caribaea (Jacq.) Lavin añil falso
FABACEAE

Synonyms: *Cracca caribaea* (Jacq.) Lavin
Galega caribaea Jacq.
Tephrosia caribaea (Jacq.) DC.
Benthamantha caribaea (Jacq.) Kuntze
Brittonamra caribaea (Jacq.) Kuntze
Tephrosia aniloides Bello

John K. Francis



General Description.—Añil falso is a low shrub, usually about 0.6 m in height, but sometimes reaching 2 m in height and 1 cm or more in basal diameter. The common name is Spanish from Puerto Rico and means false indigo. Añil falso is supported by a tap and lateral root system with a moderate amount of fine roots. The species produces round to elongated root nodules (Dubey and others 1972). The plant has a slender single stem that usually resprouts with a single stem when the plant is damaged. Plants grazed by cattle may be stunted or contorted. The current year's mature growth is tender, but the stem is woody and normally without branches. The leaves are 4 to 12 cm long, have short petioles, and 9 to 18 opposite, elliptic leaflets, 0.6 to 3.0 cm long. The foliage is yellow-green. The racemes contain one to six pea-like flowers that are white or yellowish, sometimes lined with pink or purple. The pods are linear, 4 to 6 cm long and somewhat compressed between seeds. The 10 to 25 seeds are about 2 mm long and have squared ends (Howard 1988, Liogier 1988). The diversity of the species across its range has resulted in the description of nine varieties (International Plant Index 2001).

Range.—Añil falso is native to northern Mexico through Central America and South America to Paraguay, and to Jamaica, Hispaniola, Puerto Rico, the Virgin Islands, the Lesser Antilles, and Trinidad in the Caribbean (Liogier and Martorell 2000).

Ecology.—Añil falso grows at elevations from near sea level to over 400 m in Puerto Rico. These areas receive from about 750 mm to about 1200 mm of annual precipitation. The species grows in a wide variety of well-drained soils that originate from igneous and sedimentary (including limestone) rocks. Añil falso may be found in brush lands, secondary forests, and remnant forests. It is moderately intolerant of shade. While it normally grows in the understory, it requires plenty of filtered light. It can tolerate moderate competition from shrubs, herbs, and grass, but cannot survive in heavy grass swards. The leaves are shed during the dry season. In relatively undisturbed habitat in Puerto Rico, plants may grow as densely as one per m^2. Añil falso disappears from areas that are overgrazed.

Reproduction.—Of a collection made in Puerto Rico, air-dry pods of añil falso weighed an average of 0.073 $\pm$ 0.005 g/pod. Eighteen pods were threshed and yielded an average of 12.1 seeds/pod with a minimum of two and a maximum of 19. These seeds weighed an average of 0.0028 $\pm$

0.0000 g/seed. They were sown without pretreatment on filter paper and yielded only 10 percent germination in 206 days. After mechanical scarification, 98 percent of the remainder of the seeds germinated within 12 days. Grazing animals are the principal seed vectors. Seedlings are common and well-disbursed. Large plants are prolific seed producers. Even small and suppressed plants produce a few seeds.

Growth and Management.—Añil falso grows up to about 0.5 m per year in height. Plants live from 2 to several years. Wise management of the species must preclude all but light grazing. Plantations for range improvement or environmental restoration could probably be established by sowing scarified seed into cultivated understory sites before or at the beginning of the rainy season.

Benefits.—Añil falso, when available, is grazed heavily by cattle. The species improves the soil by fixing nitrogen.

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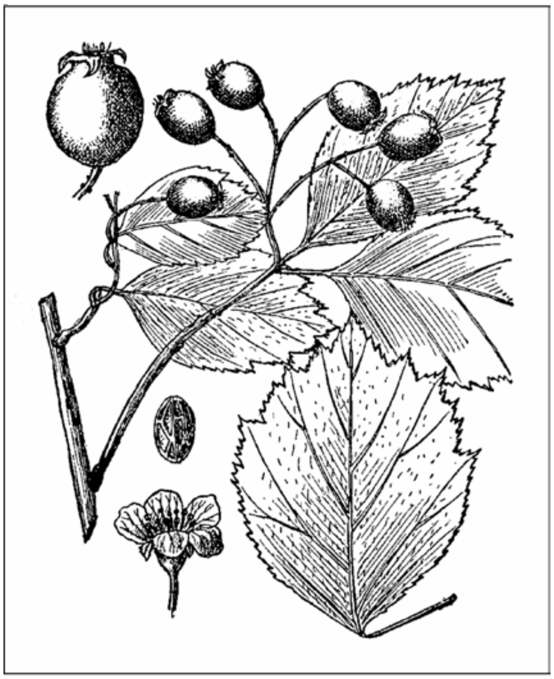
***Crataegus douglasii* Lindl.** black hawthorn
ROSACEAE

Synonyms: *Crataegus brevispina* Doug. ex Steud.
Crataegus brockwayae Sarg.

John K. Francis



General Description.—Black hawthorn, also known as Douglas hawthorn, river hawthorn, western thorn apple, and Douglas thorntree, is a thorny deciduous shrub or small tree 1.5 to 9 m in height. It may have multiple stems from the base or a single stem that begins branching just above the ground. The bark of older stems is smooth to scaly and gray to brown; twigs are hairless, shiny, slender, and reddish, and support stout, slightly curved spines up to 3 cm long. Leaves are alternate, thin, lanceolate to obovate, serrate to doubly serrate, and 1.5 to 9.5 cm long and almost as wide. Showy, five-petaled, white flowers about 12 mm wide with 10 pink stamens are borne in terminal corymbs. The flowers emit a somewhat fishy odor. Fruits are small (12 mm in diameter), apple-like black pomes with thick, light-yellow pulp and three to five nutlets (Borialforest.com 2003, Hansen 2003, Sargent 1923, Viereck and Little 1972, Welsh 1974).

Range.—Black hawthorn is native to southern Alaska, British Colombia, Alberta, Saskatchewan, Ontario, Washington, Oregon, California, Nevada, Utah, Idaho, Wyoming, Montana, North Dakota, South Dakota, Minnesota, Wisconsin, and Michigan (Borialforest.org 2003, Natural Resources Conservation Service 2003, Soper and Heimburger 1982). There are two recognized varieties. *Crataegus douglasii* var. *douglasii* occupies nearly all the range (Natural Resources Conservation Service 2003) and var. *duchenensis* is found in a small area in Utah (Welsh and others 1987). Former varieties *rivularis* and *suksdorfii* are now recognized as separate species (Natural Resources Conservation Service 2003).

Ecology.—Black hawthorn grows mostly in forest understories but also occurs in the open, often in pure thickets. It is both a riparian species and grows in upland sites where adequate moisture is available. Slopes may be level to steep. Elevations vary from 670 to 1,646 m. Soils vary greatly but typically are deep and fine textured. The species usually does not occupy recently disturbed sites. One exception is that it is common in avalanche tracks in Glacier National Park. Although the species grows along streams, it seldom grows in flood-prone areas. Black hawthorn burns readily but is somewhat fire tolerant due to sprouting and suckering. However, the extent of its stands and thickets in eastern Washington has been limited by frequent fires (Habeck 1991).

Reproduction.—Black hawthorn flowers open in May (Sargent 1923) or June (Soper and Heimburger 1982). The flowers are insect pollinated (Hansen 2003). The fruits ripen and fall in August through September (Sargent 1923). Fruits in southeastern Washington averaged 4.78 seeds/fruit (Habeck 1991). Seeds make up about 15 percent of the weight of ripe fruits. There are from 47,000 to 52,000 cleaned seeds/kg (Brinkman 1974). The species is difficult to reproduce from cuttings (Hansen 2003). Black hawthorn sprouts readily when cut and may sucker from the roots (Habeck 1991).

Growth and Management.—Growth of newly established seedlings is slow (Habeck 1991). Particulars on natural stand management are lacking. Fruits are ripe when they are black and lustrous (Habeck 1991) and must be picked by hand or clipped with a pruning pole. Pulp should be removed from the seeds by maceration and then seeds should be air dried before sowing or storage. Seeds should be scarified with H_2SO_4 and stratified at 1 °C for 84 to 112 days before sowing. Brinkman (1974) found that germination reached about 30 percent in 35 to 45 days. Another source cites 50 to 80 percent germination (Habeck 1991). Dumroese and others (1997) report germination from 20 to 80 percent for lots treated identically. Seedlings of most hawthorn species develop long taproots and should not be kept in the nursery for more than 1 year (Habeck 1991). Pruning should be avoided and final target height of seedlings should be 25 cm (Dumroese and others 1997).

Benefits.—Black hawthorn contributes to the beauty of the riparian vegetation, helps protect the soil from streambank and overflow erosion, and offers benefits to fauna. Although not as "showy" as some other hawthorns, the species is hardy and has been used to a limited extent as an ornamental. It makes excellent hedges and natural barriers, and is planted as a wildlife cover and food plant, and for stream bank stabilization (Hansen 2003). Livestock readily eat black hawthorn foliage but the thorny structure of shrubs and small trees makes it difficult for them to utilize it well. They prefer shrubs less than 1 m in height which they may hedge. Mule deer also browse it. With 3.7 percent protein, 3.8 percent fat, 19.3 percent fiber, and 4.0 percent ash, the species is moderately palatable to browsing animals. Deer, upland game birds, song birds, and rodents eat the fruits. Black hawthorn makes excellent escape and nesting cover for wildlife (Habeck 1991). The fruits are made into pies, jellies, and jams (Hansen 2003). Native Americans ate the fruits, sometimes dried and mixed with fat and other ingredients. The wood is hard and heavy and was used for tools and weapons (Washington State Department of Transportation 2003). Native Americans used the thorns for piercing ears, lancing boils, and making fish hooks (Hansen 2003). They prepared a poultice of chewed leaves to relieve swelling and took decoctions of sap, bark, wood, and root for stomach problems (Moerman 1986).

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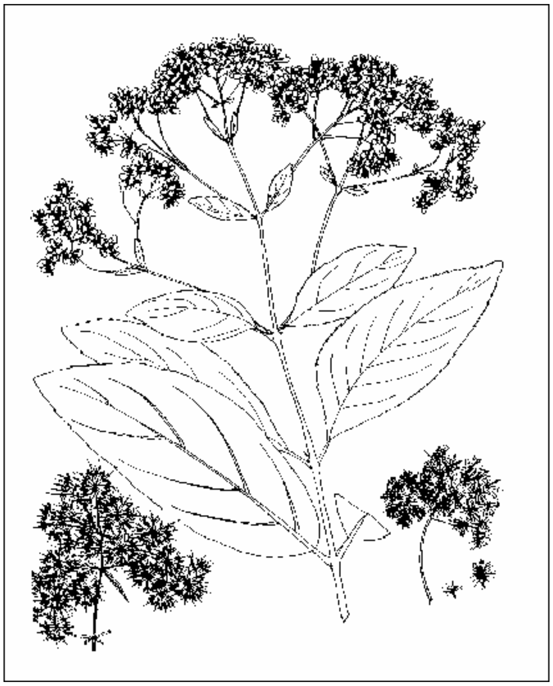
Critonia portoricense (Urban) Britt. & Wilson guerrero
ASTERACEAE

Synonyms: _Eupatorium portoricense_ Urban

John K. Francis



General Description.—Guerrero, which means warrior in Spanish, is a large shrub or small tree to 6 m in height and 15 cm in diameter at breast height. Older plants usually have multiple stems, arising from the root crown or lower stem. The wood is brittle and has a central pith 2 or 3 mm thick. Plants may or may not have well-defined taproots. Lateral roots are robust and send down sinker roots. The roots are tan-colored and stiff. Stem bark is thin, gray, and nearly smooth. The inner bark of guerrero is light green and bitter. Branches and twigs are not numerous, resulting in thin crowns. The hairless leaves are opposite, 7 to 16 cm long with short petioles, ovate-elliptic blades with serrated or wavy-toothed edges, and long-pointed tips. The foliage is fragrant. The inflorescences are heads within large, terminal corymbs with tiny white flowers that produce, at maturity, tiny (3 mm long) achenes tipped with 3-mm white hairs (pappus) (Liogier 1997, Little and others 1974).

Range.—Guerrero is found only in Puerto Rico and the adjacent island of Vieques (Liogier 1997, Little and others 1974). It is not known to have been planted or naturalized elsewhere.

Ecology.—Guerrero grows on nearly all well-drained soil types derived from sedimentary and igneous rocks (including limestone and ultramafics). Rooting is deep when soil permits, but the typical sites where the species grows are shallow over bedrock. The species is also found on poor and eroded soils. It grows from near sea level to 900 m in elevation (Little and others 1974). Mean annual rainfall ranges from about 850 to 2200 mm. Although present in openings and rock outcrops in late secondary and remnant forests, guerrero is frequently common in early and middle secondary forests. It invades neglected pastures. Minor soil disturbance such as trampling by cows appears necessary for establishment.

Reproduction.—Guerrero mainly flowers from November to February and matures fruits from December to March (Little and others 1974). Plants receiving full or nearly full sun are heavy seed producers. The seeds are wind-disbursed and may travel considerable distances. A collection of seeds averaged 0.00025 g/seed or about 4,000,000 seeds/kg. Seedlings are rare to common, but never abundant. Resprouting occurs after adult plants are burned or cut.

Growth and Management.—Guerrero grows at a similar rate as associated species in the difficult habitat where it occurs. Sprouts add about 0.5 m of height per year for the first 4 or 5 years. Life span appears to be 2 to 3 decades. No planting experience has been published.

Benefits.—Guerrero is browsed by goats but mostly ignored by cattle. The species is sometimes planted as an ornamental for its fragrant foliage (Little and others 1974). Three pyrrolizidine alkaloids were isolated from the aerial parts of the shrub (Wiedenfeld and others 1995). As a medicinal plant, extracts from its leaves are said to relieve arthritis, and to relieve pain when applied as a topical alcoholic rub (Liogier 1990). Guerrero contributes to biodiversity of the forests in which it grows, furnishes cover and nesting sites for birds, and helps protect and stabilize soil in disturbed areas.

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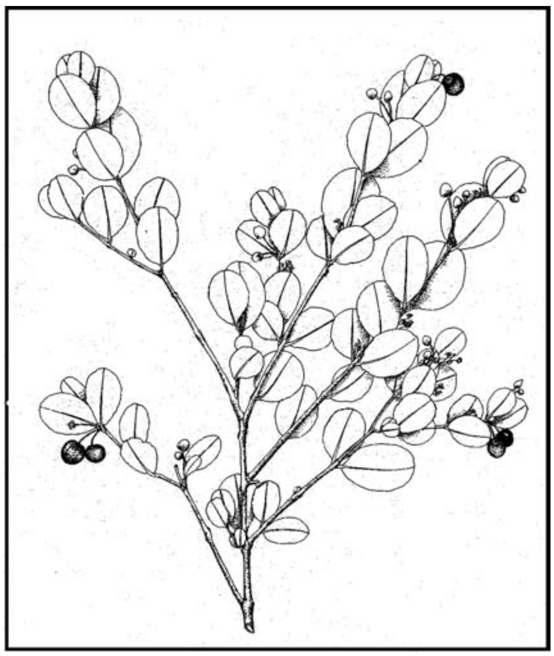
***Crossopetalum rhacoma* Crantz** maidenberry

CELASTRACEAE

Synonyms: *Rhacoma crossopetalum* L.
Myginda rhacoma Sw.
Myginda rotundata Lam.
Myginda pallens J.E. Sm. in Rees
Crossopetalum pallena (J.E. Sm.) Kuntze
Rhacoma pallens (J.E. Sm.) G. Maza
Myginda latifolia M. Vahl

John K. Francis



General Description.—Maidenberry is also known as Florida crossopetalum, rhacoma, poison-cherry, coral, manto, maravedí, palo de paloma, pico de paloma, limonejo, membrillo, ti bonbon, bonbon rouge, and placa chiquitu. It is an evergreen shrub sometimes becoming a small tree. It commonly measures 1 to 3 m in height but may reach 8 m. The shrub is supported by a major taproot and significant lateral roots with yellow bark. Maidenberry usually has multiple stems from the root crown and just above, and many branches. Three shoots form at each node, one of which usually dies. The opposite or ternate leaves have a petiole about 1 mm long, lanceolate to obovate leathery blades usually with wavy-toothed edges. The tiny greenish-red flowers are borne in axillary cymes. The fruits that follow are fleshy, egg-shaped drupes that ripen to a bright red. Each contains a stone and one or two seeds (Howard 1989, Liogier 1994, Little and others 1974).

Range.—Maidenberry is native to Southern Florida, the West Indies, and Venezuela (Howard 1989, Liogier 1994, Little and others 1974, Alarcón 2001). Howard (1989) and Liogier (1994) state that is found in Mexico and Central America, but the species is not listed in the current check lists for countries in the region.

Ecology.—Maidenberry is usually found in rocky and dry or excessively drained sites. It tolerates a wide range of well-drained soil types derived from sedimentary (including limestone), igneous, and metamorphic (including ultramafic) rocks. In Puerto Rico, maidenberry grows from near sea level to 400 m in elevation in areas that receive from 750 to about 1600 mm of precipitation. It is moderately intolerant of shade and withstands only moderate competition from grasses and shrubs. The species will survive but not prosper under low basal-area dry forest. The roots support vascular-arbuscular mycorrhizae (TreeGuide Inc. 2002). Maidenberry is listed as endangered in Florida (Florida Fish and Wildlife Conservation Commission 1997); however, it is relatively common in Puerto Rico and several West Indian islands (Little and others 1974). In Florida, it is found in pinelands and occasionally hammocks (Nelson 1996). In the West Indies, maidenberry grows in remnant and secondary forests, most often on rocky ridges and hillsides. The species' continued presence in overgrazed areas suggests that it is not palatable to cattle.

Reproduction.—Maidenberry flowers and fruits year-round as a process associated with new stem growth (Nelson 1996). Birds disperse the seeds. Despite almost constant fruit production, seedlings are not common. Plants readily sprout when cut or burned.

Growth and Management.—Maidenberry grows slowly and may live for several decades. No management experience has been published. However, cattle grazing to reduce competition from grass, herbs, and vines will probably encourage reproduction and survival.

Benefits.—Maidenberry furnishes food and cover for wildlife and protects the soil. It is listed as one of the food plants for the endangered Anegada iguana, *Cyclura pinguis* (International Reptile Conservation Foundation 2002). The wood of maidenberry is light brown and hard, but is used only for fuel. All the plant tissues, especially the roots, are diuretic and are used to promote urination and to treat kidney and bladder infections (Liogier 1990).

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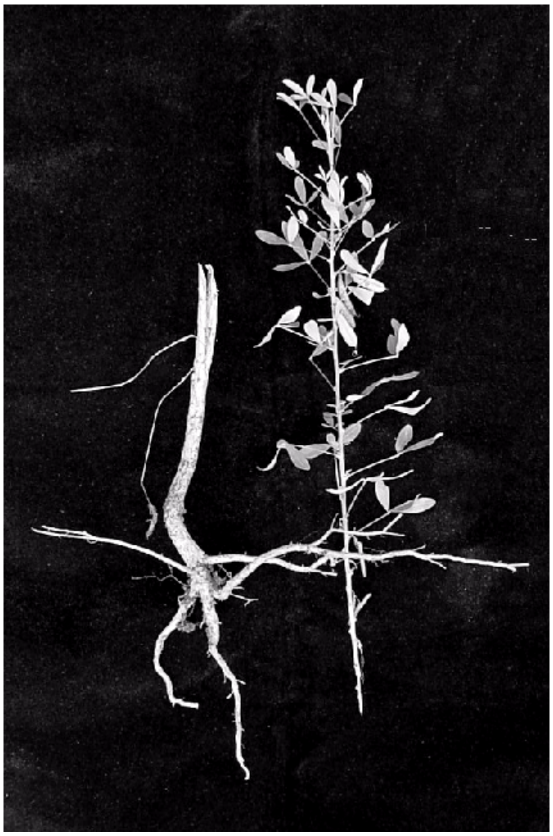
***Crotalaria lotifolia* L.** cascabelillo axilar

FABACEAE

Synonyms: *Crotalaria lotifolia* L. var. *eggersii* Senn
Crotalaria lotifolia L. var. *grandiflora* Urban
Crotalaria lotifolia L. var. *grandifolia* Urban

John K. Francis



General Description.—Cascabelillo axilar is a suffruticose or relatively short-lived shrub usually 1 m in height and 6 mm in basal diameter but sometimes reaching 2 m in height and more than 1 cm of basal diameter. It usually has a single stem, stiff and straight in its lower portions, which branches sparingly. The wood is moderately hard and tough. The branches are slender. Stem bark is yellowish-green and striated. The plant is supported by a tap and lateral root system with moderately stiff roots with yellow bark. Foliage is concentrated near the top of the plant. Leaves are trifoliate on long (2 to 6 cm) petioles. Leaflets are light green or yellow-green, oblong to elliptic, and 1 to 5 cm long. The inflorescences are few-flowered, axillary racemes whose unequal flowers have a yellow corolla 5 to 7 mm long. The legumes (pods) are 2 to 3 cm long and 6 mm wide and contain a few tan seeds that rattle when dry suggesting the Spanish name cascabelillo, which means little rattlesnake (author's observations, Howard 1988, Liogier 1988).

Range.—Cascabelillo axilar is native to the Bahamas, the Greater Antilles, St. Barts, Dominica, Martinique, the Grenadines, Barbados, Mexico, and Honduras (Howard 1988, Liogier 1988).

Ecology.—In Puerto Rico, cascabelillo axilar grows from a few meters above sea level to about 500 m elevation on the southern slopes of the Sierra Central. These areas receive from 750 to about 2200 mm of mean annual precipitation. It grows on a variety of soils derived from igneous, sedimentary (including limestone), and metamorphic (including ultramaphic) rocks (Breckon 2002). Cascabelillo axilar is moderately intolerant of shade. It grows in openings and in the understory of low basal-area forest, often in rocky and excessively drained areas. The forests are remnants and middle to late secondary. The species does not tolerate competition from tall grass swards and thick herb and brush growth.

Reproduction.—Cascabelillo axilar probably flowers near the end of the wet season. Plants with mature pods were observed by the author in Puerto Rico in March. Seed production can be abundant. Eighteen pods collected in Puerto Rico averaged 6.7 seeds per intact pod. An unknown seed insect had attacked some of the pods. Seeds collected from the same area averaged 0.0086 $\pm$ 0.0008 g/seed or 117,000 seeds/kg. Sown on moist blotter paper without pretreatment, 35 percent germinated in 5 months. Seeds from the same batch, mechanically scarified, all germinated in 12 days. Germination is epigeal. Seed pods spring open upon drying flinging the seeds a short distance. Grazing animals probably also move seeds. Seedlings are relatively common on sites where the species is present.

Growth and Management.—Once established, cascabelillo axilar adds about 0.5 m in height each year and loses most of it to die-back the following dry season. Individual plants probably live 1 to 3 years or more. No management experience has been published. Scarified seed sown and incorporated into prepared ground or seed spots at the start of the wet season may offer a good chance of success.

Benefits.—Cascabelillo axilar contributes in a minor way to standing biomass, cover for wildlife, the aesthetics of the forest understory, and it helps protect the soil. The species is browsed by cattle and consequently is more common in protected areas. Cascabelillo axilar is present in moderately grazed areas but absent from seriously overgrazed areas.

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***Crotalaria spectabilis* Roth** showy rattlebox

FABACEAE

Synonyms: *Crotalaria leschenaultii* DC.
Crotalaria macrophylla Weinm.
Crotalaria retzii Hitchc.
Crotalaria sericea Retz.

John K. Francis

General Description.—Showy rattlebox, also known as showy crotalaria and rattlebox, is an annual semiwoody herb in temperate areas, and a short-lived shrub in its frost-free subtropical and tropical range. In Puerto Rico, it grows up to 2 m in height and 3.5 cm in basal diameter. It normally has a single stem. The lower stems are covered with whorled, short, shelf-like old leaf bases and stipule remnants. The leaves and fruiting branches are shed progressively upward after they mature so that foliage and branches are only found on the upper portion of the stem. The mid- and lower stem has a white, brittle, medium-hard wood with a 1.5-mm pith. The upper stem, branches, and foliage are green to yellow-green. The plant is supported by a tap and lateral system of stiff, tan roots. The simple, whorled leaves are oblanceolate to elliptic, 5 to 17 cm long, entire, and have a 2-mm petiole and broad, triangular stipules. The inflorescences are terminal or subterminal racemes with 20 to 25 flowers with linear-triangular bracts. The bright yellow unequal flowers are 1.5 to 2 cm long. Inflated brown to black legumes are 3 to 5 cm long and 1.8 to 2 cm thick. They contain several hard, shiny brown to black seeds 4.5 mm long (author's observation, Damron and Jacob 2001. Howard 1988, Liogier 1988, Stevens and others 2001).

Range.—Showy rattlebox is native to the Indo-Malaysia area (Parrotta 2001). It has been planted widely and has naturalized in many tropical countries including the Southern United States, Hawaii, and Puerto Rico (International Legume Database and Information Service 2002).

Ecology.—Not much is known about showy rattlebox in its natural habitat. It grows on roadsides and disturbed areas in Florida (Long and Lakela 1976), and in Puerto Rican coastal sands and limestone rubble in areas receiving about 1650 mm of annual precipitation (author's observation) and at the edge of mangroves (Liogier 1988). Parrotta (2001) reports that it is common along stream banks in deciduous forests in India. The species is a weed of agricultural crops in the Southern United States (Bradley and Hagood 2002). It is intolerant of shade and does not grow under a forest canopy. The species seems to favor sandy soils (McGregor 1976), grows well in alkaline soils, and at least tolerates moderate soil salinity. Plants are often parasitized by dodder (*Cuscuta* spp.) in Puerto Rico. Showy rattlebox is well nodulated with nitrogen-fixing bacteria (McGregor 1976).

Reproduction.—Showy rattlebox blooms all year in Florida (Long and Lakela 1976) but is reported to flower in April and May and fruit in October in Nicaragua (Stevens and others 2001) and flower between November and January and fruit from December to February in India (Parrotta 2001).

The flowers are visited by honey bees and other insects (McGregor 1976). A collection of seeds from Puerto Rico averaged 0.0154 $\pm$ 0.0000 or 65,000 seeds/kg. Only 3 percent of unscarified seed placed on moist blotter paper germinated in 6 months. However, 99 percent of scarified seed germinated between 4 and 7 days after sowing. Germination is epigeal. When sufficiently dry, pods spring open, flinging the seeds a short distance.

Growth and Management.—Showy rattlebox has a moderate to fast growth rate and may reach a meter of height by 1 year old. Plants appear to live 2 or 3 years in Puerto Rico. Parrotta (2001) refers to the species as biennial. Plantations are established by sowing scarified seed into prepared ground.

Benefits and Detriments.—Showy rattlebox is a beautiful plant and contributes to the aesthetics of wildlands and gardens where it is planted. It serves as a nurse species during early reforestation and helps protect the soil. Showy rattlebox is used as a green manure crop, particularly where rotation for control of nematodes is important (Zago and others 2002). It has also been grown as a fodder plant. This has largely been abandoned because of the toxic alkaloids (principally monocrotaline) it contains. Concentrations are reported as: leaves 0.008 percent, seedpods 0.366 percent, and seeds 1.958 percent (Burkill 1995). Chickens, turkeys, and quail are very sensitive. Concentrations of crotalaria alkaloids between 0.01 and 0.1 percent of the diet have adverse effects and 0.3 percent is fatal (Damron and Jacob 2001). Horses, cattle, and swine are also sensitive. Sheep, goats, and dogs are more resistant. Effects can be both acute and chronic and include bloody diarrhea, anemia, jaundice, hair loss, and unthriftiness. There is no known treatment (Alabama Cooperative Extension Service 2002). In herbal medicine, extracts of the whole plant are used to treat impetigo and scabies (Jain and De Filipps 1991), as an antiseptic for cuts, and to treat intestinal worms (Parrotta 2001).

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***Cuphea hyssopifolia* Kunth** false heather
LYTHRACEAE

Synonyms: *Parsonia petiolata* (L.) Rusby
Cuphia petiolata Koehne

John K. Francis

General Description.—False heather is sometimes called cuphia, clammy cuphia, tarweed, elfin herb, or simply, heather (Griffiths 1992, Pope 1968). It is a woody, much branched shrub, although diminutive in size. While Howard (1989) states that the species may reach 70 cm in height and Turner and Wasson cite 60 cm as maximum height, 25 to 30 cm are more typical (Liogier 1994). A definite leader is maintained, but many of the lateral branches grow along the ground surface. The bark is reddish brown and stringy. The root system consists of a short taproot and many laterals of equal thickness. The tertiary roots are fibrous. The leaves are subsessile, 1 to 3 cm long and linear, lanceolate, or oblanceolate. Young stems and the underside of leaves are pubescent. The small white, pink, violate, or reddish purple flowers appear in the axils of new leaves (Turner and Wasson 1997). There 5 to 8 ovules in each flower, and generally six 1-mm seeds per fruit (Howard 1989).

Range.—False heather is native from Mexico to Panama (Howard 1989, Liogier 1994). It has been planted widely and has naturalized and escaped in at least Hawaii (Pope 1968), Puerto Rico (Liogier 1994), Montserrat, and St. Lucia (Howard 1989).

Ecology.—A moderate amount of disturbance is required for false heather to establish and maintain itself. Mowing, animal and vehicular traffic, and light cultivation are typical enabling disturbances. A moist climate (above 1400 mm of annual precipitation) is required for natural stands. It does not tolerate frost or salt (Watkins and Sheehan 1975). Partial shade from trees and light competition from grass and weeds are tolerated, but tall grass and heavy weeds will eliminate it. In Hawaii, false heather is most abundant in moist and partially shaded places above 240 m elevation (Pope 1968). Clayey and medium textured soils with good drainage are best. Japanese beetles (*Popillia japonica* Newman) sometimes defoliate it in Hawaii (Pope 1968).

Reproduction.—Flowering and seed production takes place constantly. The seeds are tiny (1.3 million per kg) and difficult to collect. The period between flowering and seed formation is short, and the seeds are expelled from the fruits at maturity. A germination test of 94 seeds on filter paper resulted in only two seeds germinating, over a period of 14 days. Seedlings are not uncommon on moist, disturbed soil. False heather also reproduces by layering whenever horizontal branches touch the ground. Both seedlings and layers are important in the maintenance of natural stands. Obtaining new plants from seed is difficult. Nursery plants are reproduced by cuttings; tips will root any time of year (Watkins and Sheehan 1975). Artificial reproduction by air and ground layers is also possible.

Growth and Management.—False heather is a short-lived plant except when layering prolongs its life. After about 1 year, most plants begin a decline in vigor and eventually die. Renewal of decadent older plants can be promoted by mowing at about 5 cm height, which cuts away the old plant structure from the newly layered branches. Nursery plants should be watered during dry periods or as needed and given frequent light fertilizer applications. False heather is susceptible to nematodes. Use of nematode-free media is recommended (Watkins and Sheehan 1975).

Benefits.—False heather has been cultivated widely as an ornamental. It is used as a potted plant, for low borders, and as ground cover in small beds. False heather may become a weed in warm climates (Turner and Wasson 1997) and has become a serious weed in some parts of Hawaii (Pope 1968).

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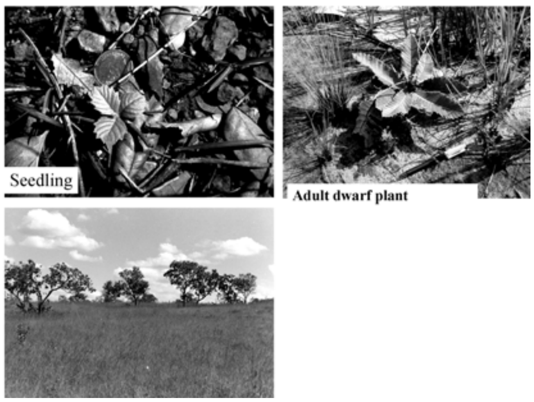
***Curatella americana* L.** chaparro

DILLENIACEAE

Synonyms: none

Ariel E. Lugo and Ernesto Medina



General Description.—Chaparro in English is known as the rough-leaf tree and it is also known as careicillo, peralejo macho, vacabuey, aperalejo, curatela, peralejo, peralejo de sabana, pomme torche, raspa viejo, tlachicón, hoja man, yaha, lengua de vaca, malcajaco, hoja chigüe, raspa, raspa guacal, chumico de palo, hoja chigüe, yahal, saha, chumico, azufre, curata, paricá, chaparro de sabana, chaparro sabanero, chaparro colorado, parica, feuille rude, curatahie, carne de fiambre, caimbe, cajueiro bravo, sambaiba, caimbahiba, cambaiba, sobro, sabaibinha, and chaáco (Liogier 1983, 1990, Standley and Record 1936, Salas Estrada 1993, Siegel and Paguaga 1991, Vargas Ulate 2001, Standley 1920, 1937, Pérez Arbelaez 1978, Record and Mell 1924, Bastos 1984, Kileen and others 1993). *Curatélla* means "plants being used or worked", for example, for polishing weapons and metal (Bailey 1941). It is an evergreen woody shrub less than 50 cm tall to a tree 6 to 10 m in height (Lundell 1937, Liogier 1990, Killeen and others 1993). Its most frequent habit is that of a gnarled shrub or small tree (Sarmiento and Monasterio 1983).

In a family dominated by lianas, chaparro is a twisted, thick-barked shrub/tree with pubescent young branches (Schnee 1960). Leaves are simple, alternate, oval to elliptic oval, 5 to 12 cm wide and 10 to 15 cm long, rounded to emarginated, pinnately veined, hard, pubescent (when young), and with very scabrous surfaces and sinuous margins (Pittier 1926, Gentry 1993, Killeen and others 1993). Leaf borders are dentate. The apex is retuse and the base is decurrent on a short petiole (Schnee 1960). Stipules are deciduous and form small scars on the stem.

Leaf morphology contributes to reduction of heat loads and prevents overheating (Medina 1982). Stomata are slightly elevated and the leaf epidermis is heavily cutinized (Mérida and Medina 1967). Leaves of chaparro are scleromorphic, with low specific leaf area (<100cm^2/g) and low nutrient concentrations (Mérida and Medina 1967, Medina 1977, 1982, Sarmiento and Monasterio 1983).

Throughout its range, chaparro is most commonly associated with the following species: trees such as *Bowdichia virgilioides* and *Byrsonima crassifolia*; and grasses and sedges such as *Leptocoryphium lanatum* and *Trachypogon plumosus*; and species of *Andropogon*, *Axonopus*, *Bulbostylis*, *Paspalum*, and *Rhynchospora* (Sarmiento 1983). In Belize, chaparro grows in pine forests (Standley and Record 1936). Pollen from chaparro appeared in Suriname and Colombia in strata dated at 45,000 years before present at the beginning of the Pleistocene and during glacial times (Van der Hammen 1983). Chaparro pollen was associated with grass pollen and dry periods and has shown cycles of abundance and disappearance in response to climate change. The presence of chaparro pollen in lake sediments established the evolution of savanna vegetation in the Neotropics before the presence of humans (Sarmiento 1983). Chaparro pollen also established the boundary between rain forests and savannas in Bolivia and the southern expansion of the rain forest boundary over the past 3,000 years in response to climate change (Mayle and others 2000), and vegetation changes in southeastern Brazil and Colombia since the Holocene and late Quaternary (Behling 1995, Behling and Hooghiemstra 1999).

Range.—Chaparro has a large geographic range that includes Cuba (Grisebach 1963); Hispaniola; the states of Tepic, Tabasco, Chiapas, Veracruz, Campeche, Oaxaca, and Guerrero of México (Standley 1920); Honduras; Belize (Standley and Record 1936); Nicaragua; Costa Rica; Panamá (Woodson and Schery 1965); Guatemala; El Salvador; French Guiana; Suriname; Guyana; Trinidad; Venezuela; Colombia (Pérez Arbelaez 1978); Perú (Macbride 1956); Brazil; and Bolivia (Beard 1953, Sarmiento 1983, Liogier 1990, Salas Estrada 1993).

Genetics.—Comparative flavonoid chemistry of chaparro and other members of the Dilleniaceae family resulted in reticulate distribution of the substances identified and did not permit recognition of taxa beyond the level of genus and family (Gurni and Kubitzki 1981). Woodson and Schery (1965) reported *pentagyna* as a variety of chaparro in Panamá.

Ecology.—Chaparro is a savanna plant with a uniform spatial distribution (San Jose and others 1991). It is adapted to fire, high air temperature, and harsh soil conditions (Pittier 1926, Lundell 1937). Chaparro is among the first invaders after a fire (Salas Estrada 1993). Medina and Silva (1990) describe the savannas where chaparro grows as "steady state (s) regulated by water-fire interactions on a background of low nutrient availability." However, during the early phases of growth, chaparro is susceptible to fire disturbance (San José and Medina 1975). A low allocation of N to leaves--even young ones--reduces photosynthetic capacity, but it is adaptive to fire as only a small amount of N is lost when leaves burn (Medina and Francisco 1994).

Chaparro grows up to 500 m elevation in Bolivia (Killeen and others 1993), and Venezuela (Sarmiento 1983), and it has extended its range in Colombia to up to 500 to 1,500 m due to savannization of forest lands (Cavalier and others 1998). Frost appears to limit its northern and southern distribution, and flooding or soil saturation also limits its distribution (Sarmiento 1983).

High acidity, high clay content, low mineral nutrient concentration, high exchangeable Al, poor drainage, and poor aeration in the deeper soil horizons favor chaparro (Lundell 1937, Gottsberger and Morawetz 1986). Chaparro will grow in depressions. In some sites, chaparro dominates the community and forms dense groves. For example, within a matrix of flooded savannas in Bolivia, chaparro forms groves on ant and termite hills and on hummocks (Killeen and others 1993). *Sahales* is the name used to describe groves of chaparro in northern Petén (Lundell 1937). Chaparro grows in a wide range of moisture conditions from dry to wet savannas. In the Venezuelan Llanos, San José and Medina (1975) report a mean annual rainfall of 1335 mm and a range of 580 to 1990 mm. A "normal" year has a 4 to 6 month dry season. Beard (1953), Sarmiento and Monasterio (1975), Sarmiento (1983), Medina and Silva (1990), and Medina and Huber (1992) report details of the climatic and edaphic conditions of tropical American savannas where chaparro is one of the most common woody species.

Chaparro grows in many soil types. The most favorable are well-drained soils. Examples of soils are red sands, red sandy loams, yellow sands, well drained latosols, hard laterite crusts, ill-drained latosols, deeply weathered quartz gravel and sands, serpentine-derived soils, entisols on well drained sites, entisols on young alluvial surfaces to oxisols on more ancient ones, alfisols, and vertisols (Sarmiento 1983). Vargas Ulate (2001) attributed the presence of chaparro in Guanacaste, Costa Rica, to acid and infertile soils. In Colombia, the loss of the A and B horizons of granitic soils in sierra Nevada have led to savannization and the establishment of chaparro in lands where it normally does not grow (Cavalier and others 1998).

Chaparro has a deep root system reaching the water table in its adult stage. The species is a phreatophyte, so it grows new leaves during the dry season (Sarmiento and Monasterio 1983, Medina and Francisco 1994).

Competition between chaparro and other plants in the savanna occurs in two stages: establishment and subsequent growth. During establishment, grasses may hinder the growth of saplings and constitute a risk because of the high fire frequency. Chaparro roots face water shortages as they grow through the grass root layer, so establishment is favored by sequences of wet years when fire frequency diminishes and soil moisture increases. Eventually, chaparro will out-grow grasses and shade them out (for example in tree groves).

The chlorophyll content of chaparro is low and correlated with low N and high ash concentrations (Medina and Francisco 1994). Leaf photosynthesis rate reached maximum values in mature leaves during the humid season and declined in younger and older leaves and during the dry season (Sobrado 1996b). Young leaves are more efficient in water use than mature leaves.

Stomatal conductance, and water loss, decline during the dry season. Chaparro leaves do not show photoinhibition. Stomatal conductance differences between dry and wet season appear to be responsible for maintaining a homeostatic balance of leaf water and thus maintain xylem integrity in spite of the species vulnerability to embolisms (Sobrado 1996a). Predawn water potential, minimum leaf water potential, and hydraulic resistance of chaparro, did not show significant differences throughout the year. In spite of the scleromorphic appearance of leaves, chaparro appears adapted only to short-term diurnal deficits (Meinzer and others 1983). The transpiration curves for chaparro during the dry season are always bimodal (Medina 1977, 1982) as plants close their stomata at noontime, independently of water availability (Medina 1967, 1983). Transpiration rates are also low. The dependency of leaf dark respiration on air temperature changes seasonally (Medina 1982). The steepness of the relationship decreases from December, to February, to March, and to September through November, when the relationship is flat.

The fungus *Pseudocercospora curatellae* was isolated from leaves of chaparro (Furlanetto and Dianese 1999). The earthworm *Pontoscolex roraimensis* was associated with chaparro (Guerra Torquemada 1994). Epiphytes are not abundant on chaparro bark, probably due to its flaky deciduous nature (Gottsberger and Morawetz 1993). Leaf herbivory on chaparro was 4.6 percent near Cuiaba, Mato Grosso, Brazil (Nascimento and others 1990).

Reproduction.—The white flowers have a “disagreeable smell” (Grisebach 1963), occur in lateral panicles on defoliated old branches, and are rarely terminal. Flowers are actinomorphic and hermaphroditic. Four to five petals are white or pinkish, 5 to 6 mm, free, and imbricate (Liogier 1990). Four to five green sepals are rounded, 5 mm long, persistent, and externally pilose (Schnee 1960). Stamens are numerous, free, and persistent. The gynoecium has two hirsute carpels of 6 to 7 mm (Liogier 1990) with longitudinal dehiscence (Schnee 1960). They are coned at the base and covered by long and abundant hairs. Follicles are globose, hispid, coned in the lower half, with two seeds (Killeen and others 1993). Flowers and fruits of chaparro are fasciculate and ramiflorous (Gentry 1993). Chaparro flowers between July and November in Bolivia (Killeen and others 1993) and December to February in Venezuela (Montes and Medina 1977). Seeds are oblong, bright, chestnut brown to black, 3 mm long, with a small membranous hilum (Schnee 1960, Liogier 1983). Seeds are long-lived and remain buried until the proper conditions for germination occur (Medina and Francisco 1994). Fire induces germination and sprouting of stems that are too thick to sprout under normal conditions (Foldats and Rutkis 1969). Seeds are dispersed by birds (Salas Estrada 1993), including parrots and parakeets who eat chaparro fruits (Pérez Arbelaez 1978).

Growth and Management.—Chaparro assimilates carbon all year, but its photosynthetic capacity is reduced due to high mesophyll resistance to CO_2 transfer (Medina 1982). Growth is seasonal and its flowering is tardy (Sarmiento and Monasterio 1983). It flowers and produces new leaves during the dry season (Medina 1982). Leaf development takes 45 days (Nascimento and others 1990), and leaf longevity is about 11 months (Montes and Medina 1977). However, young, mature, and old leaves overlap in an individual (Medina and Francisco 1994). Fruiting and seed dispersal may continue for a short time during the rainy season. Fire does not interrupt this cycle as burned leaves fall and within days there is a new flush.

Two hundred randomly selected trees of chaparro growing in the seasonal savannas of western Venezuela had a mean stem diameter at ground level of 8.3 cm. The largest recorded diameter was 39.8 cm (Sarmiento and Monasterio 1983). Chaparro wood has no growth rings and its sapwood is not clearly defined (Record and Mell 1924).

Under a regime of annual burning, chaparro will experience die back of all its annual growth shoots, and growth will start the next season from adventitious buds that develop from vascular cambium of older branches (Sarmiento and Monasterio 1983). As a result of this response, “the tree behaves as a mechanical structure supporting a crop of annual branches” (Sarmiento and Monasterio 1983). The vascular cambium assumes the role of apical meristem as the main replacement tissue. Chaparro can maintain itself as a hemixyle--with annual shoots and woody underground structures--and even complete the reproductive process in this growth form (Sarmiento and Monasterio 1983). Chaparro can develop new individuals from injured roots (Foldats and Rutkis 1975). Usually, saplings that develop from injured roots have higher water potentials than normal saplings because they are already connected to the water table. Injury to roots will stimulate vegetative regrowth, which in turn also facilitates formation of groves (San Jose and others 1991).

The mineralization of nitrogen, soil organic matter, soil exchangeable Ca, Mg, and K, and total soil nitrogen were higher in soils under chaparro trees than soils under savanna grasses. For soil organic matter, K, and cation exchange capacity, chaparro exceeded values measured under deciduous trees in savannas (García Miragaya and others 1994, Sánchez and others 1997). Although chaparro is not an aluminum accumulating plant, it exhibits seasonal variation in its nutrient concentration (Villela and de

Lacerda 1992). Potassium, Fe, Cu, and Zn were highest in August, Ca and Mg in November, and Al and Mn in May. The Al and Mn concentration of mature chaparro leaves is 171 and 105 parts per million, respectively (Medina 1977).

Benefits.—Chaparro produces good wood with a reddish hue and specific gravity of 0.85. Record and Mell (1924) and de Matos Araujo and de Matos Filho (1977) contain wood anatomy information for chaparro. Small stem sizes limit wood utilization of shrubs and trees. However, the wood is durable and used for charcoal, fuelwood, posts, small cabinetwork, and for turning (Record and Mell 1924, Standley and Record 1936, Killeen and others 1993, Salas Estrada 1993). Termites do not attack chaparro wood (Pérez Arbelaez 1978). Wood utilization increases where trees or shrubs become locally abundant and grow in groves (Pittier 1926). People use dry leaves as substitutes for sand paper and for cleaning kitchen utensils or polishing metals (Killeen and others 1993). Chaparro bark produces tannins that provide a gray color when used for dying pelts (Killeen and others 1993). Ground seeds mixed with chocolate flavors the drink in Oaxaca, México (Standley 1920). Chaparro was one of the most abundant pollens in honey samples during the months of January, February, and March from an apiary north of Roraima State, Brazil (da Silva and Absy 2000). Siegel and Paguaga (1991) suggested using chaparro twigs and pods for prospecting for gold in Costa Rica. In Venezuela, Clamens and others (1999) evaluated chaparro for industrial gum production and found the species promising.

Pharmaceuticals.—Chaparro is a medicinal plant used extensively in folk medicine throughout its range. Infusions from leaves and stems are used for arthritis, diabetes, and to lower blood pressure (Killeen and others 1993, Liogier 1990). Guerrero and others (2002) found that a dose of 20 mg/kg of ethanolic extracts of chaparro showed significant antihypertensive activity in rats. In Brazil, chaparro is used for treatment of inflammation and ulcer. Anti-inflammatory and analgesic tests with hydroalcoholic extract of bark were successful in mice (Alexandre Moreira and others 1999). Cooked leaves are used to mitigate skin eruptions, for dressing wounds, and the water for purifying blood (Liogier 1990).

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***Cytisus scoparius* (L.) Link** Scotch broom
FABACEAE

Synonyms: *Sarothamnus scoparius* (L.) Wimmer ex Koch
Genista scoparius Lam.
Spartium scoparium L.

John K. Francis

Drawing source: Britton and Brown 1913.

General Description.—Scotch broom is also known as broom, common broom, Scot's broom, English broom, green broom, broom tops, Irish tops, witch's broom, basam, escoba negra, and retama de escobas. It is a shrub, usually 1 to 2, occasionally 3 m in height, which sheds its leaves early and remains leafless for most of the year. The green twigs are the principal photosynthetic organs. Branches are upright to arching. The angular, flexible twigs often occur in moderately long sprays. Old stems become gray-brown. The plant grows a deep root system with a taproot. Leaves are trifoliate low on the twigs and simple and sessile near the tips. The obovate to lanceolate leaflets are 4 to 8 mm long, and petioles are 2 to 10 mm long. It's perfect flowers, which are solitary in leaf axils or in clusters of two or three, are about 2 cm long, brilliant yellow, and have the typical form of flowers in the pea family. Orange, red, pink, purple, and lilac flowers are available in ornamental varieties. The fruits are dark brown, linear pods 4 to 5 cm long that are ciliate at the margins and contain five or six seeds each. The seeds are 3 to 4 mm long, greenish brown, and in the form of a flattened oval. There are 2n = 46 or 48 chromosomes (Abrams 1944, Meyer 2003, New England Wild Flower Society 2003 University of Connecticut 2003, Welsh and others 1987).

Range.—Scotch broom is native to Western and Eastern Europe, including the Mediterranean islands, the British Isles, and western Scandinavia. It has been planted and naturalized in Eastern and Western United States, Hawaii, Canada, the Azores, the Canary Islands, Australia, New Zealand, South Africa, India, China, and parts of southern South America (International Legume Database and Information Service 2003, Natural Resources Conservation Service 2003). Two varieties of Scotch broom have naturalized in the United States. Variety *andreanus* occurs only in California and var. *scoparius* accounts for the rest of the naturalized range (Natural Resources Conservation Service 2003).

Ecology.—Scotch broom grows as scattered plants, small clumps, and pure stands, and competes fiercely with forbs, grasses, and tree seedlings. It requires disturbance, especially disturbance resulting in bare mineral soil to become established. It prefers sandy soils, but will grow in a wide variety of well-drained soils (Prasad 2003). Scotch broom is drought tolerant. The species is intolerant of shade and cannot survive under a closed forest stand. Nitrogen fixation occurs in root nodules, and fixed nitrogen is released to the environment in the litter (Parker and others 1994). Top injury from subfreezing temperatures may occur in cold climates, but plants usually survive (Michigan State University Extension 1998). Scotch broom is commonly seen along roads, in vacant lots and inactive construction sites, in old logging areas, in neglected pastures and orchards, and along fence-rows.

Reproduction.—Scotch broom flowers in May or June (New England Wild Flower Society 2003). The flowers are pollinated by honey bees and bumblebees (Meyer 2003). Seed production starts when plants are 2 years old in Tasmania with around 300 seeds/year and increases to 12,000 to 30,000 seeds/shrub/year. The seeds are spread by explosive release from the pods, which can throw the seeds 1 to 3 m (Alchemy-works 2003), as well as by water, soil movement, and machinery (National Haritage Trust 2003). Ants also disperse seeds. Seeds average 125 seeds/g. (Meyer 2003). Seeds can remain viable in the soil seed bank for as long as 80 years (National Haritage Trust 2003). The species can also be propagated with cuttings (University of Connecticut 2003).

Growth and Management.—Scotch broom grows from 30 to 46 cm/year (Michigan State University Extension 1998) and usually lives from 10 to 15 years (Prasad 2003). Fruits can be picked by hand after they are mature but before they burst open. They should be spread to dry, threshed, and screened. These seeds are orthodox and can be stored for many years. Because they are hard-coated, scarification is needed to ensure adequate and uniform germination. This can be done by nicking or sanding the seed coat or by applying dry heat for 1 minute at 130 °C or 15 minutes at 70 °C. Viability is normally about 80 percent. Because roots are delicate, the use of containerized stock is recommended for planting rather than bare-root stock (Meyer 2003). However, because the species is invasive, planting for conservation or ornamental purposes is usually discouraged. In fact, the species has been declared a noxious weed in five Western States where planting is prohibited (Natural Resources Conservation Service 2003). Scotch broom is not a problem in cultivated land or in land fully timbered, only in pastures, roadsides, sites normally occupied by low vegetation, and in regenerating timberlands. Control of Scotch broom is difficult. Grubbing large plants and pulling seedlings, or power cultivation, effectively kills the plants, but new seedlings continually appear from the soil seed bank. Mowing only encourages branching near the ground. Stands of Scotch broom do not carry a fire readily (Parker and others 1994), and burned stands reproduce prolifically. The application of herbicides has sometimes been effective (Prasad 2003). A number of insect enemies of Scotch broom have arrived accidentally or have been introduced into the United States. They may already be having a minor impact on the competitive ability of the species (Syrett and others 1999). Research into biological control continues, particularly in Australia and New Zealand (CSIRO 2003).

Benefits.—Scotch broom, which produces a spectacular annual floral display and possesses a unique form, has been planted throughout the temperate regions of the world as border and accent plants. It is particularly useful in this regard because it succeeds on poor soils with little care. It has also been used successfully to protect exposed soils and stabilize dunes. Scotch broom furnishes food (mainly from the seeds) and cover for wildlife. The leaves and twigs are generally unpalatable to domestic livestock and wild mammals. The tissues contain the alkaloids cytisin, sparteine, and isosparteine, and the glycoside scoparin. However, large amounts must be ingested before illness or death results (Everest and others 2003). The stems and twigs have been used from ancient times to make brooms and were used for ritual brooms called besoms. The species was also used to make baskets, thatching, wattle fencing, and a green dye, and to flavor beer before the introduction of hops (Alchemy-works 2003). Decoctions of the twigs and leaves were and are still occasionally used to treat gout, jaundice, edema, and other conditions (Grieve 2003).

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***Dalbergia ecastaphyllum* (L.) Taubert** coin vine

FABACEAE

Synonyms: *Hedysarum ecastaphyllum* L.
Pterocarpus ecastaphyllum L.
Ecastophyllum ecastophyllum (L.) Britton
Amerimnon ecastophyllum (L.) Standl.

John K. Francis

General Description.—Coin vine is a scrambling and climbing shrub that sometimes becomes a small tree with stems that extend as much as 10 m (Howard 1988). It is also known by the common names maraimaray, palo de pollo, mangle médaille, popian, and a host of other common names (Burkill 1995, Liogier 1988). Coin vine develops a tap and lateral root system. The tan colored roots support many nodules that attach directly to the tap and lateral roots. The older stems, which may reach 7 cm or more in diameter, are gray and extend into the crowns of low trees and scramble over low obstacles. There are many long, vine-like branches that bear leaves only on the current year's growth. The simple leaves have petioles 5 to 12 mm long and elliptical or ovate blades 2.5 to 14 cm long and 2 to 8 cm broad. They are leathery, glossy green, rounded at the base, pointed at the tip, and pubescent on the under side. The small white flowers are grouped in panicles in the leaf axils. These develop into small groups of copper-colored to gray-brown, elongated lenticular fruits about 1.5 to 3 cm long that contains one flattened, brown seed (Holdridge and Poveda 1975, Howard 1988, Liogier 1988, Nelson 1996).

Range.—Coin vine is native to Florida, the Bahamas, the Greater and Lesser Antilles, Trinidad, the east coasts of Mexico, Central America, and South America to southern Brazil, and the coast of tropical West Africa (Liogier 1988, Burkill 1995).

Ecology.—Coin vine inhabits coastal sand dunes, open coastal forests and brush fields, lagoon sides, landward sides of mangrove swamps, shell mounds within mangroves, coastal hammocks, and estuaries (Burkill 1995, Nelson 1996). It also encroaches on dense grass swards. The species is most common on sands or sandy soils, but also grows on heavier soils. Coin vine inhabits areas in Puerto Rico that receive from about 1200 to 2200 mm of annual precipitation. It also survives droughts well (Workman 1980). The species frequently grows on sites where there is constant salt spray and sometimes in moderately salty soils. Old plants tend to form dense thickets.

Reproduction.—A collection of mature fruits from Puerto Rico weighed an average of 0.290 $\pm$ 0.010 g/fruit. Seeds extracted from 24 of the pods constituted 69 percent of the pod weight. The pods are tough and the seeds are fragile. Extraction is difficult and unnecessary because seeds germinate through the exocarp without difficulty. Seventy-three percent of 100 fruits sown in commercial potting mix germinated between 31 and 181 days after sowing. Germination is hypogeal. Seeds disburse by lateral branch extension and by water. Seed may be collected after they wash up on the shores (Workman 1980), directly from the shrubs, and from the ground under them. Natural seedlings are abundant near coin vine plants. However, few survive more than a few weeks. Branches layer whenever they come in contact with the ground.

Growth and Management.—Early height growth is moderate but steady. A small group of nursery seedlings reached about 15 cm in 5 months. Older plants grow about 2 m per year. By resprouting and layering, plants (clones) can survive almost indefinitely.

Benefits.—The extensive horizontal branches and their roots cover, bind, and stabilize coastal sand dunes (Burkill 1995). The stems are brittle and not suitable for wooden implements or basketry. The crushed roots and bark contain a chemical that was used by Native Americans to stupefy and catch fish (Workman 1980). Coin vine is listed among the honey plants of the Dominican Republic (Marcano Fondeur 2001). In Senegal, the leaves are put into inhalations and baths to treat various debilities (Burkill 1995). Various extracts are used in herbal medicine as a diuretic, an emetic, and a vermicide. Care must be taken, because some of the tissues are toxic (Liogier 1990).

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Dasiphora floribunda (Pursh) Kartesz, comb. nov. ined. shrubby cinquefoil
ROSACEAE

Synonyms: *Potentilla fruticosa* L.
Dasiphora fruticosa auct. non. (L.) Rydh.
Potentilla floribunda Pursh.
Potentilla fruticosa ssp. *floribunda* (Pursh) Elkington
Potentilla fruticosa var. *tenuifolia* Lehm.

Juanita A.R. Ladyman

Illustration source: USDA—Forest Service collection, Hunt Institute

General Description.—*Pentaphylloides floribunda* is commonly known as shrubby or bush cinquefoil, but local names also include golden hardback, prairie-weed, fivefinger, buckbrush, ninebark, widdy, and yellow rose. It is also frequently referred to by the most common synonym, *Potentilla fruticosa* (Kartesz 1994). This is a distinctive shrub and easily separable from the other *Potentilla* species that are all herbaceous (Cronquist and others 1997). Recently it has been reported as *Dasiphora floribunda* (Pursh) Kartesz comb. nov. ined (ITIS 2002). The genus *Dasiphora* includes approximately 8 or 9 species that are all exclusively in Asia except for shrubby cinquefoil. The genus name "*Pentaphylloides*" is derived from the Greek and refers to the pinnate five-foliate leaves. "Penta-" means "five-"and "phylloides" means "leaved." "*Fruticosa*" is a Latin adjective that means "shrubby" or "bushy." This shrub is usually from 10 cm to 1 m tall but may grow to a little over 1.5 m. The herbage of the current year is covered by soft hairs, but the stem becomes smooth on aging with, eventually, a red-brown shreddy bark. The leaves comprise usually five, but sometimes three to seven, elliptic-shaped leaflets. The flowers are solitary in the leaf axils along the stem but form three- to seven-flowered clusters (cymes) at the stem tips. Petal color is usually yellow, although it may be white, or even pink and red, in cultivated varieties, and there are 15 to 25 stamens per flower (Carter 1997, Cronquist and others 1997, Hitchcock and Cronquist 1973, Vines 1986). This is a wide-ranging species, but apparently chromosome number differs between new and old world material. North American plants have a chromosome number of 2n = 14 while Asian and European plants have 2n = 28 (Cronquist and others 1997).

Range.—Shrubby cinquefoil is a common, wide-ranging circumboreal shrub ranging from Greenland and Labrador, to Alaska and south to the mountains of California, Nevada, Arizona, Colorado, New Mexico, and through the northern states into Iowa, Indiana, Illinois, Ohio, Pennsylvania and New Jersey in North America. It also occurs in Europe, for example England, Ireland, Scandinavia and Bulgaria, and in Asia (Stace 1997, Gibbons and Davies 1994, Polunin 1997).

Ecology.—Shrubby cinquefoil grows in moist soils in mountain regions from lower foothills to sub alpine. The elevation tends to depend somewhat upon latitude, but generally plants are found between approximately 1,800 m and 3,400 m. It grows in open woods, wet mountain meadows, calcareous bogs, limestone pavements, and along streams (Cronquist and other 1997, Gibbons and Davies 1994, Vines 1986, Welsh and others 1993). It has also been reported from relatively xeric habitats such as mountain shrub lands and rocky mountain slopes (McGregor and others 1986, Stace 1997, Thilenius 1972). The degree of permanent soil moisture required is likely to depend on average precipitation, temperature, and localized water collection sites or drainage channels. It is a frequent member of willow (*Salix*)-dominated communities, and in some parts of its range, for example New Mexico, it is a member of the Krummholz communities found at the lower tundra edge (Dick-Peddie 1993). Shrubby cinquefoil may be the dominant shrub in many situations and can also grow in fairly pure stands. For example, it may be the dominant shrub in aspen stands or other forest clearings where snow accumulation prevents tree establishment (Knight 1994, Thilenius 1972). In addition, it frequently attains dominance in limestone-derived soils (Thilenius 1972).

Reproduction.—Shrubby cinquefoil generally flowers in June through August, although flowers may be found until the first frost (Epple 1995, McGregor and others 1986, USDA FS 1988). The achenes mature in summer and fall. The bright yellow flowers are insect pollinated. The fruit is a densely hairy achene.

Growth and Management.—Shrubby cinquefoil increases in response to overgrazing and other disturbance. In the Western United States it does not appear to be an invasive species, but in New England it can be an aggressive invader of agricultural land and may be difficult to eradicate once established (USDA FS 1988). It has been used as an indicator species of past disturbance (Dick-Peddie 1993). Shrubby cinquefoil is widely used as an ornamental and in wild land seeding. It does best in full sun as it tends to flower poorly in shade conditions. Seed apparently does not require cold stratification for germination and will germinate immediately after harvesting (Bonde 1965, Tykač 1990). The highest germination rate was achieved at 18 ^{o}C (Bonde 1965). However, it has been proposed that cold stratification may reduce the temperature requirements for seed germination (Baskin and Baskin 2001). A cold, moist stratification period of 2 months has been generally recommended for *Potentilla* species, including *Potentilla fructicosa*. (Phillips 1987). Shrubby cinquefoil can also be propagated from softwood cuttings in the spring or from suckers (Tykač 1990). Container grown plants, that are very popular within the landscape business, can be planted in spring and fall. Even old plants are reported to tolerate transplanting (Tykač 1990).

Benefits.—Shrubby cinquefoil leaves are bitter tasting, and the forage and browse value varies depending upon the part of the world in which it grows. It is generally on summer range, although at lower elevations it may be valuable for fall browsing (Dayton 1931). It is likely that just as the shrubs' morphology varies, the levels of secondary plant products that impart the bitter taste differ between habitats and geographic range. Generally, it is considered inferior forage for livestock, but it is used by cattle in Arizona and Montana (Epple 1995, Vines 1986). It is also often an important browse for sheep and goats especially in the Southwestern United States and in southwestern Montana and contiguous portions of southeastern Idaho (Dayton 1931). In Montana it is rated 18th among the most important browse species. Similarly, it is reported unpalatable to deer (Thilenius 1972) but does provide browse for deer and elk in some regions (Epple 1995, Vines 1986). On some overgrazed range it is often grazed quite closely, and the shrubs assume a hedge-like appearance (USDA FS 1988). Such use indicates overstocking and a critical reduction, if not elimination, of other palatable plant species. It provides effective protection against soil erosion (Epple 1995, Vines 1986). Native Americans have used various parts of the plant for an assortment of purposes including as a medicine and in ceremonials (Moerman 1998). The Blackfoot peoples have used the leaves to fill pillows and the bark as tinder, while the Eskimos of Alaska and the Arctic have used dried leaves for tea (Moerman 1998). Leaves were also used for tea in Russia. The name "potentilla" is derived from the Latin "potens," which means powerful and may refer to the medicinal value of some species. A preparation made from the leaves was used by the Cheyenne for protection and was also considered a deadly arrow poison, only to be administered by holy people (Carter 1997, Moerman 1998). Shrubby cinquefoil has commercial value in the landscape and horticultural trade. It is a popular ornamental shrub, and many cultivars exist that have been chosen for the degree of leaf pubescence (hairiness), flower color, and growth form. A list of some of the recognized cultivars available can be found in Bailey and others (1976) and Tykač (1990).

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***Dasylirion wheeleri* S. Wats.** Wheeler sotol

AGAVACEAE

Synonyms: None.

Juanita A. R. Ladyman

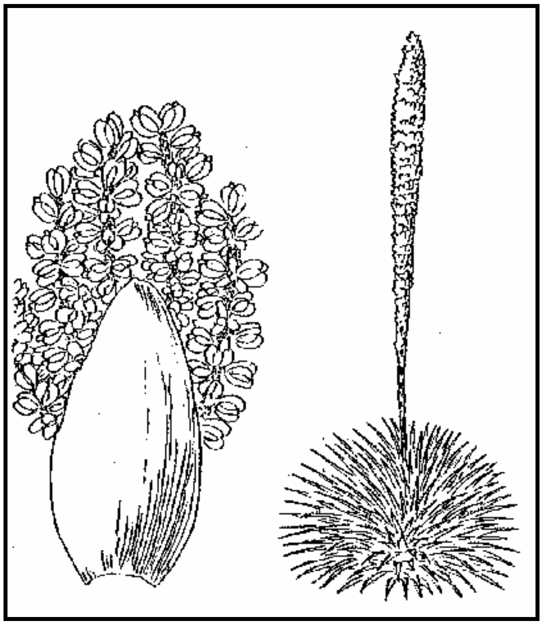

Illustration credit: Robert De Witt Ivey

General Description.—The common names for *Dasylirion wheeleri* are Wheeler sotol, sotol, desert spoon, spoonplant and spoonleaf. The latter names refer to the enlarged, spoon-like bases of the long serrated leaves. *Dasylirion wheeleri* grows from a thick, woody, mostly subterranean caudex with a large rosette of rigid leaves that are armed with sharp curved spines, or teeth, around the margins (Kearney and others 1960). The long flowering stalk arises out of the center of the rosette and is topped by a slender compound panicle. The genus name, *Dasylirion,* means thick, or hairy, white lily from "dasy-" and "lirio" (Gledhill 1992). *Dasylirion wheeleri* is distinguished from *Dasylirion leiophyllum* Engelm. ex Trel. by having the leaf margin spines directed apically rather than basally (Carter 1997). There are two recognized varieties of *Dasylirion wheeleri*, var. *wheeleri* and var. *wislizenii* (Vines 1960).

Range.—Wheeler sotol grows on well-drained rocky and gravelly hillsides or slopes in Western Texas, southern to central New Mexico, southern Arizona in the U.S.A. and in Chihuahua in northern Mexico (Kearney and others 1960, Powell 1998, Tesky 1993, Vines 1960).

Ecology.—Wheeler sotol occurs in chaparral, southwestern oak (*Quercus*) woodland, desert and semi-desert grasslands communities at 914 to 1,830 m in elevation (Carter 1997). It occurs in seral, climax, and postclimax communities. In the desert plains grasslands it is often sub-dominate in the beargrass-scrub oak postclimax community and the curly mesquite (*Hilaria belangeri*)-blue grama climax community. It has been described as a diagnostic climax member of desert grasslands (Dick-Peddie 1993). In Trans-Pecos, Texas, it is commonly found growing on limestone and granite (Powell 1998, Schmutz and others 1992). Wheeler sotol usually grows on rocky soils in desert grasslands that are often described as too moist for open desert scrub but too dry for oak or juniper woodland (Burgess 1995, Dick-Peddie 1993, Schmutz and others 1992). These are areas where subsurface water is generally not available. Wheeler sotol can store relatively large amounts of water internally that act as a buffer against the rapid onset of drought stress. It is classed as a water storer, or "succulent" plant (Burgess 1995, Thomas 1991). The species can also tolerate several degrees of frost (Vines 1960).

Reproduction.—The flowering stalks elongate to up to 5 m in late spring and bloom from May to August (Bowers 1993). Wheeler sotol is dioecious, the male and female flowers being borne on separate plants. Female flowers frequently flower later than the male plants (Warnock 1974). The female flowers are wind pollinated, and wind also disperses the seed that are contained within a papery, one-celled, three-winged capsule. Wheeler sotol grows readily from seed.

Growth and Management.—Wheeler sotol occurs in desert grasslands that are being increasingly managed with fire (Thomas and Goodson 1992). In these areas, fire is primarily used to stimulate grass production and reverse dense scrub invasion. The apical meristem of sotol is usually protected from fire by a cluster of green leaves, and this species can also resprout from the caudex that is the region at the base of the stem (McPherson 1995, Thomas 1991). However, frequent fires and stable soil moisture regimes tend to exclude wheeler sotol (Burgess 1995). The response of sotol to fire tends to vary depending upon conditions. Kittams (1973) observed that mature sotol (in this case *Dasylirion leiophyllum*) were usually killed by fire. White (1969) randomly selected 50 individuals after a fire in desert grassland in Arizona and classified them with respect to the level of the damage (severe, moderate, or light) experienced. All of the lightly or moderately damaged plants survived, but only 3 percent of the severely damaged plants survived. Sprouting did not occur except as refoliation from the terminal bud (White 1969). Ahlstrand (1982) investigated the response of *Dasylirion leiophyllum* to fire at sites in New Mexico and western Texas. He reported losses of 50 percent or more on burned sites, but surviving top-killed plants regained much of their pre-burn coverage after three growing seasons. This was similar to the observations after a semidesert grassland fire in southern Arizona where 47 percent of the Wheeler sotol plants burned to death (Thomas and Goodson 1992). Of the 71 Wheeler sotol plants that survived, all had apical regrowth, but despite the fact that sotol may occasionally produce new shoots from below ground, no offsets or seedlings were found 11 months after the fire (Thomas and Goodson 1992). In this study no individuals evaded the fire in refugia.

Benefits.—The head-like trunks and leaf bases of Wheeler sotol are edible and American Indians roasted and ate the young flower stalks (Moerman 1998, Powell 1998). The basal trunks contain starch and are also roasted, fermented and distilled to make alcohol (Powell 1998). Currently an alcoholic beverage, generally known as sotol, is made in parts of Mexico (Bowers 1993). Bighorn sheep and javelinas browse sotols (Epple 1995, Kearney and others 1960, Starr 1999). In times of stress Wheeler sotol has been used as feed for livestock in a variety of ways. The trunks and leaf bases have been used during drought, and the plants have also been machine-cut and shredded for emergency feed (Dayton 1931, Powell 1998). In addition, ranchers have burned off the leaves and split the heads (trunks) for livestock (Vines 1960). The leaves have been used to make mats, baskets, thatch, and paper (Moerman 1998, Powell 1998). The long flowering stalks have been used extensively within its range for corral, porch and house roofs, and other structures (Powell 1998). They have also been used for ceremonial purposes by Native Americans (Moerman 1998). Wheeler sotol plants are commercially used as ornamentals and described as “one of the most striking accent plants available” (Starr 1999). The leaves were once sold for use in floral arrangements, but this practice has been discouraged due to conservation considerations (Epple 1995).

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***Datura inoxia* P. Mill.** devil's trumpet
SOLANACEAE

Synonyms: *Datura metel* auct. non L.
Datura fastuosa sensu Griseb. non L.

John K. Francis

Drawing source: Missouri Botanic Garden 2003

General Description.—Devil's trumpet is also known as angel's trumpet, thorn apple, Indian apple, purple datura, garden datura, horn-of-plenty, David bush, chaico blanco, buenas tardes, concombre zombi, cornicopio, trompette du jugement, and pomme épineuse. It is a shrub or woody herb to 2 m in height that is often grown as an annual in temperate zones. The stems are semiwoody and suffruticose in the moist tropics. In drier environments, it dies to the ground annually. The alternate leaves have petioles 3 to 7 cm long and ovate to elliptic blades 6 to 15 cm long with sinuate to irregularly toothed edges. The tubular flowers are axillary and usually solitary. They are erect or nodding, have a five-toothed calyx 5 to 7 cm long and a white, purple, or yellow corolla 8 to 20 cm long, often double in horticultural varieties. The ovoid capsule is nodding, about 3 cm in diameter and covered with stout, soft prickles 2 to 4 mm long. The capsules remain on the plant for a long period. The yellowish-brown seeds are flat, kidney-shaped, about 5 mm long, and have a small fleshy aril. *Datura* species normally have 12 pairs of chromosomes (Bonde 2001, Burkill 2000, Howard 1989, Liogier 1995, Stevens and others 2001).

Range.—The native range of devil's trumpet appears to have been Mexico and the U.S. Southwest (Schultes and Hofmann 1992), the Caribbean Islands (Howard 1989), India, and China (Schultes and Hofmann 1992). There are related species in all these areas and ancient traditions of its use (Bonde 2001, Schultes and Hofmann 1992). The species apparently naturalized in Africa hundreds of years ago (Burkill 2000). Today, devil's trumpet grows throughout the Tropics.

Ecology.—Devil's trumpet grows naturally in disturbed areas such as eroded sites, old fields, vacant lots, overgrazed pastures and rangeland, roadsides and abandoned roadbeds, and fencerows. Apparently, disturbance and reduced competition are required for the plant to become established and grow. A wide variety of well-drained soils on both igneous and sedimentary parent materials are suitable. In Puerto Rico, the species grows naturally in areas that receive from 750 to about 1000 mm of mean annual precipitation from near sea level to about 400 m. Devil's trumpet grows on sites up to 900 m in elevation in Nicaragua (Stevens and others 2001)

Reproduction.—Devil's trumpet flowers and fruits throughout the year in some environments, but in India principally from July to September (Parrotta 2001), and from September through November in Nicaragua (Stevens and others 2001). Hummingbirds sometimes visit the flowers, but are affected by the alkaloids in the nectar and must limit their consumption. Honeybees are apparently unaffected. The flowers have an intense night fragrance (Annie's Annuals 2002), which perhaps helps attract night-flying moths. The seeds are distributed by ants and some species of birds that are resistant to the chemicals they contain (Bonde 2001). Seeds germinate in less than 2 weeks at soil temperatures of 27 °C (Hardy Plants 2002). Devil's trumpet is normally propagated with seeds.

Growth and Management.—In dry environments, devil's trumpet reaches a maximum height of about 0.5 m in one growing season. In moist areas, it can reach two to four times this height although it is not clear whether it does so in a single season. New stands can be established by cultivation and planting. Although control information has not been published, weedy plants can probably be reduced or eliminated without difficulty by cultivation or spraying with broadleaf herbicides.

Benefits and Detriments.—Devil's trumpet is grown in all but the coldest climates as a flowering ornamental. Beautiful white, purple, and yellow varieties with large, single and double blossoms are available. From ancient times continuing to the present, the taking of *Datura* spp. tissues, particularly the seeds, was used in shamanistic rituals as a path to enlightenment (Schultes and Hofmann 1992). Today, people frequently experiment with it for the hallucinogenic effect, but the results are so unpleasant (dark visions, disorientation, amnesia, blurred vision, dry mouth, and incontinence) that they seldom recommend the experience (Erowid 2002). Overdoses can result in death. The plant has been used to treat impotence, asthma, diarrhea, as an analgesic, to control fever, kill parasites, and as a drug for criminal purposes (Bonde 2001, Parrotta 2001). Devil's trumpet contains a host of phytoactive chemicals including atropine, hyoscyamine, hyoscine, scopolamine, norscopolamine, meteloidine, hydroxy-6-hyoscyamine, tiglic esters of dihydroxytropine, and a number of withanolides (Gupta and others 1991, Janthangvith and others 2000). Alkaloid concentration in tissues is around 0.5 percent (Niber and others 1992) but varies according to environmental circumstances (Burkill 2000). Devil's trumpet is a minor weed in tropical and some subtropical countries. It causes erratic behavior and even death of livestock that have eaten it, but it is seldom a problem for pastured animals because they carefully avoid consuming it.

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Desmanthus virgatus (L.) Willd. wild-tantan
FABACEAE

Synonyms: _Mimosa virgata_ L.
Acuan virgatum (L.) Medikus
Acuan guadeloupense Britton & Rose
Desmanthus depressus Humb. & Willd.

John K. Francis

General Description.—Wild-tantan, also called prostrate bundleflower, dwarf koa, desmanthus, desmanto, acacia courant, acacia savane, and pompon blank, is a suffruticose shrub or perennial woody herb that reaches 0.5 to 2 m in height and 3 to 10 mm in basal diameter. The plant is supported by a deep woody taproot and descending laterals. Each dry season, wild-tantan dies back to the root crown or lower stems and grows anew when the rains return. The stems and branches are semi-woody to woody, pithy in the center, angular, slender, green turning brown, and erect or semiprostrate. There may be as many as 50 stems, depending on the age, vigor, and disturbance history of the plant. The 2- to 8-cm leaves have a short petiole, less than seven pinnae, 10 to 25 pairs of leaflets per pinnae that are linear-oblong and 4 to 9 mm long. The flowers occur in axillary heads with peduncles 2 to 7.5 cm long. The petals are white or creamy yellow. The pod, a legume, is linear, 50 to 90 mm long, 3 to 4 mm broad, reddish-brown, and contains 20 to 30 seeds (Howard 1988, Liogier 1988, Skerman and others 1988). There are 2n = 28 chromosomes (Long and Lakela 1976).

Range.—Wild-tantan is native to the Greater and Lesser Antilles, Trinidad and Tobago, from Texas to Argentina, and the Galapagos Islands (Liogier 1988, Howard 1988, Skerman and others 1988). It has naturalized in Florida and Hawaii (Institute of Systematic Botany 2002, Neal 1965). The species has been planted throughout the tropics and subtropics and has probably naturalized in many other areas.

Ecology.—Wild-tantan grows well in deep, well- to moderately well-drained silts, clays, loams, and sands with pH's from about 5 to about 8, formed over both igneous and sedimentary rocks. It is seldom seen in shallow, rocky sites. The species is recommended for planting in Australia in areas receiving from 550 to 750 mm of mean annual precipitation (Department of Primary Industries 2002) and grows naturally in Puerto Rico in areas that receive from 750 to about 1600 mm of mean annual precipitation. Wild tantan tolerates seasonal drought without difficulty. The species grows from near sea level up to 300 m in elevation (Skerman and others 1988). Wild-tantan is intolerant of shade. It tolerates severe competition from grass and herbs but disappears when overtopped by trees. The species is usually more or less evenly dispersed in stands of grass and herbs, often at 1 or 2 per square meter. Although plants are killed to the ground by heavy frost, they regrow from the root crown (Forlin and others 2000). It withstands heavy grazing pressure and recovers well from fire.

Reproduction.—Wild-tantan blooms at the end of the wet season, and fruits mature about 1 month later. Seeds collected in Puerto Rico weighed an average of 0.0041 $\pm$ 0.0005 g/seed or 244,000 seeds/kg. Placed to germinate on moist filter paper, only 28 percent germinated in 1 year. The remaining seeds were scarified (by nicking) and 100 percent germinated starting in 2 days (author's observation). In nature, scarification occurs by weathering of the seed coat in the soil or while passing through an herbivore. Artificial scarification by treatment with concentrated sulfuric acid for 8 minutes is recommended (Skerman and others 1988). The seeds are dispersed by ruminant animals. Many seedlings spring up under favorable conditions in natural stand, but few survive. The species can be propagated by rooting hormone-treated leaves (Forlin and others 2000).

Growth and Management.—Wild-tantan normally grows from 0.5 to 1.5 m/year in height. After establishment, the root crown gradually increases in size until it reaches 15 cm across in 3 years. Plantations are established by sowing 2 kg of scarified seed per hectare into well-prepared seedbeds at a depth of 1 to 1.5 cm. Plantations can be cut for feed 4 times/year and yield 35 tons/ha/year of dry matter. There is little mortality up to at least the fourth year (Skerman and others 1988).

Benefits.—Wild-tantan is planted throughout the tropics as a forage and hay crop and is appreciated as a forage in range land. The forage is nontoxic and palatable to cattle and other ruminants. It is a favorite of white-tailed deer in southern Texas (Soltero-Gardea and others 1994). Crude protein content of whole plants from plantations ranges from 10.5 to 15.5 percent, the leaves having 22.4 percent and the stems 7.1 percent (Skerman and others 1988). Wild-tantan is planted as a hedge-row plant in the alley cropping system on steep land in the Philippines (Labios and others 1994). It has been shown to be an efficient nursery-stage host for sandalwood (*Santalum album* L.) (Fox and others 1996). The species can become a serious weed in sugar cane fields (Neal 1965).

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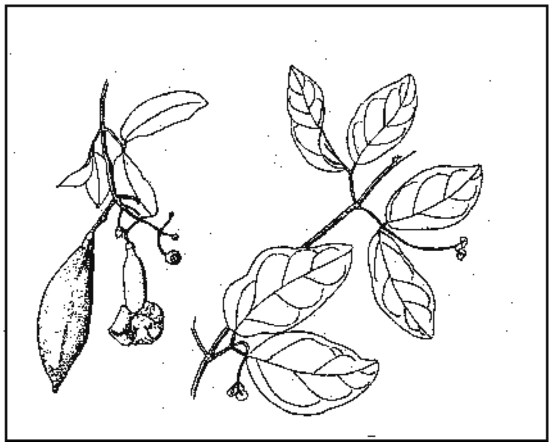
***Distictis lactiflora* (Vahl) DC.** pega palo
BIGNONIACEAE

Synonyms: *Bignonia lactiflora* Vahl
Bignonia rigescens Jacq.
Bignonia odorata Bello
Distictis rigescens (Jacq.) DC.
Macrodiscus lactiflorus (Vahl) Bureau ex Baill.

John K. Francis



General Description.—Pega palo, also known as liana fragante and viuda, is a climbing woody vine that clings to objects by means of sticky disks and may extend 6 m or more into the crowns of trees or laterally along rocks and fences (Acevedo-Rodríguez 1985). Older plants may have multiple stems arising from ground level. Like many other vines in the Bignoniaceae, pega palo has a characteristic pattern in the stem cross-section, shamrock-shaped in this case. The brown stems are slender, furrowed, and fissured. Older plants have no taproot, only lateral roots with sinkers and a moderate amount of fine roots. The larger roots have the same general appearance as the stems. There are few branches until the crown of the plant is reached. Branches usually arise in three's at the nodes (author's observation). The opposite, compound leaves have two leaflets with the tendril in place of a third leaflet. The leaf blades are ovate, 3 to 8 cm long, and obtuse, rounded, or acute at the tip. Terminal panicles support a few white tubular flowers with a yellow throat, 3 to 7 cm long. A few of the flowers develop into narrowly ellipsoid, somewhat flattened capsules 7 to 12 cm long and brown at maturity. They split open by a medial suture and release brown, winged seeds (Liogier 1995, Acevedo-Rodríguez 1985). Pega palo occurs in the same areas and is similar in appearance to *Macfadyena unguis-cati* (L.) A. Gentry. They are distinguished by the tripartite tendril, yellow flower, and long pod of *M. unguis-cati*.

Range.—Pega palo is native to Cuba, Hispaniola, Puerto Rico, and the Virgin Islands. It has been introduced into Guadeloupe (Liogier 1995).

Ecology.—Pega palo grows in areas that receive from about 750 to 2000 mm of annual precipitation. It grows on most types of well-drained to excessively drained soils derived from sedimentary (including limestone), igneous, and metamorphic (including ultramafic) rocks. Pega palo grows from near sea level to over 600 m in elevation. The species is moderately intolerant, growing in low basal-area forests, forest edges and openings, brushy pastures, fencerows, and disturbed forests. Pega palo is not eaten by cattle and is often common in overgrazed range. Although the usual habit of the species is to ascend into trees or over rocks, it forms mounds and scrambles over the ground when trees are absent. Pega palo resprouts after fires. An unknown insect in Puerto Rico often destroys all the seeds in immature capsules.

Reproduction.—Pega palo flowers from December to July (Acevedo-Rodríguez 1985). Because the species requires nearly full sunlight to bloom and fruit and because it does not climb to the tops of most of the trees it invades, fruiting plants are not abundant. A collection of fruits from Puerto Rico contained seeds of which only about one in four contained endosperm. Visually culled, filled seed weighed an average of 0.0153 g or 65,000 seeds/kg. Sown without any pretreatment on peat, 55 percent germinated within 44 days. Germination is hypogenous. Seedlings, whose first two leaves have an unusual dark-green color tinged with purple and a whitish net-like vein pattern, are common, but few survive the first year (author's observation). Vines layer (root) when they come in contact with the ground.

Growth and Management.—Pega palo grows at least a meter per year from sprouts. Individual vines live several years, and strong plants develop new stems periodically. Grazing of dry and moist forest areas probably promotes the species.

Benefits.—Pega palo contributes to the biodiversity of moist and dry forests and helps protect the soil. Its foliage and white flowers add to the beauty of the forest. The species has been used as an ornamental to a limited extent.

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Dodonaea viscosa (L.) Jacq. ‘a‘ali‘i
SAPINDACEAE

Synonymns: *Dodonaea angustifolia* L.
Dodonaea eriocarpa Sm.
Dodonaea sandwicensis Sherff
Dodonaea scottsbergii (Sherff) Degener & I. Degener
Dodonaea spathulata DC.

Amanda J. Stevens, Sarah A. Taylor, and Randy S. Senock

General Description.—‘A’ali’i is also known as a’ali’i-ku ma kua, a’a’li’i ku makani, lampuaye, hop bush, hopseed bush, togovao, and akeake. It is usually a many-branched shrub or small tree reaching a height of 4.5 to 9.0 m, and 7.5 cm in diameter (Little and Skolmen 1989). The bark is reddish brown to gray or blackish gray, finely furrowed, black heartwood. Leaves are simple, alternate, and membranous to chartaceous, 3 to 10 cm long and 1 to 3 cm wide and vary in shape from elliptic to spatulate, oblanceolate or lanceolate, entire margins, finely hairy when young, yellow green, sticky coating, slightly shiny above, and paler below. Petioles are 0.1 to 1.1 cm long and slightly winged (Wagner and others 1990, Little and Skolemen 1989, Lamb 1981).

Range.—‘A’ali’i has a pantropical distribution occuring in temperate regions of Australia, Africa, Mexico, New Zealand, India, Samoa, Guam, Northern Mariana Islands, Virgin Islands, Puerto Rico, Florida, Arizona, South America, Hawaii and elsewhere (West and Noble 1984). ‘A‘ali‘i occurs on all the main Hawaiian islands except Kaholawe.

Ecology.—‘A’ali’i grows on most types of soils and substrates in Hawaii, from old deeply leached soils, to fertile soils high in organic materials, to barren ‘a‘a and pahoehoe lava, and ash and cinder. A’ali’i seedlings are considered fairly shade intolerant and usually grow in open sites (Williams and Buxton 1989). The ‘a‘ali‘i has a broad ecological amplitude and can occur from near sea level up into the sub-alpine zone, and from wet forests to arid shrub and grasslands. It resists droughts well and is generally one of the heartiest plants in the arid shrublands of leeward Hawaii. In response to wildfire ‘a’ali’i resprout from both the root crowns and from seed. Following wildfire in diverse ‘a‘ali‘i-dominated montane shrublands, it doubled its preburn density within 1 year. Its density, however, declined over subsequent years but did regain preburn cover values 4 years following the burns (Sherry and others 1999). In Hawaii, a’ali’i can be affected by a yellowing disease distinguished by chlorotic witches’-brooms. Infected areas of the plants fail to produce flowers, while flowering is normal on the nonafflicted parts of the same plants. The terminal leaves of the portion of the afflicted branches become chlorotic, crinkled, and reduced in size. This disease can affect all stages of maturity, and plants will eventually die. A relatively small portion of these plants are infected in Hawaii, but this disease is spreading and can be found on all the major islands (Borth and others 1995).

Reproduction.—The flowers are unisexual, sometimes perfect, in paniculate inflorescences usually 1 to 5 cm long, clustered at the ends of the twigs (Wagner and others 1990). The flowers are sticky with fine hairs, three to five sepals, and without petals. Female flowers have four stigmas and male flowers have ten stamens (Little and Skolmen 1989). Male and female flowers are born on different trees. The fruit is a capsule straw-colored to dark reddish purple, exceedingly variable, turgid to inflated bladder or compressed. Seeds are compressed-ovoid, about 3 mm long. The two to four-winged, papery capsules are either dispersed by wind or adhere to plumage of birds (Burrows 1995). The seed coats of most of the ‘a’ali’i seeds are impermeable to water and there also appears to be a micropylar plug present. The hard seed coat and the micropylar plug may play a role in delayed germination. Some evidence suggests that higher temperatures, which may enhance the breakdown of the plug, as well as scarification of the seed coat, may be necessary for germination (Burrows 1995). ‘A‘ali‘i is able to reproduce through sprouting following disturbance.

Growth and management.—‘A‘ali‘i is popular as an ornamental in xeriscape gardens. Seedlings should be planted from containers after last frost in any kind of soil. Water infrequently once established and prune if a more formal appearance is desired. Plant emits strong odor during pollen season. Plant is frost damaged at approximately –6.6° C (Anonymous 1999).

Benefits.—‘A‘ali‘i has enormous potential as a landscape species. ‘A’ali’i also possesses many medicinal properties and has been used by native peoples from all regions where it is found. Its leaves can be used to combat rheumatism, skin infections, fevers, swellings, aches, and “gastrointestinal disorders” including diarrhea, and can be used as a antispasmodic agent (Rojas and others 1996). The Australian aborigines used the leaves and roots as a painkiller to soothe toothaches and headaches (Crib and Crib 1981). The flowers (or hops) of ‘a’ali’i are used as a “home-brew” substitute to bestow a bitter flavor, and also used as a tonic. A red dye is extracted from the fruit, and the capsules are also commonly used in leis (Little and Skolmen 1989). In India the seeds are used as fish poison (Wagner and others 1987). The wood from ‘a’ali’i is extremely hard and has been used for tools, spears and weapons (Lamb 1981). In India ‘a’ali’i is an important source of fuelwood (Jain 1998).

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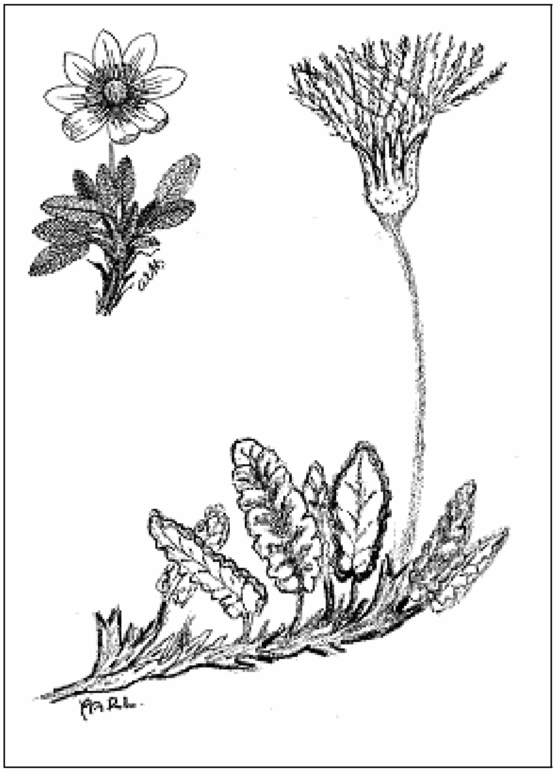
***Dryas octopetala* L.** white mountain avens

ROSACEAE

Synonyms: *Dradetum octopetalae* Keiner

Juanita A.R. Ladyman



Drawing source: USDA—Forest Service collection, Hunt Institute

General Description.—*Dryas octopetala* is commonly known as alpine dryad, mountain avens, or white mountain avens in areas where more than one Dryas species occur (Stace 1997, Kershaw and others 1998, Carter 1988). The epithet "dryad" and "dryas" is derived from the mythical oak-nymph, Dryas, because the shape of its leaves resembles that of an oak species (Gledhill 1992, Zwinger and Willard 1996). This prostrate, trailing perennial shrub is usually less than 30 cm tall, but can grow up to 50 cm, and commonly forms mats. The oval to oblong leaves are 5 to 25 cm long and the margins are coarsely round-toothed (crenate) and somewhat rolled under (Carter 1988, Kershaw and others 1998, Stace 1997). Typically the shrub is described as "evergreen" but has also been observed as "semi-deciduous," because it loses some of its foliage in winter (Williams and others 1986). The leaves are dark green, wrinkled and hairless on the upper side but densely white-hairy on the lower surface (Kershaw and others 1998). The stalk, midrib, and veins have yellowish-brown glands on the lower surface. Each flower has eight (sometimes nine or 10) egg-shaped white, rarely yellowish, petals and lance-shaped sepals. The flowers are 2 to 3 cm across and are solitary on hairy stalks that are 1 to 20 cm long. The seeds (achenes) are 2.5 to 4 mm long with a feathery plume (style) at the tip (Komarov 1941). The chromosome number is 18 (Stace 1997, Welsh and others 1993). The species tends to be heterogeneous throughout its range. The stature and organs of white mountain avens plants in North America and a part of the Western Arctic appear to have smaller dimensions than those in Russia and alpine Western Europe (Komarov 1941). At least four subspecies and several varieties of *Dryas octopetala* are recognized (Hitchcock and Cronquist 2001, Kartesz 1994): *Dryas octopetala* L. ssp. *alaskensis* (Porsild) Hultén, ssp. *hookeriana* (Juz.) Breit., ssp. *punctata* (Juz.) Hultén, and ssp. *octopetala* of which there are at least three varieties; namely var. *angustifolia* Hitch., var. *kamtschatica* (Juz.) Hultén, and var. *luteola* Hultén. Some other varieties are described in Kartesz (1994) and Komarov (1941).

Range.—White mountain avens is a circumpolar species occurring in arctic and alpine zones in Europe, Asia, and North America. In North America, it grows in sub-alpine and alpine tundra zones from Greenland, Labrador, and Alaska to the Cascade Mountains in Washington and Oregon and through the Rocky Mountains to Montana, Wyoming, and Colorado and west to high elevation sites in Utah and Idaho (Britton 1901, Hitchcock and Cronquist 2001, Welsh and others 1993, Kershaw and others 1998). It is found in Scandinavia, the British Isles, Ireland, and the Alps, Pyrenees, Carpathians and Dinarid Mountains of Europe (Praprotnik 1997, Ellenberg 1988). It also dominates the tundras of Novaya Zemlya, Wrangel Island, the Urals and mountin slopes in Siberia (Komárková 1979, Botch and Masing 1983).

Ecology.—Mountain avens is often the dominant or co-dominant species in areas where it occurs throughout its range. The elevation at which it grows is associated with latitude. Plants are found at 3,500 m to 3,965 m in Utah whereas they may occur at 100 m or less in northern parts of its range, such as Greenland (Borge Wills 1996, Welsh and others 1993). It typically grows above the timberline in sites with low snow cover on calcareous or basic soils (Dorn 2001, Dorn 1984, Komárková 1979, Ellenberg 1988, Stace 1997, Weber and Wittman 2001). It is not an indicator of calcareous sites *per se* as it is common on granitic substrates in the Colorado Rocky Mountains (Weber 1960). However, on this substrate calcium is likely available to the plants as a leachate (Weber and Wittman 2001). Mountain avens grows in dry meadows, rocky tundra, fellfields, and in relatively moist sites in fen lands. In Russia, it has been reported as a co-dominant in "frost mound bogs" that are essentially permanently frozen ridges, or mounds, that alternate with wet hollows (Botch and Masing 1983). In contrast, mountain avens and lichens are of primary importance on the dry upland meadows in the Alaskan Arctic and on the windswept fellfield slopes of the Rocky Mountains of Colorado U.S.A. (Komárková 1979, Langenheim 1962). These shrubs have an trellis-like growth habit clinging closely to rocks and stones and anchoring its roots in cracks or between stones. The radiation is so intense at high elevations that the temperature can rise to more than 65 ^{o}C where the ground is dark colored. In these locations the prostrate seedlings and young plants can be heat damaged (Ellenberg 1988). A mutualistic association exists between mountain avens and ectomycorrhizal fungi (Monson and others 2001). The most dominant fungus is *Cenococcum geophilum*, an ascomycete.

Reproduction.—White mountain avens reproduce by seed. Flowering is from June into August. The flowers always face the sun on calm, sunny days, and their parabolic shape directs the sun's heat on to the stigma, which can then become up to 3.5 ^{o}C warmer than the surrounding air temperature (Kershaw and others 1998). The warmer temperatures can attract insects and also speed pollen germination. Hybridization occurs between sympatric *Dryas* species (Komarov 1941). Seed is, at least in part, distributed by wind.

Growth and Management.—White mountain avens seeds have physiological dormancy but do not appear to require stratification for germination (Baskin and Baskin 2001). Forty-eight percent of freshly matured seeds germinated after 4 days in the light at 25 ^{o}C (Baskin and Baskin 2001). However, in England seeds failed to germinate when sown outdoors in the autumn while seeds did geminate the following spring, suggesting that cold stratification lowers the temperature requirement for germination (Elkington 1971). The stems root easily and contribute to the rapid spread of plants. As part of studies on the consequences of global climate change, experiments have been made on the response of white mountain avens to elevated temperatures in the Colorado Rocky Mountains (Welker and others 2001). The results suggested that warmer, wetter conditions would initially lead to greater productivity (increased leaf mass and higher numbers of seed per ramet) although decomposition may be retarded, leading to a lower nutrient availability in subsequent years (Welker and others 2001). Under longer term conditions, a switch in the source-sink activity of the community occurred. Under current conditions the mountain avens community is a carbon sink of about 8 g CO^{2}-C m^{-2}. However, after 4 years of experimental warming, the community switched to a carbon source of almost 10 g CO^{2}-C m^{-2} per summer due primarily to an increase in the rate of respiration without a concomitant increase in photosynthesis (Welker and others 2001). This switch in source sink activity has been reported for *Dryas* and other communities in the Arctic (Welker and others 2001, Oechel and others 1993). This finding may be significant when considering the repercussions of increasing industrial "greenhouse gas" emissions

Benefits.—White mountain avens is a pioneer species and is important in stabilizing the thin soils on mountain slopes (Zwinger and Willard 1996, Ellenberg 1988). It spreads relatively rapidly and is popular in landscape rock gardens (Williams and others 1986). Several cultivated varieties, including hybrids, are available (Kershaw and others 1998). One hybrid, *xSuendermannii* Kellerer, between *Dryas octopetala* and *D. drummondii* is morphologically similar to *D. octopetala,* but the flowers are yellow in bud becoming white and nodding upon opening (Bailey and Bailey 1976). White mountain avens is an important food source for ptarmigian (Nelson 1992) and pikas (Martin and others 1951).

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***Duranta erecta* L.** golden dewdrop
VERBENACEAE

Synonyms: *Duranta repens* L.
Duranta ellisia Jacq.
Duranta plumieri Jacq.

John K. Francis

General Description.—Golden dewdrop, also known as skyflower, pigeon berry, angels-whisper, duranta, cuentas de oro, azota-caballo, fruita de paloma, lila, lluvia, and grão de galo, is an upright to drooping shrub that sometimes takes the form of a scrambling shrub or rarely a small tree (Liogier 1995, Little and others 1974). It usually matures with a height 1 to 3 m. The species develops tap and lateral root systems with abundant fine roots. There are normally several stems arising from below and just above the ground line. Crowns of golden dewdrop are replete with fine branches and twigs that are often thorny. The bark is light gray, becoming rough and fissured when old. Light-green, opposite leaves are elliptic to ovate and 1.5 to 8 cm long. Light-blue, lavender, or white, tubular, five-lobed flowers are borne on terminal or axillary racemes. The yellow or yellow-orange fleshy fruits are ellipsoidal with five lobes and grow in hanging clusters. These fruits may contain up to eight nutlets (Hardin and Arena 1969, Howard 1989, Liogier 1995, Little and others 1974).

Range.—Golden dewdrop is a native of Mexico, Central America, South America to Argentina, southern Florida (possibly naturalized), Bermuda, the Bahamas, and the West Indies (Howard 1989, Liogier 1995, Little and others 1974). The species is widely cultivated and escaped in the tropics and subtropics including Hawaii, American Samoa, and Guam (Pacific Islands Ecosystems at Risk 2002).

Ecology.—Golden dewdrop grows wild mostly in dry coastal areas (750 to 900 mm of annual precipitation in Puerto Rico) from near sea level to over 100 m in elevation (Little and others 1974). It also grows in disturbed areas in moister habitat, especially along roads (Pacific Island Ecosystems at Risk 2002). Because it is moderately intolerant of shade and does not compete well with taller vegetation, golden dewdrop is usually found in rocky or sandy areas with low shrubs and sparse grass and herbs. Although it is more common on limestone, the shrub also grows in areas with igneous rocks. The species tolerates light to moderate salt spray. In natural stands, golden dewdrop may be found in small tangled stands or as occasional plants. Plants under droughty and infertile natural conditions tend to be short (about 1 m in height). Where cultivated in deep, moist, fertile soils, golden dewdrop grows faster and to larger sizes. As an ornamental, it can be grown in moderate shade at elevations up to 1,300 m (Bruggeman 1974). Plants in the northerly extent of the naturalized range die to the ground after frosts but resprout from the roots in the spring (Floridata 1999). The species is subject of attack by scale, mealy bugs, caterpillars, and nematodes (Watkins and Sheehan 1975, Woman's Club of Havana 1958).

Reproduction.—Natural stands of golden dewdrop in Puerto Rico flower and fruit in spring and summer (Little and others 1974). However, ornamental plants in Puerto Rico flower and fruit throughout the year (author's observation), and in Florida, both flowers and fruit are present on the shrubs at the same time (Nelson 1996). A collection of golden dewdrop fruits from Puerto Rico averaged 0.515 $\pm$ .009 g/fruit. Air-dried seeds separated from them averaged 0.0346 $\pm$ 0.0005 g/seed or 28,900 seeds/kg. Set to germinate on moist filter paper without any pretreatment, 29 percent of the seeds germinated beginning 128 days after sowing (Francis and Rodíguez 1993). Birds disseminate the seeds (Watkins and Sheehan 1975). However, seedlings are seldom common. After establishment, plants thicken and spread laterally a few decimeters vegetatively. Golden dewdrop are produced commercially from seeds, cuttings, and by layering (Floridata 1999).

Growth and Management.—Golden dewdrop plants live at least 15 years. The species has a moderate growth rate, usually about 0.5 m/year for the first few years. Ornamental plants need regular thinning and pruning to keep them under control and to remove dead branches (Floridata 1999). Although they withstand poor soil and drought well, plants grow best if watered and fertilized (Woman's Club of Havana 1958).

Benefits and Detriments.—Golden dewdrop forms a part of the coastal scrub community and contributes to soil and ecosystem stability. It is a popular ornamental used for accent plants and hedges in tropical and subtropical parts of the world because of its profuse displays of flowers and fruits (Floridata 1999). Golden dewdrop flowers attract butterflies and hummingbirds (Floridata 1999). It is sometimes grown in greenhouses in areas too cold for natural plants. The wood is light brown and hard and useful for stakes and fuel. Golden dewdrop is a poisonous plant and has caused deaths of children. Saponins in the fruits and foliage cause gastroenteric irritation, drowsiness, fever, nausea, vomiting, and convulsions. Dermatitis sometimes occurs from handling the plants (Hardin and Arena 1969, Westbrooks and Preacher 1986). However, birds feed on the fruits without difficulty (Nelson 1996). Ethyl acetate and aqueous extracts of leaves showed significant antimalarial activity when administered to mice (Castro and others 1996). In small quantities, fruits are used to treat intestinal worms (Whistler 2000).

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***Encelia farinosa* Gray ex Torr.** brittlebush
ASTERACEAE

Synonyms: none

Catherine E. Koehler and Arlee M. Montalvo

General Description.—Brittlebush, a dry environment-adapted shrub with weak branches, is also known as incienso because it has fragrant resin, and as desert encelia because it occurs in desert and semidesert habitats. The specific epithet *farinosa* refers to the mealy pubescence of the leaves, which is composed of appressed wooly hairs. These shrubs have dense rounded canopies with alternate whitish to greenish-gray leaves clustered near stem tips. Adults are 0.3 to 1.5 m tall, shallowly rooted (40 cm), with one to several many-branched stems. Leaves are simple, 3 to 8 cm long, ovate to rhombic in outline, with wavy margins, and short petioles. Heads are arranged in loose, naked panicles and have both disk and ray flowers subtended by green, glandular bracts that embrace the flat, obovate, 4.5 mm long achenes. Involucre bracts are imbricate in three to four series. Disk florets are yellow or rich purple and are surrounded by 8 to 12 mm long yellow ray florets (Munz and Keck 1968, Hickman 1993). Munz and Keck (1968) recognize two varieties: *E. f.* var. *radians* Bdg. ex Blake from southeastern California with glabrate leaves and involucre and yellow disk flowers, and *E. f.* var. *phenocodonta* (Blake) Jtn. from the southern Colorado desert with purple disk flowers. Plants have n = 18 chromosomes (Hickman 1993). Brittlebush hybridizes readily with *E. fructescens* (A. Gray) A. Gray, *E. californica* Nutt. and *E. actoni* Elmer (Ehleringer and Clark 1988, Hickman 1993). Intergeneric hybrids with the annual *Gerea canescens* T. & G. have also been reported (Kyhos 1967).

Range.—Brittlebush occurs within sage scrub of the inland valleys of southern California, eastward and southward into arid habitats of the Sonoran and Mojave deserts and into Arizona, northwestern Mexico, southern Nevada, and southwestern Utah at under 1,000 m elevation (Munz and Keck 1968, Hickman 1993, Sandquist and Ehleringer 1997). In California, it has been extending westward and northward due to roadside and other plantings.

Geographic Variation.—Geographic variation and adaptation to local environments have been documented for many brittlebush traits. In particular, adaptation to water availability has been well demonstrated, including genetic differentiation in water use efficiency (Sandquist and Ehleringer 2003). Also, individuals with brown-purple disk florets (var. *phenicodonta*) occur in areas with higher levels of soil moisture and are replaced by the yellow-disked form (var. *farinosa*) in drier sites. This pattern may involve natural selection in response to water availability (Kyhos 1971) but may also be linked to the lower frost tolerance of var. *phenicodonta* (Sandquist and Ehleringer 1996). Similarly, Monson and others (1992) found localized physiological and genotypic differences in water use between plants at the base and the top of a slope that coincided with a moisture stress gradient.

The degree of leaf pubescence varies across regions with different mean annual rainfall, and variation in number of leaf hairs is both a plastic response and genetically determined. Leaves of plants growing in arid regions are more pubescent, thereby having greater control over leaf temperature and water loss, but they have lower photosynthetic capacity due to higher reflectance of light than plants from more mesic regions. Differences are maintained when offspring are planted together in common gardens (Sandquist and Ehleringer 1997, Housman and others 2002). However, an additional plastic response allows plants in more mesic gardens to grow less-pubescent leaves than sibling plants in desert gardens, a response which allows plants to take advantage of higher water availability and increased photosynthetic ability through leaf-hair reduction (Ehleringer and Clark 1988). The inverse relationship for leaf pubescence and photosynthetic activity may involve pleiotropy or linkage to other genetically determined morphological differences between populations or from environments with different moisture regimes (Housman and others 2002).

There is also clinal variation in production of chemical compounds that provide defense against herbivores. From north to south in Baja California and east to west from the Sonoran desert to coastal regions of California, plants produce progressively less of a sequiterpene and more of a chromene toxin, which may influence local resistance to herbivores (Wisdom 1985, Kunze and others 1995). Seasonal production of these compounds may also influence herbivores (Wisdom and Rodriquez 1983). There are higher concentrations of these chemicals and nitrogen in young tissues. In addition, populations differ in the relative amount of different compounds. The specialist beetle *Trirhabda geminata* Horn experienced lowered larval growth rates when fed higher levels of the secondary compounds.

Ecology.—In sage scrub, brittlebush occurs on flats and slopes, primarily on weathered sandstone, granite, diorite, and alluvial deposits; in the desert it occurs on rocky slopes, flats, and in washes (Munz and Keck 1968, Hickman 1993). Studies on the adaptive significance of variation in leaf form and pubescence both within and among populations is reviewed by Housman and others (2002) and by Sandquist and Ehleringer (1997, 1998). Plants react to seasonal increase in water stress at the end of the rainy season by replacing the larger, less hairy leaves produced earlier in the growing season with more pubescent leaves that are smaller and thicker. This reduces water loss and regulates leaf temperature, but it also decreases photosynthetic capacity. Prolonged drought leads to dormancy and leaf drop.

Brittlebush shows variation among individuals and populations in water-use efficiency (the ratio of photosynthesis to transpiration, or delta value). Individuals with a high delta have a higher growth response if water stress is decreased but perform poorly in response to drought stress, while those with a low delta show lower growth response under low water stress and a greater capacity to survive drought conditions (Ehleringer 1993). In general, however, brittlebush is drought adapted and responds quickly to water addition through rapid CO_2 uptake, leaf production, and stem growth (Nobel and others 1998).

Reproduction.—Brittlebush flowers from March through May (Munz and Keck 1968) and individuals must be cross-pollinated in order to produce seed (Ehleringer and Clark 1988). Flowers are visited by various insects including butterflies, moths, flies, bees, wasps, and beetles (Kyhos 1971, Moldenke 1976). In one study, a beetle (Malachiidae) was found to be 10 times more common than all other insect species combined (Kyhos 1971). These potential pollinators do not discriminate between plants with different disk-flower color (Kyhos 1971). Achenes are collected from May to July (Mirov and Kraebel 1939) with about 770,000 bulk seeds/kg (personal communication with S&S seeds, Carpenteria, CA). Seed viability varies among years, with as few as 35 percent of seeds viable (personal communication with M. Wall, Rancho Santa Ana Botanical Garden, Claremont, CA). Seed production is influenced by water stress heightened by competition. In a desert study in which nearby neighbors were removed, shrubs experienced lower water stress, had higher survival, grew to nearly twice the mass, and produced 53 percent more flower heads per twig and 220 percent more achenes per head than shrubs with brittlebush neighbors within 2 m (Ehleringer 1984).

Establishment and Growth.—Brittlebush becomes established rapidly following disturbance. Seedlings emerge and become established in open areas in the winter rainy season. Plants become dormant and drop many leaves during the dry season and then sprout new leaves with the onset of winter rains. Plants can reach maturity within 2 years and often live for 10 to 15 years. In sage scrub vegetation, resprouting success of shrubs from the base is inversely related to fire intensity (Westman and others 1981, Martin 1984). In one study, 2 to 30 percent of brittlebush resprouted on slopes previously dominated by the shrub, and resprouts and seedlings surpassed prefire densities within 2 years (Martin 1984). For coastal sage scrub in general, both resprouting and seedling emergence from a soil seed bank are negatively correlated with fire intensity (Keeley 1998).

Seed germination.—Some authors report seed germination without pretreatment (Mirov and

Kraebel 1939, Emery 1988), but pretreatment can increase otherwise low germination rates. Padgett and others (1999) found that seed stored for 6 months at room temperature had 2 to 4 percent germination while seed stored at 5 to 10 ^{o}C in a refrigerator had 10 to 12 percent germination. In addition, treatment with gibberelic acid or $Ca(NO_3)_2$ increased germination of both warm- and cold-stored seeds approximately two-fold, and leaching with water for several days increased germination by about 50 percent.

Growth and Management.—Maximum growth of roots occurs in the winter and early spring (Drennan and Nobel 1996), so plants will establish best if sown in late fall. Planting brittlebush seeds can yield vegetative cover and visual appeal relatively quickly. However, seed mixtures should be balanced carefully because overuse can retard establishment of other species (Went 1942, Gray and Bonner 1948). Ample evidence for local adaptation in this species underscores the need to collect seed material for wildland restoration from within the same ecological zone and vegetation type as the targeted planting site so as to maximize success of planting projects. Because of potential competition and hybridization, it is also important that correct native species are specified and used. Mistaken plantings of *E. californica* instead of brittlebush, or vice versa, abound (authors' observation), and hybrids between species have been found in such locations (personal communication with A. Sanders, University of California, Riverside). Improper seed choices can compromise the success of restoration efforts and the genetic integrity of wild populations.

Benefits.—Brittlebush was used by native tribes for medicinal and other purposes. The resinous gum, heated or made into a salve, was applied to the chest to relieve pain and loosen bronchial mucous. A decoction of boiled blossoms, leaves, and stems was held in the mouth to relieve gum and tooth ache (Bean and Saubel 1972, Moore 1989). In addition, tea made from the gum has a numbing effect and was used to relieve arthritic pain (Moore 1989). The resin was also burnt as incense or melted and used as a varnish (Moore 1989, Hickman 1993).

Brittlebush feeds numerous pollinators and herbivores. It is an important nectar and pollen source of the bee, *Calliopsis pugionis* Cockerell, which is the host of the rare cleptoparasitic bee, *Holcopasites ruthae* Cooper in Riverside County, CA (Visscher and Danforth 1993). Mountain sheep eat brittlebush, but it is only found in fecal pellets in spring, summer, and fall in trace amounts (Perry and others 1987). The dominant herbivores on brittlebush leaves are the larvae and adults of the beetle, *Trirhabda geminata* (Wisdom 1985). The fly *Neotephritis finalis* Loew lays its eggs between the florets, and the larvae feed on the achenes (Goeden and others 1987).

Horticulture.—Brittlebush does best with full sun and good drainage (Hickman 1993, Keator 1994). The rounded form with striking yellow flowers is attractive near the back of borders or rock gardens, and it is especially suitable on dry slopes (Perry 1992, Keator 1994). Plants can be established quickly from seed or containers (Perry 1992). Provision of occasional summer water allows plants to remain attractive throughout the year (Keator 1994).

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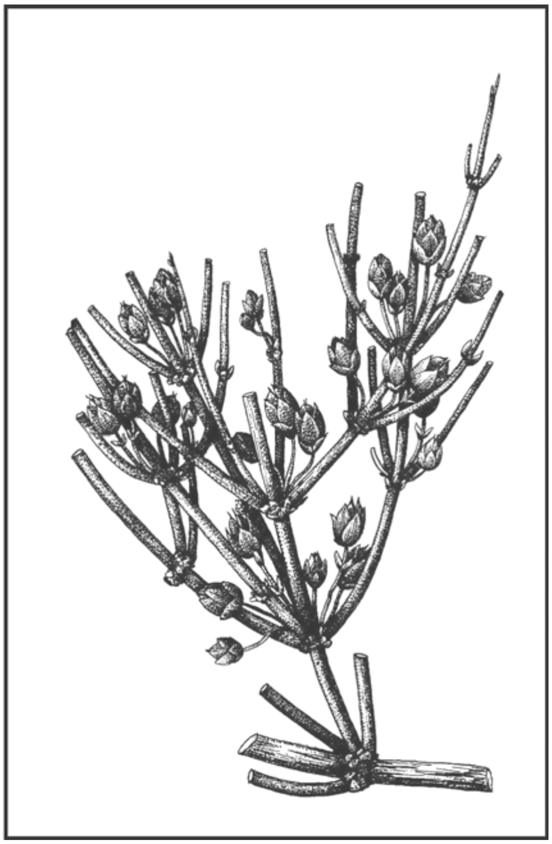
Ephedra nevadensis S. Wats. Nevada ephedra
EPHEDRACEAE

Synonyms: *Ephedra aspera* Engelm. ex S. Wats
Ephedra reedii Cory
Ephedra antisyphilitica sensu S. Watts in King

Stanley G. Kitchen



General Description.—Nevada ephedra, also known as Nevada jointfir, gray ephedra, or mormon tea, is an erect, 0.3 to 1.5 m tall, coniferous shrub with opposite spreading branches. Roots are deep and fibrous extending from an expanded root crown. Stems are jointed and grooved. Internodes are 1.5 to 6 cm long (Cronquist and others 1972). The combination of small cones, ring porous wood, wide multiseriate rays, and vessels in older stems separate *Ephedra* from other gymnosperms (Stevenson 1993). Bark on older branches is gray and fissured. The erect, photosynthetic branchlets (1 to 5 mm wide) are pale green to gray, glaucous and smooth. Leaves are reduced to 2 to 5 mm long, deciduous scales, positioned in opposite pairs at the nodes. A thickened gray base remains after leaf-fall. One to several oval-shaped male cones, 4 to 8 mm long, are subtended by several pairs of membranous bracts attached at the nodes (Cronquist and others 1972). Egg-shaped female cones, 5 to 11 mm long and light-brown to yellowish-green, are attached on short stalks (peduncles) and partially enclosed by 8 to 10 bracts at young nodes. Fruits are smooth brown nutlets, 4 to 9 mm long, 2 to 4 mm wide, and occur individually or in pairs (Cronquist and others 1972). The inner cone scales enclose the seed mimicking the angiosperm pericarp. The embryo has two cotyledons.

Taxonomy.—*Ephedra* is monotypic to Ephedraceae with a worldwide distribution (except for Australia) and is represented by approximately 60 species (Stevenson 1993). Two varieties, of Nevada ephedra are recognized; *E. nevadensis* var. *nevadensis* and var. *aspera* (Engelm. ex S. Wats) L. Benson (Kartesz 1994). Chromosome number is 2n = 14 or 28 (Stevensen 1993).

Range.—Nevada ephedra is endemic to arid and semiarid parts of the Great Basin, Colorado Plateau, and desert Southwest of western North America. Its range extends from Oregon and California on the north and west, into Texas in the east, and Mexico in the south (Tirmenstein 1990). In Utah it grows from 1,220 to 1,830 m in elevation (Dittberner and Olson 1983).

Ecology.—Nevada ephedra grows in well drained, sandy to rocky soils on arid hills, alluvial fans, and plains, and on ridges and canyons partially to completely devoid of trees (Stanton 1974). It is moderately salt-tolerant (Stanton 1974, Plummer 1977). It occurs in large pure stands and in mixed pinyon-juniper woodlands, salt-desert, sagebrush, and hot-desert transitional shrublands, and mountain and desert grasslands (Tirmenstein 1990). Mean annual precipitation varies from 150 to 400 mm. Plants sprout from the woody crown and from roots following fire (Young and Evan 1978, West and Hassan 1985). Fire seasonality, intensity, and severity affect plant capacity to recover after burning (Stanton 1974, Wright 1980, McLaughlin and Bowers 1982). A lack of fuel continuity in many Nevada ephedra communities results in fire being a rare event. Plants spread vegetatively through underground stolons in response to burial. Natural recruitment from seeds is often from rodent caches (Tirmenstein 1990). Of North American ephedra, Nevada ephedra is considered to be the most important forage species (Tirmenstein 1990). It is used extensively by mule deer (*Ococolius hemionus*), pronghorn (*Antilocapra americana*), and bighorn (*Ovis canadensis*) and domestic sheep during winter and in periods of drought (Stanton 1974, Smith and Beale 1980). Nutritive value and palatability of young branchlets is considered to be fair to good (Tirmenstein 1990).

Reproduction.—Nevada ephedra is dioecious (occasional monoecious) with female and male cones occurring on separate plants. Male plants are more common on dry slopes and female plants dominate more favorable locations, maximizing reproductive output (Freeman and others 1976). Plants are wind-pollinated. The timing of cone maturation, or coning, and pollination is weather-dependent and generally occurs over a period of 1 to 2 weeks between early March and early June (Stanton 1974, Turner and Randall 1987). Seeds ripen between May and August. Turner and Randall (1987) observed considerable inter-annual variation in timing of phonological development. Cones are not produced every year, and good seed crops are typically several years apart for any given population (Plummer and others 1968). Years of good cone production are apparently synchronized among most plants of a population by an interaction between years of above-average precipitation and time since last major seed crop. There are approximately 45,000 seeds (nutlets) per kg (Kitchen and others 1999).

Growth and Management.—Once ripe, seeds are easily dislodged. Ripened seeds can be collected by gently striking or shaking seed-bearing branches over tarps or hand-held hoppers. In good years, large quantities of seeds can be harvested in relatively short time if harvests are well timed. After drying, seeds are cleaned to remove light, unfilled seeds, stem fragments, cone scales, and other inert material. Purity and viability levels of commercially available seed are generally high. Seed germination is rapid across a wide range of temperatures (5 to 20 ^{o}C) with little or no dormancy (Young and others 1977, Kitchen and others 1999). Seed viability has remained high for up to 5 years (Stevens and others 1981). Although seedlings tolerate drought well, they are slow growing and may take 5 to 10 years to reach 60 cm in height (Plummer and others 1968). Plants establish well from direct seeding when more competitive species are controlled. Successes with transplants and cuttings to revegetate minelands and other degraded shrublands have also been reported (Luke and Monsen 1984, Shaw and Monsen 1984).

Benefits.—Nevada ephedra provides forage and cover for numerous species of wildlife, especially during winter and periods of drought (Stanton 1974, Smith and Beale 1980, Dittberner and Olsen 1983). It is also used as forage by domestic sheep and cattle but is considered poor forage for horses. The species is used effectively in restoration planting on harsh sites (Plummer and others 1968, Luke and Monsen 1984, Shaw and Monsen 1984). Indigenous humans used roasted seeds in foods and various concoctions from seeds and stems to treat a variety of symptoms including coughs, headaches, cold, fever, and kidney ailments (Steward 1938, Tirmenstein 1990). Mormon pioneers also made teas from stems. All members of the genus produce unique secondary compounds with potential medicinal applications (Caveney and others 2001). Nevada ephedra, and other North American members of the genus, lack the nueroactivating ephedrine alkaloids found in some Old World species. However, a class of compounds with antimicrobial potential, kynurenates, are found in Nevada ephedra (Caveney and others 2001). It is occasionally used as an ornamental (Cronquist and others 1972).

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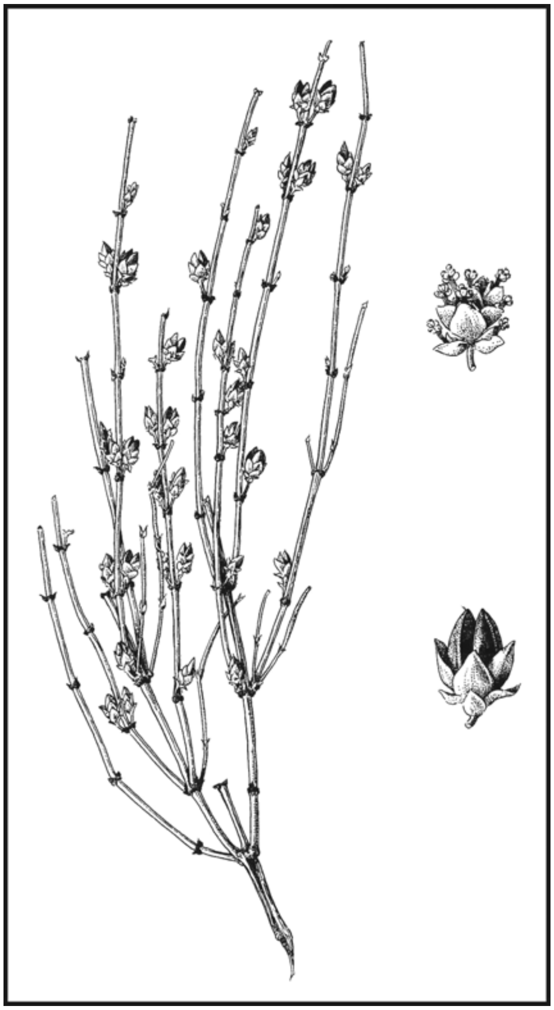
***Ephedra viridis* Coville** green ephedra

EPHEDRACEAE

Synonyms: *Ephedra nevadensis* subvar. *pluribracteata* Palmer ex Stapf.
Ephedra nevadensis var. *viridis* (Colville) M.E. Jones

Stanley G. Kitchen



General Description.—Green ephedra, also known as Mormon tea, or jointfir, is a spreading to erect, coniferous shrub, 0.5 to 1.5 m tall and with a crown 1 to 3 m wide at maturity (Cronquist and others 1972, USDA Forest Service 1976). A fibrous, somewhat fragile root system originating from several, almost parallel, taproots descends deep into the soil profile. Stems are jointed and grooved. Internodes are 1 to 4.5 cm long (Cronquist and others 1972). Lower bark is gray and irregularly fissured (Anderson 2001). Photosynthetic upper branches are thin (1 to 3 mm), bright green to yellow green and broom-like, with opposite or falsely whorled attachment (Welsh and others 1987). Leaves are reduced to 1.5 to 4 mm, deciduous scales, positioned in opposite pairs at nodes. A thickened brown base remains after leaf-shed. Egg-shaped cones are borne at nodes, singly or whirled. Two or more male cones, 5 to 7 mm long, are subtended by opposite membranous bracts, 2 to 4 mm long, while female cones, 6 to 10 mm long, are partially enclosed by thickened bracts, 4 to 7 mm long (Cronquist and others 1972). Brown, three-sided seeds are smooth and 5 to 8 mm long and 2 to 4 mm wide. The combination of small cones, ring porous wood, wide multiseriate rays, and vessels in older stems separate *Ephedra* from other gymnosperms (Stevenson 1993).

Taxonomy.—Two varieties of green ephedra are recognized. Variety *viscida* (Cutler) L. Benson differs from the more widespread var. *viridis* by the presence of short stalks (peduncles) on female cones and the often sticky nature of stems (Welsh and others 1987). Chromosome number is 2n = 28 (Stevensen 1993).

Range.—Green ephedra is closely associated with the Great Basin and Colorado Plateau provinces of western North America (Anderson 2001). Its range extends from California and Oregon east and south to western Texas and Chihuahua, Mexico. In Utah and California its elevational range varies from 900 to 3,000 m (Welsh and others 1987, Anderson 2001).

Ecology.—Green ephedra is found on sedimentary, volcanic, and metamorphic substrates in sandy, gravelly, or rocky, well-drained, underdeveloped soils (Anderson 2001). Populations are found on a variety of landforms including: plains, alluvial fans, mesa tops, washes, and canyon walls on all aspects. Salt tolerance is limited. Plants tolerate partial shade but do best in full sun. Although rarely considered a dominant, green ephedra is associated with a wide variety of plant community types including: big sagebrushbunchgrass, black sagebrush, blackbrush, desert grassland, pinyon-juniper, mountain mahogany, oak woodland, mountain shrub, mixed conifer, and ponderosa pine (Anderson 2001). It is present in early, mid, and late successional stages (Young and Evans 1973, Koniak 1985). Mean annual precipitation varies from 200 to 430 mm (Anderson 2001). Plants sprout from crown or roots following top-kill by fire (USDA Forest Service 1976, Young and Evans 1978, Koniak 1985, Everett 1987). Reported survival following fire is variable (Anderson 2001). Sprouting response following fire may vary by season of burn, fire severity, or among population variation in fire tolerance. Green ephedra is found in communities for which a wide range of fire frequencies is known. It also establishes on disturbed sites from seed (Koniak 1985). Green ephedra is used as winter forage by big game and livestock but receives only limited use during other seasons (Jameson and others 1962, Kufeld and others 1973). Palatability and nutritive quality of young stems are generally ranked as fair to good for most wildlife species and classes of domestic livestock (Dittberner and Olson 1983, Anderson 2001). Seeds are eaten by birds and rodents and appear to be moderately prefered (Everett and others 1978). Rodents probably play an important role in seed dispersal.

Reproduction.—Green ephedra is dioecious. Spatial segregation of the sexes results from high male plant representation on dry ridges and slopes and high female plant representation on microsites with relatively favorable soil moisture conditions (Freeman and others 1976, Brunt and others 1988) providing for greater reproductive efficiency. Plants are wind-pollinated. Timing of cone maturation, or coning, and seed maturation is dependent upon variation in weather, elevation, aspect, and geography. Coning and pollination occur for approximately 2 weeks, usually between April and June. Seeds mature between June and September. Cones are not produced each year, and good seed crops may be several years apart (Plummer and others 1968). There are approximately 45,000 seeds per kg (Meyer and others 1988).

Growth and Management.—In years of good seed crops, significant quantities are easily harvested by hand (Plummer and others 1968). Ripened cones are easily dislodged by gently shaking or striking cone-bearing branches over tarps or hand-held hoppers. Timing of harvest is critical as thunder storms can cause considerable shattering after seeds ripen. After drying, seeds are cleaned to high purity and viability levels using conventional milling equipment. Freshly-harvested seed may be partially dormant (Meyer and others 1988). Dormancy can be broken with a 4-week moist prechill or stratification (Meyer and others 1988). Germination for after-ripened or prechilled seed is relatively rapid. Germination of non-dormant seeds occurs over a range of cool temperatures (Young and others 1977). Seed viability remains high for at least 5, and perhaps as long as 15 years (Stevens and others 1981). Seedling growth rate is slow. Seedlings may require 5 to 10 years to reach 60 cm in height (Anderson 2001). In restoration plantings, seedlings are susceptible to competition from weeds and faster-growing grasses and forbs in the seed mix (Ferguson and Frischknecht 1981). Plants establish well from direct seeding and transplants (USDA Forest Service 1976, Plummer 1977, Everett 1980, Luke and Monsen 1984). Stem cutting are capable of root development in greenhouse conditions (Wieland and others 1971). Green ephedra was toxic to domestic cattle and sheep during pregnancy in a controlled diet study (Keeler 1989). No detrimental effects were observed for developing calves and lambs. Conflicting reports have been published on the possible presence of ephedrine alkaloids in green ephedra. While Anderson (2001) suggests the presence of this group of compounds in this species, Caveney and others (2001) failed to find these compounds common to Old World ephedras in any New World species. Tannin content is high.

Benefits.—Green ephedra is valuable for restoring vegetation structure and diversity and for erosion control on disturbed lands, including roadsides, minelands, and degraded rangelands (USDA Forest Service 1976, Everett 1980, Ferguson and Frischknecht 1981, Ferguson and Frischknecht 1985, Herbel 1986), in areas in which it is adapted. When competition is controlled, it establishes well from seed and persists after wildfire. It provides important winter forage for wildlife and domestic livestock (USDA Forest Service 1976). Green ephedra has had limited use as an ornamental (Anderson 2001). Native Americans made both medicinal and nonmedicinal teas brewed from stems and used seeds and roasted seeds (nutlets) for food (Steward 1938, USDA Forest Service 1976). Mormon settlers were also known to use it in the production of a beverage, a cause for the frequently used moniker, 'mormon tea'. Undetermined medicinal applications for a group of unique secondary compounds associated with members of the genus have not been fully determined, including possible antimicrobial applications for kynurenates (Caveney and others 2001).

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Eriogonum fasciculatum Benth. California buckwheat
POLYGONACEAE

Synonyms: *Eriogonum rosmarinifolium* Nutt.
Eriogonum fasciculatum var. *maritimum* Parish
Eriogonum fasciculatum var. *oleifolium* Gand.
Eriogonum aspalathoides Gand.
Eriogonum fasciculatum ssp. *aspalathoides* S. Stokes

Arlee M. Montalvo

General Description.—California buckwheat is a widespread and morphologically variable shrub and is one of the most important components of sagebrush scrub, desert scrub, and especially coastal sage scrub (Kirkpatrick and Hutchinson 1977, Westman 1981). Although the four taxonomic varieties partly overlap in geographic distribution each is associated with a different climatic zone and combination of traits, especially color, chromosome number, leaf shape, degree of revolute leaf margins, and pubescence (Munz and Keck 1968, Hickman 1993). All forms have alternate cauline, linear to oblanceolate leaves that are white wooley with appressed hairs beneath, and darker, generally less hairy to glabrous above. Leaves are 1 to 2 cm long and cluster tightly at nodes on short axillary shoots, giving the leaves a fascicled appearance. Flowers are small (about 3 mm long) with six white to pinkish sepals and are born in heads of tightly to loosely packed involucres with few flowers per involucre. The heads (or dense cymes) are born singly or in umbels subtended by long, naked peduncles (often > 5 cm). Branching of the umbels varies from one to four levels. Umbels are rounded to flat-topped depending on the extent of branching. Flowers produce small (about 1.5 to 2 mm long), single seeded achenes that are partially enclosed in a dry, persistent calyx. Below is a summary of diagnostic differences among varieties following Munz and Keck (1968), Reveal (1989), and Hickman (1993).

Range and Taxonomy.—*E. f.* var. *fasciculatum* (see insert) has 2n = 40 chromosomes (Munz and Keck 1968). Shrubs are often low and spreading and 0.6 to 1.2 m tall. Leaves are linear to linear-oblanceolate, green and glabrate above, sparsely pubescent beneath, with leaf margins strongly rolled under (revolute). Involucres and flowers are usually glabrous. Plants occur from nearly sea level to just over 300 m in coastal scrub and sage scrub along coastal bluffs and cliffs, and in canyons and dry slopes of the foothills near the coast from San Luis Obispo Co. south to central Baja California.

E. f. var. *foliolosum* (Nutt.) S. Stokes ex Jones (Munz and Keck 1968), the interior flat-topped buckwheat, is tetraploid with 2n = 80 chromosomes (Stebbins 1942). Shrubs are erect to spreading, 0.5-1.5 m tall and occur on interior slopes and mesas below 1000 m (seldom on coast) in chaparral and sage scrub from Monterey Co., California south to northern Baja California. Leaves are often linear, dark to gray-green and pubescent above, and densely pubescent below. Involucres and perianth are usually pubescent. Synonyms are *E. rosmarinifolium* var. *foliolosum* Nutt., *E. f.* ssp. *foliolosum* S. Stokes, and *E. f.* var. *obtusiflorum* S. Stokes.

Eriogonum f. var. *polifolium* (Benth.) Torrey & A. Gray (flowering shoot in photograph) has 2n = 40 chromosomes (Stebbins 1942). These greyish, pubescent, rounded shrubs occur at 600 to 2300 m on dry slopes and washes. They are widespread across inland mountains and deserts of California, from the inner coast ranges of San Luis Obispo and Fresno Cos., south to San Diego Co., eastward into the Mojave Desert to southern Nevada, Utah, and Arizona, and south into northwestern Senora, Mexico and central Baja California. In inland sage scrub, plants overlap in distribution with var. *foliolosum,* especially in Riverside Co., but occupy drier sites. Leaves are oblanceolate to obovate, densely pubescent beneath, and usually tomentose above with leaf margins sometimes barely revolute. Involucres and sepals are pubescent. Heads tend to be born in simple to once-compound umbels. Reveal (1989) reports hybridization between var. *polifolium* and *E. cinereum* Benth in areas were *E. cinereum* has been introduced within the range of var. *polifolium*. Synonyms are *E. f.* ssp. *p*. S. Stokes and *E. p.* Benth.

Eriogonum f. var. *flavoviride* Munz & Johnson has n = 20 chromosomes (Reveal 1989) and is 2 to 3 dm tall. The rounded shrubs occur on dry rocky slopes and washes from 200 to 1300 m in creosote bush scrub of the southern Mojave Desert, San Bernardino Co., south through eastern Riverside Co. to far eastern San Diego Co., and south to central Baja California. Leaves are light green to yellowish-green, linear, strongly revolute, and glabrous above. Peduncles are glabrous; involucres and sepals are subglabrous. Synonym is *E. f.* ssp. *flavoviride* S. Stokes.

Ecology.—California buckwheat occurs on dry slopes and often granitic substrate (Westman 1981). The woody, branched roots penetrate to under 1.5 m (Kummerow and others 1977). Plants lose some leaves in the dry season and can shed many leaves in severe drought. Plants are vulnerable to hot fires so resprout success is low and most regeneration is from seeds (Keeley 1998). Frequent fires deplete the seed bank, making populations vulnerable to local extinction. In Riverside Co., this shrub has decreased dramatically since the 1940's, with the largest decreases on alluvial soils (Minnich and Dezzani 1998). Decreases are attributed to a combination of competition with exotic annual grasses, too frequent a fire interval, that is exacerbated by weeds which carry fire, and by atmospheric deposition of nitrogen, which encourages growth of competing weeds. California buckwheat does well on rocky road cuts and in shallow soils that are inhospitable to annual grasses.

Reproduction.—Plants flower from early spring through summer. The four taxa have slightly shifted flowering times, with var. *flavoviridae* having the earliest season (Munz and Keck 1968) and var. *polifolium* flowering before the other two. In all taxa, stamens and stigmas are exerted and open to generalist pollinators, including honey bees and many species of small native bees, flies, wasps, and beetles. Achenes mature from June to September and disperse when dried inflorescences shatter in autumn. The dry calyx provides buoyancy to detached achenes and assists dispersal by wind and water. Harvester ants also disperse achenes (DeSimone and Zedler 1999). Seedlings emerge in the rainy season in mid to late winter within light gaps and open areas. Survival is unusually high as shown by studies in a variety of sites and years, often ranging from 80 to 90 percent (Wright and Howe 1987, Miriti and others 1998, Montalvo and others 2002). Most shoot elongation and leaf growth occurs before flowering from late winter to mid spring (Cole 1967). Plants can reach maturity in 1 to 2 years.

Seed Germination.—Light improves germination (Cole 1967, Keeley 1987). Atwater (1980) suggests that light increases permeability of seed coats, water adsorption, and possibly leaching of inhibitors, allowing seeds to germinate. Light-induced seed coat permeability would allow some buried seeds to remain viable and dormant in the seed bank, a bet-hedging strategy. Cole (1967) found coastal populations germinated at 15 to 25 ^{o}C while inland populations germinated over a larger range of 5 to 35 ^{o}C. Keeley (1987) examined the effects of light, dark, heat, and leachate through charred wood (charrate) on germination. Seeds germinated equally well on soil vs. filter paper, and light controls had a two-fold increase in germination compared to dark controls (83 vs. 45 percent germination). Charrate did not affect germination. In light, seeds exposed to 120 ^{o}C for 5 min suffered a large decrease in germination under all conditions relative to seeds heated to 70 or 100 ^{o}C, suggesting fire may kill many seeds in the upper centimeter of the seedbank. Heat sensitivity and a light requirement for germination encourage colonization of disturbed or open sites.

Horticulture.—Plants can be propagated from seeds or rooted from cuttings. Seeds and container plants should be planted in the fall to early winter to take advantage of the moist cool season for growth. In one study, seeds planted by seed imprinting and hydroseeding, shallow methods that allow light to reach planted seeds, had at least twice the emergence success as drilling that covered seeds with 0.5 to 1 cm of soil (Montalvo and others 2002). Seeds germinate within 2 weeks if soil is moist and over about 15 ^{o}C. Plants require full sun and good drainage. No irrigation is required if planted before seasonal rains.

The grey-green var. *polifolium* provides a nice contrast to the other green varieties in the garden, but all do well in dry landscaping. The flowers last far into the summer and become an attractive rusty-brown in fruit. Some prostrate cultivars of California exist, including "Theodore Payne," "Prostrata," "Dana Point," and "Wildwood" (Perry 1992).

Greenhouse studies indicate that California buckwheat forms facultative associations with arbuscular mycorrhizal fungi (Egerton-Warburton, Montalvo, and Allen, unpublished report). The plant's facultative dependence on mycorrhizal fungi may be instrumental to successful colonization of barren sites. Montalvo and others (2002) found that plants grew quickly to maturity on a graded site with low organic matter and nutrients, but establishment, growth, and flowering all decreased significantly with decreasing soil nitrogen (NO_3-N mean = 7.89 mg/g, range = 0.8-69 mg/g in the study plot).

Benefits.—California buckwheat provides habitat and food for numerous animals. Osborne (1998) found high abundance and diversity of arthropod species on California buckwheat. Some are species-specific feeders such as the larvae of the moth, *Hemileuca electra* (Wright) (Rubinoff 1998). Numerous species of butterfly larvae feed on California buckwheat and specialize on different plant parts and taxa (Howe 1975), sometimes according to timing of growth. For example, the larvae of the butterfly, *Apodemia mormo* (Felder & Felder), has three biotypes in the Mojave Desert. The spring morph feeds on California buckwheat while the others feed on species with different flowering times. *E. parvifolium* Sm. in Rees. is the host of the rare El Segundo blue butterfly (*Euphilotes bernardino allyni* Shields). When California buckwheat was planted instead of later flowering *E. parvifolium,* competing insect species used California buckwheat, built up populations, and then competed with the rare butterfly for *E. parvifolium* flowers (Longcore and others 2000).

Vertebrates also use California buckwheat. The rare orange-throated whiptail is associated with open vegetation with this shrub (Brattstrom 2000). Rare California gnatcatchers (*Polioptila californica californica*) forage and nest in the shrub. California buckwheat and *Artemisia californica* Less. are dominant shrubs used by gnatcatchers (Mock and Bolger 1992). The rare mountain sheep (*Ovis canadensis nelsoni*) browses on California buckwheat in the San Gabriel Mountains of southern California (Perry and others 1987), and deer eat the inflorescences (Schopmeyer 1974).

Genetics, Geographic Variation, Hybridization, and Fitness.—Stebbins (1942) hypothesized that tetraploid populations of var. *foliolosum* arose from hybridization between diploid var. *fasiculatum* and var. *polifolium* (= *E. f.* subsp. *foliolosum*, *E. f.* subsp. *typicum*, and *E. f.* subsp. *polifolium*, respectively, in the paper). He examined the distribution of taxa in relation to climatic factors and concluded that the morphology and ecological tolerances of var. *foliolosum* combined the morphology and tolerances of the two diploid taxa. The variety *polifolium* was in areas with some snow, frost, and only 10 to 13 cm of rainfall, *fasciculatum* was in the areas with no frost, often frequent fog, and 22 to 37 cm of rainfall, and *foliolosum* often occurred in habitats intermediate to the two diploids. Cole (1967) tested assumptions about the distribution of morphology and ecological tolerances of vars. *fasciculatum* and *foliolosum*. Cole compared their physiologies over an ecological gradient from the cool coast across the mountains to the hot inland valleys and found that coastal var. *fasciculatum* were the least hairy, and populations of var. *foliolosum* became more hairy inland. There was a clear morphological cline from the coast to the interior among and within ecotypes that correlated with habitat. Photosynthesis vs respiration ratios and photosynthetic rates and respiration rates all varied in a clinal manner that correlated with morphological characters. The variety *fasciculatum* forms a distinctly adaptive coastal ecotype, while var. *foliolosum* forms an inland ecotype.

Analysis of eight allozyme loci for eight populations of var. *foliolosum* and four *fasciculatum* revealed ample genetic variation (Montalvo, Ellstrand, and Clegg, unpublished data). All loci were polymorphic and there was an average of 5.7 alleles/locus. Expected heterozygosity was also high at 0.42. Nei's genetic distances among populations ranged from 0 to

0.074, with the largest distance between varieties. Overall, the proportion of total variation explained by differences among populations (G_{ST}) was 0.025. By itself, the tetraploid var. *foliolosum* had no significant structure (G_{ST} = 0.005), while G_{ST} = 0.028 for var. *fasciculatum*. These values suggest high levels of gene flow and outbreeding.

Seed Collection and Processing.—Seeds are collected after heads have turned rusty brown. The chaff can be separated from seeds by pushing seeds through a screen and then separating seeds from chaff with an air separator or fan (author's observation). Commercial seed companies usually skip the screening and just break up the chaff, air separate the seeds from crude chaff, and sell seeds with the persistent calyx intact. A recommended target for minimum quality of purchased seeds is 15 percent purity and 65 percent germination. Here, a bulk seed pound with about 990,000 seeds/kg, would have about 96,800 pure live seeds (personal communication, S & S Seeds, Carpenteria, CA).

Growth and Management.—Seeds have been widely planted for restoration, roadside erosion control, slope stabilization, landscaping, and apiary (Schopmeyer 1974, Perry 1992). Despite the clear geographic pattern and ecological affinities of the four taxonomic varieties, most researchers and consultants fail to designate taxonomic variety on publications, plant lists, or plant palettes. They also commonly fail to specify appropriate ecological zone for seeds used in wildland plantings. This has resulted in extensive plantings outside natural ranges and habitats (Reveal 1989). Projects should use seeds of appropriate taxa to maximize project success.

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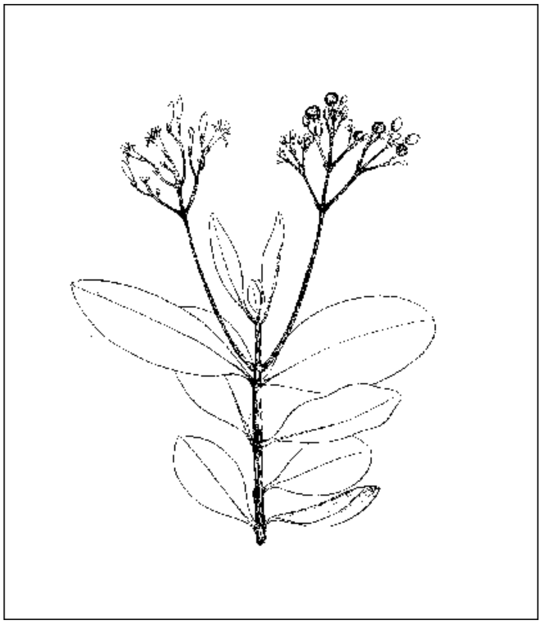
***Erithalis fruticosa* L.** black torch
RUBIACEAE

Synonyms: *Erithalis revoluta* Urban
Erithalis angustifolia DC.
Erithalis elliptica Raf.
Erithalis inodora Jacq.
Erithalis odorata Pers.
Erithalis parviflora Griseb.

John K. Francis



General Description.—Black torch, also known as candlewood, tea, parrot apple, cubra prieta, jayajabico, manglillo, tarro de chivo, bois flambeau, and bois chandelle, is an evergreen shrub that typically is 1 or 2 m in height but occasionally reaches 8 m in height. Usually the species has multiple stems arising near the ground line and many branches that are stiff and sometimes gnarled. The bark is gray and smoothish to warty. The resinous wood is brown, hard, fine-textured, heavy, and has visible growth rings. Black torch plants are supported by brown roots that are often contorted as they grow over rocks and into cracks. The foliage may be dense or diffuse depending on whether the shrubs grow in full sun or partial shade. The opposite leaves have 3 to 20 mm petioles, orbicular to oblanciolate blades 2 to 12 cm long with entire edges, and dark-green upper surfaces. The inflorescences are lateral or terminal panicles containing many small, white flowers. The black fruits are globose or flattened drupes 3 to 4 mm in diameter that have a bitter-sweet flavor and contain five to 10 nutlets (Howard 1989, Liogier 1997, Little and others 1974, Nelson 1996). It is morphologically a highly variable species (Long and Lakela 1976).

Range.—Black torch is native to Florida, the Bahamas, the Greater and Lesser Antilles, Trinidad, Margarita and other Venezuelan islands, Quintana Roo (Mexico), and Belize (Howard 1989, Little and others 1974).

Ecology.—Black torch grows from near sea level to 120 m in elevation in Puerto Rico (Little and others 1974) in areas that receive from 750 mm to about 1800 mm of annual precipitation. The species is drought-hardy and moderately intolerant of shade and can grow under the canopy of low-density forest. Because of slow growth, it is restricted to areas with reduced competition. Black torch is most common near beaches and on rock outcroppings and bluffs near the shoreline, especially in moist limestone areas, and on limestone hills in the interior. In Florida, black torch is found in beach strand vegetation, on sand dunes, and coastal hammocks (Nelson 1996).

Reproduction.—Black torch flowers and fruits throughout the year (Little and others 1974, Nelson 1996). Open-grown individuals produce fruits and seeds in abundance. Fruits collected in Puerto Rico averaged 0.1087 $\pm$ 0.0071 g/fruit. Air-dried seeds separated from them averaged 0.00092 g/seed or 1,080,000 seeds/kg. Presumably, the seeds are dispersed by birds that eat the fruits. Seedlings and saplings are relatively common in Puerto Rico. The stems layer (root) when they come in contact with the ground.

Growth and Management.—Black torch is slow growing, especially when situated on rock outcrops. Management should mainly consist of protection from fires and clearing of sites for development.

Benefits.—Black torch contributes to biodiversity in the forests where it grows, helps protect the soil, and furnishes food and cover for wildlife. It would probably make an acceptable ornamental for green areas and nonirrigated gardens. The wood is good for turned articles but available only in small sizes. It is resistant to rot and has been used for piles and posts. Formerly, it was split and used for torches (Little and others 1974) but tended to be smoky (University of the Virgin Islands 2002). The bark, fruits, and the resin have diuretic and astringent properties and are used to treat inflammation of the kidney and bladder, and blennorrhoea (Liogier 1990). The leaves are parched and ground and used to treat skin sores (University of the Virgin Islands 2002).

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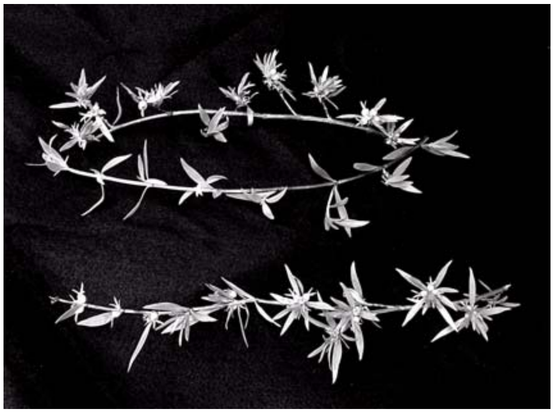
***Ernodea littoralis* Sw.** golden creeper

RUBIACEAE

Synonyms: *Ernodea angusta* Small

John K. Francis



General Description.—Golden creeper, also known as cough bush, beach creeper, wild pomegranate, ernodia de playa, wild pamgramma, and liane-séche, is an evergreen prostrate or arching shrub to about 1.5 m in height. Heavy lateral roots support the plants. The stems are four-angled and orange or reddish brown. Golden creeper leaves have a short petiole (1 to 2 mm), lanceolate blades, and a spiny, pointed tip. In some environments, leaves are somewhat fleshy; in others they are hard or coriaceous. White-to-pink tubular flowers are solitary, axillary, and sessile. The fleshy fruits are golden orange, in the shape of tiny pomegranates, and have an apple-like flavor. The seeds, borne one per fruit, are brown with a longitudinal furrow (Howard 1989, Liogier 1997, Nelson 1996).

Range.—Golden creeper is native to Southern Florida, the Bahamas, the Greater Antilles, the Lesser Antilles as far south as Marie Galante, Mexico, Belize, and Honduras (Howard 1989, Liogier 1997). It is planted as an ornamental but is not known to have naturalized into any new range as a result.

Ecology.—Golden creeper will grow in acidic to mildly alkaline soils with the whole range of textures (Gilman 1999) and over a variety of parent materials including serpentine. In Puerto Rico, it grows in areas receiving from 750 to about 1400 mm of mean annual precipitation and at elevations from near sea level to about 400 m. Golden creeper is tolerant of salt spray and mild salt concentration in the soil. The species is drought-tolerant and usually grows in excessively drained sites. However, it withstands short-term flooding (Carney-Kulig and others 2002). In Florida, it is common in coastal dunes (Nelson 1996). The variety *angusta* grows in pinelands in Florida (Workman 1980). In Puerto Rico, golden creeper also grows on coastal rocks (usually limestone) and on rocky ultramafic (serpentine) slopes. It is a sun-loving plant that usually grows in the open. When the shrubs grow under low trees in open forest, they do not become thick and robust. Golden creeper benefits from mild disturbance that eliminates shade and taller competition.

Reproduction.—Golden creeper blooms and fruits all year (Gilman 1999, Nelson 1996). Fruits collected in Puerto Rico weighed an average of 0.0467 ± 0.0014 g/fruit. Air-dried seeds separated from them weighed an average of 0.0078 ± 0.0002 g/seed or 128,000 seeds/kg. Sown without pretreatment on commercial potting mix, 24 percent germinated between 35 and 146 days of sowing (author's observation). The fruits are presumably eaten and the seeds dispersed by birds. Once established, plants thicken and spread by root suckering and layering.

Growth and Management.—The growth rate of golden creeper is reported to be moderate (Gilman 1999). Individual stems appear to live about 2 to 5 years, but the plants, being clonal, can go on indefinitely. Golden creeper is produced and sold in commercial nurseries. Plants in commercial production are produced by ground layering and rooted cuttings. Field planting of hormone-treated cuttings is also recommended (Centro Ecologico Sian Ka'an 2002). Wildlings (seedlings and plants dug up from natural stands) transplant well (Workman 1980). Recommended spacing for planting is 0.9 to 1.5 m (Gilman 1999). Once planted, golden creeper needs little attention (Workman 1980); in fact, it often dies if over-irrigated (Gilman 1999).

Benefits.—Golden creeper contributes to the biodiversity of the sites where it grows, stabilizes the soils in those fragile environments, and provides food and cover for wildlife. It is planted as an ornamental for landscaping, usually as ground cover. Golden creeper is also used for beach dune stabilization. It is particularly promoted for water-restricted landscaping (Workman 1980). A tea is made from the leafy shoots as a treatment for coughs (Centro Ecologico Sian Ka'an 2002).

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Erythroxylum areolatum L. — false cocaine

ERYTHROXYLACEAE

Synonyms: none (genus also spelled *Erythroxylon*)

John K. Francis

General Description.—False cocaine, also known as redwood, swamp redwood, thin-leafed erythroxylon, indio, palo de hierro, arabo carbonero, limoncillo, huesito, cocaina falsa, and poirier, is a deciduous shrub or small tree 2 to 7 m in height and 5 to 15 cm in stem diameter. The plant may have a single stem or multiple stems branching from near the ground and is supported by a tap and lateral root system. The roots are dark brown, stiff, and woody. The bark is gray and scaly and the inner bark is red. Moderately robust branches and many twigs form a "branchy" crown, often with a dense display of foliage. Alternate leaves are tightly grouped on short side branches or spread out on new twigs. The leaves are light green to dark green, elliptic to oblong, 3 to 13 cm long, with entire margins and petioles 5 to 7 mm long. Tiny, fragrant, five-merous white flowers are borne in clusters in the leaf axils. At maturity, the thin-fleshed, 6- to 9-mm drupes are bright red. Each fruit contains one oblong, bony seed (Britton and Millspaugh 1962, Liogier 1988, Little and Wadsworth 1964, Stevens and others 2001).

Range.—False cocaine is native to the Bahamas, the Greater Antilles, the Cayman Islands, southern Mexico, and Central America (National Trust for the Cayman Islands 2002, Stevens and others 2001). It is not known to have been planted or naturalized elsewhere.

Ecology.—False cocaine grows in areas of Puerto Rico that receive from about 750 to 900 mm of mean annual precipitation at elevations of a few meters above sea level to about 300 m. It grows in gallery forests in Nicaragua from 40 to 380 m elevation, frequently associated with limestone rocks (Stevens and others 2001). False cocaine is common in limited areas but uncommon in most of its range, growing in remnant and middle to late secondary forests. False cocaine grows on deep, medium-textured soil and sandy beach-strand soils (Vásquez and Kolterman 1998). The species is most frequent on limestone parent material, as skeletal rock or porous solid rocks but grows in areas with igneous and metamorphic (including ultramaphic) rocks. It has an intermediate tolerance to shade and will grow in openings or in the understory of medium to low basal area forests.

Reproduction.—False cocaine has been observed flowering from October to June in Puerto Rico (Little and Wadsworth 1964). Fresh fruits collected in Puerto Rico weighed an average of 0.119 $\pm$ 0.013 g/fruit. Seeds cleaned from them weighed (air-dried) an average of 0.0493 g/seed or 20,300 seeds/kg. Sown on moist filter paper without pretreatment, they germinated at 35 percent, beginning 12 days after sowing (Francis and Rodríguez 1993). Apparently, birds are the principal dispersers of seeds. Seed production can be abundant in some years. Seedlings and saplings vary from rare to common.

Growth and Management.—False cocaine grows slowly, about 1 to 3 mm in diameter per year and is capable of living several decades. Published planting or management experience is not known to the author. Protecting forests and stands containing the species is probably the best management approach until research can be performed.

Benefits.—False cocaine protects the soil and furnishes food and cover for wildlife. The wood is heavy, hard, fine-grained, durable, and strong. The sapwood is light brown and the heartwood is reddish or chocolate brown (Little and Wadsworth 1964). Available only in small sizes, it is useful for stakes, fuel, carving, and turnery. The foliage of this species does not contain useful amounts of cocaine, which is extracted from a sister species (*E. coca* Lam.) from the Andean Highlands (Little and Wadsworth 1964).

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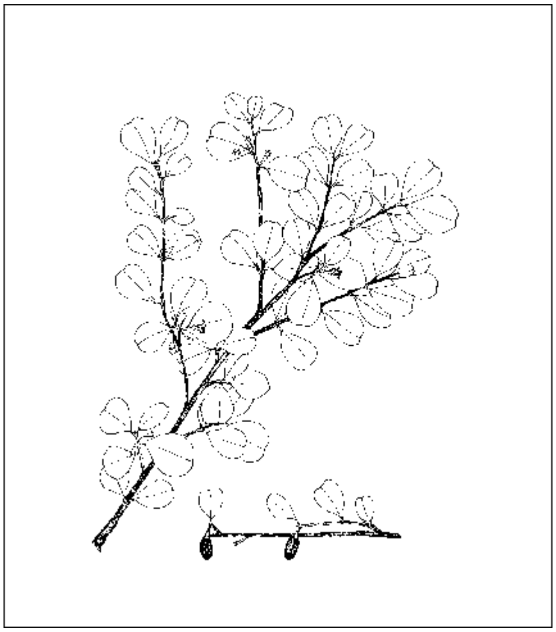
***Erythroxylum brevipes* DC.** brisselet
ERYTHROXYLACEAE

Synonyms: *Erythroxylum brevipedatum* St. Lager
Erythroxylum rhamnoides Peyr. ex Schulz

John K. Francis



General Description.—Brisselet is a shrub, usually 1 or 3 m in height, that sometimes becomes a small tree to 8 m in height. It is also known by the common names, rat-wood, jibá, ratón, yaría de costa and rocío in Spanish and bois vinette and brésillette in French (Liogier 1988, Little and others 1974). Older plants often have multiple stems from below or just above the ground level. They are supported by a tap and lateral root system consisting of dark-brown, tough, and brittle roots. The shrub's crowns are cluttered with slender branches and twigs. The bark of brisselet is gray or light brown. Foliage on older branches is borne on short spurs. The 1- to 3-cm obovate leaves have prominent light-colored central nerves and are sometimes notched at the tips. The small, white, five-petaled flowers are clustered one to four at the leaf axils. Brisselet fruits are red, ellipsoidal, fleshy drupes 5 to 9 mm long (Howard 1988, Little 1988, Little and others 1974).

Range.—Brisselet is native to Hispaniola, Puerto Rico, the Virgin Islands, and St. Barts in the West Indies (Howard 1988). It has been much confused in the literature with *E. rotundifolium* Luman that also occurs in Puerto Rico (Liogier and Martorell 2000), southern Mexico through Central America as far south as Costa Rica, and in the Bahamas, Cuba and Jamaica (Stevens and others 2001).

Ecology.—Brisselet grows in most types of soil, except poorly drained or salty soils. Plants are more frequent in eroded areas and rocky terrain where competition is weaker. Annual rainfall in the Puerto Rican range varies from about 750 to about 2000 mm. Elevation where it grows ranges from near sea level to about 760 m (Little and others 1974). Brisselet is moderately intolerant of shade. It invades abandoned pastures, fields, and disturbed areas, usually as scattered plants. It is common in early and mid-secondary forest and is an important plant of the understory of remnant and late secondary forests that are not too dense. Grazing cattle benefits the species, probably by reducing its competition. Cut stems will resprout. No observations are published on sprouting after single fires, but repeated fires will eliminate it from an area.

Reproduction.—Brisselet flowers during the summer months and fruits in late summer or early fall (Little and others 1974). Fruit production can be heavy in open-grown plants but is rare in shaded understory plants. A collection of fruits from Puerto Rico weighed an average of 0.0936 $\pm$ 0.0035 g/fruit. Air-dried seeds separated from them weighed an average of 0.0401 $\pm$ 0.0007 g/seed or 24,900 seeds/kg. Sown in commercial potting mix without any pretreatment, these seeds began germinating in 19 days and completed 99 percent germination in 47 days. Germination is epigenous. A thin, deep taproot is quickly produced. The seedlings are woody, stiff, and easy to lift and transplant. Birds disperse the seeds. Seedlings are relatively common and widespread.

Growth and Management.—Both height and diameter growth of brisselet is slow. Weaver (1990) measured the mean annual diameter growth of 33 brisselet stems 4 to 14 cm in diameter in St. John, U.S. Virgin Islands at 0.5 mm/year. Apparently, plants live for several decades. No management experience has been published.

Benefits.—Brisselet is an important component of dry and moist forests, protects the soil, and furnishes cover for wildlife. Although seasonal, the fruits are a consistent source of food for birds. Bees are attracted to the fragrant flowers (Little and others 1974). The sapwood is light tan while the heartwood is dark brown, hard, and flexible. Because of its small diameters and lengths, the wood is useful for little other than fuel. Brisselet tissues do not contain cocaine, as obtained from its more famous relative *Erythroxylum coca* Lam.

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Eugenia foetida Pers. boxleaf stopper

MYRTACEAE

Synonyms: *Eugenia buxifolia* (Sw.) Willd.
Eugenia myrtoides Poir.
Myrtus axillaries Poiret in Lam.
Myrtus poiretii Sprengl
Eugenia triplinervia O. Berg.
Eugenia lateriflora sensu Griseb.

John K. Francis

General Description.—Boxleaf stopper is also known as Spanish stopper, gurgeon stopper, stopper bush, white watting, anguila, hoja menuda, escobón, pico de paloma, guairaje, bois petites feuilles. It is an upright, evergreen shrub or small tree sometimes reaching 10 m in height and 12.5 cm in diameter at breast height. There is usually a single stem from the ground, but it may branch near the ground. The stems and branches are slender with gray, smooth to lightly fissured or platy bark. The inner bark is pink and slightly bitter. The sapwood is light brown, and the heartwood is dark reddish brown. The wood is hard, heavy, and fine-grained. This deep-rooted species has a tap and lateral root system of slender, flexible to moderately stiff brown roots. The paired, leathery, green to dark green leaves are obovate or oblanciolate 2 to 5 cm long and have a 1.5 to 3 mm petiole and usually have a rounded tip. The foliage, especially when crushed, emits a mild, offensive, skunk-like odor. Small, four-petaled, white flowers are grouped in few-flowered, axillary racemes. Fruits are black globose berries 4 to 7 mm in diameter with one or two small seeds (Howard 1989, Liogier 1994, Little and others 1974).

Range.—Boxleaf stopper is native to Florida, Puerto Rico, the U.S. Virgin Islands, Jamaica, Hispaniola, Cuba, Anguilla, St. Martin, St. Barts, Netherlands Antillies, Yucatan in Mexico, Belize, and Guatemala (Howard 1989, Liogier 1994, Little and others 1974). The species has not been reported to have naturalized outside its native range.

Ecology.—Boxleaf stopper most frequently grows in areas underlain by limestone rock, usually on ridges and hill sides. It grows on clay and courser-textured soils, rocky rubble, and often directly into cracks in fractured rock. The species also occurs on sandy flats behind beaches. In Florida, it grows on hammocks near the coast and on pinelands in the Lower Keys (Nelson 1996). Elevations vary from near sea level to about 100 m. Mean annual rainfall of the native range in Puerto Rico ranges from about 750 and 1700 mm (author's observation, Little and others 1974). The species is drought tolerant (Gilman 1999). Although boxleaf stopper eventually reaches the stature of a small tree on favorable sites, much of its habitat is so difficult that the plant completes its life cycle in sizes (2 to 5 m in height) usually associated with shrubs. The species is moderately intolerant of shade, growing in the understory, as an intermediate or codominant in low-basal area, short-statured, dry forests.

Reproduction.—Flowering of boxleaf stopper in Puerto Rico is reported to occur in spring and summer (Little and others 1974). It flowers in the summer in Florida (Gilman 1999). Fresh fruits collected in Puerto Rico averaged 0.181 $\pm$ 0.032. Air-dried seeds separated from them averaged 14,900 seeds/kg. Placed in moist potting mix, 51 percent germinated beginning 69 days after sowing. The new seedlings grow slowly. In the wild, seeds are dispersed by birds. Seedlings and saplings are widely scattered to relatively common.

Growth and Management.—The growth rate of boxleaf stopper is moderate to slow, depending on habitat. Apparently, it is relatively long lived (a few decades). Potted stock is available from nurseries for planting. Although expensive for wildland plantings, this may be the best way to establish them in order to get them above competing weeds and grass. Ornamental plants may be pruned into hedges or forced to single-stemmed trees (Gilman 1999). Because they are relatively slow growing and not aggressive invaders, control of the species in natural stands should not be necessary.

Benefits.—Boxleaf stopper protects the soil, furnishes cover for wildlife, and contributes to the aesthetics of the forest. Aromatic compounds released from the leaves of this species apparently are responsible for the slight musky smell present in forests in Puerto Rico where it is common. Foliage of the species is not eaten by Key deer (*Odocolleus virginanus clavium*) (Schaus and others 2003) and probably is avoided by other ruminant herbivores. Although small, the fruits are edible to humans, and birds consume them when available. Boxleaf stopper is recommended and used for screens, hedges, parking lot, yard, and street trees in Florida (Gilman 1999).

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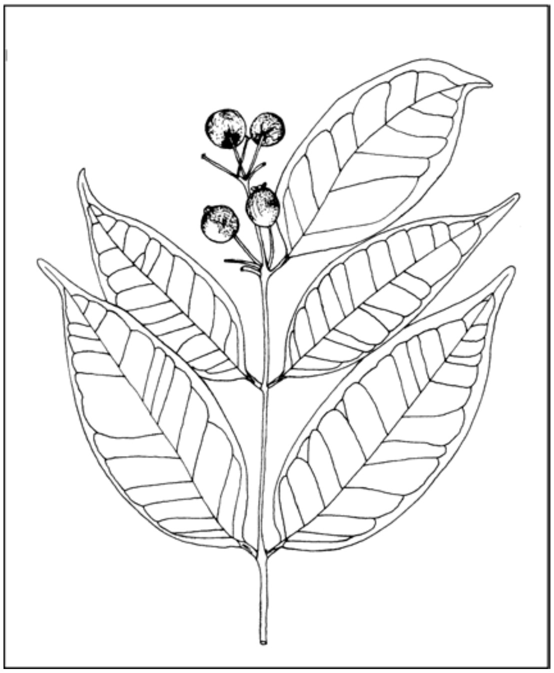
***Eugenia pseudopsidium* Jacq.** wild guava
MYRTACEAE

Synonyms: *Eugenia megalocarpa* Urban
Eugenia portoricensis DC.
Eugenia thomasiana Berg
Myrtus willdenovii Spreng.
Stenocalyx portoricensis Berg

John K. Francis



General Description.—Wild guava, which is also known as bastard guava, Christmas cherry, guayaba silvestre, quiebrahacha, goyavier de montague, bois plié, and goyavier bâtard, is a shrub or a small tree reaching a maximum of 20 m in height and 30 cm in trunk diameter (Howard 1989, Liogier 1994, Little and others 1974). Mature plants are usually 3 to 5 m in height and 4 to 8 cm in stem diameter. Wild guava has a tough, woody root system with tap and lateral roots. The stems are light gray, slightly fissured, and scaly. The wood is light to reddish brown, hard and very heavy (specific gravity = 1.3). Twigs are green, turning to brown (Little and others 1974). The crowns branch to the third order and branches tend to be slender. The opposite leaves have short petioles, are generally elliptic, rounded or short pointed at the base and long pointed at the apex. They are dark green above and light green beneath. Small white flowers arise in the leaf axils, one to three per axil. The globose fruits retain the calyx of the flower. They are orange, turning to bright red, and astringent with little flavor. Each fruit contains one rounded seed.

Range.—The native range of wild guava includes Hispaniola, Puerto Rico, the Virgin Islands, Guadalupe, Dominica, Martinique, and St. Lucia. The same plant or a very similar one also occurs in Venezuela, the Guyanas, and Amapá, Brazil (Howard 1989). That it is wild guava is supported by its listing in the Smithsonian (2001) checklist of plants for Guyana.

Ecology.—Wild guava grows inland a few meters above sea level to elevations of 670 m in Puerto Rico (Little and others 1974). It occurs in areas that receive from about 1400 to 2200 mm of annual precipitation. Medium- to heavy-textured soils derived from sedimentary, igneous, and metamorphic (including ultramafic) rocks are colonized. It does not appear sensitive to topographic position but rarely if ever grows on excessively or very poorly drained soils. Wild guava is shade tolerant and normally is confined to the understories of remnant old growth and advanced secondary forests.

Reproduction.—Wild guava flowers and fruits irregularly throughout the year (Little and others 1974). Understory plants produce fruits in small numbers; plants receiving increased sunlight in gaps or thinned canopies produce several times more fruits. Wild guava fruits collected in Puerto Rico weighed an average of 1.284 $\pm$ 0.043 g. Seeds extracted from these fruits weighed an average of 0.565 $\pm$ 0.010 g (air dry) or 1,800 seeds/kg. Eighty-one percent of the seeds from this collection germinated between 59 and 143 days after sowing in commercial potting mix. When the new seedlings are damaged above ground by fungi or insects, they sprout from the ground level, usually with more than one shoot (author's observation). Birds disperse the seeds. Seedlings and saplings are well-scattered and relatively common. Wild guava sprouts readily after cutting or damage.

Growth and Management.—The growth rate of wild guava appears to be relatively good for an understory shrub. A 2.5-m tall sapling, 2.5 cm d.b.h., under partial shade in Puerto Rico, had five growth rings in its trunk near the ground. Wild guava germinates, survives, and transplants well in the nursery, but growth is somewhat slower than most commercial nursery plants. Unfortunately, no plantation or ornamental use has been reported.

Benefits.—Wild guava is used to a limited extent for firewood and fence posts. With its dark green leaves, bright red fruits, and clean form, the species has a pleasing appearance and probably would make a fine ornamental, especially in shady locations. It provides food and cover for wildlife and contributes to the scenic beauty and biodiversity of the forests where it grows.

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Euonymus alatus **(Thunb.) Sieb.** winged burning bush
CELASTRACEAE

Synonyms: *Celastrus alatus* Thunb.
Celastrus striatus Thunb.
Euonymus arakianus Koidz.
Euonymus sacrosanctus Koidz.
Euonymus striatus (Thunb.) Loes.
Euonymus subtriflorus Blume
Euonymus thunbergianus Blume

Jinshuang Ma and Gerry Moore

Illustration soruce: Ma, J.S. 2001

General Description.—This species is commonly known as winged burning bush or winged spindle tree because of its stems, which have two to four conspicuous brown, corky ridges or wings, 2 to 3.5 mm wide and 1.0 to 1.2 mm thick. It is the only species of *Euonymus* L. in North America to have such prominent wings on its twigs. It is also occasionally called Asian spindle tree because it is native to Asia. Winged burning bush is a low-growing shrub, usually up to 2 m tall, never more than 4 m. The plant does spread well horizontally, sending out stems in many directions. Its buds are axillary (two per axil), ovoid or obovate, scattered along the stem. The leaves are opposite, two per node, and are spaced somewhat evenly along the stem. The leaf petioles are short, round in cross section, glabrous, 2 to 3.5 mm long (rarely shorter than 2 mm., the leaves then appearing subsessile). The leaf blades are glabrous, lanceolate to obovate, 4.5 to 7.3 (rarely to 10) by 1.2 to 2.3 (rarely to 4.5) cm, leathery to papery, with cuneate or attenuate bases, crenate to serrate margins and acuminate to cuspidate apices. The five to seven pairs of ascending lateral veins disappear before reaching the leaf margin. The flowers develop on the current season's growth and are are bisexual (rarely functionally unisexual). They are in small axillary clusters (cymes), the clusters on slender peduncles, 2.0-2.5 cm long, usually with one dichotomous branch and three or fewer flowers. Each flower is on a pedicel 4 to 7 mm long. The flowers are about 9 mm in diameter with the parts in fours, and the sepals and petals readily distinguishable from one another. The petals are yellowish green. The fruits are ovoid, four-lobed capsules, 8 to 14 by 10 to 16 mm. At maturity the capsules are red to brown-purple and they split open along the lobes (often one or more lobe is abortive), exposing the one to four seeds, each enclosed in a fleshy orange aril. The seeds (sans aril) are glabrous, light brown to black, ellipsoid, 6 to 12 by 4.0 to 5.5 mm. Some spell the specific epithet "alata" instead of "alatus" used here. This is because botanists disagree as to whether the genus name *Euonymus* should be treated as feminine ("alata") or masculine ("alatus") (Paclt 1998). In classical Greek, the generic name was treated as feminine; however, Linnaeus treated the genus as masculine. The spelling *"Euonymus"* has formally been conserved over Linnaeus's originally spelling *"Evonymus,"* which has also occasionally been used (Gilstra 1991).

Range.—Winged burning bush is native to east Asia being distributed in far eastern Russia (Far East), Japan, Korea, and China. In its native range, it occurs in areas with annual precipitation of 400 mm or more and in elevations ranging from 40 to 2,700 m (Ma 2001). It was first introduced into the United States about 1860 (Rehder 1940), as an ornamental plant, and it eventually became naturalized in the Eastern United States (Ebinger 1996, Gleason and Cronquist 1991, J. Ma in personal observation). Currently winged burning bush is known from 21 Eastern and Mid-Western States (Connecticut, Illinois, Indiana, Iowa, Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Missouri, North Carolina, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, South Carolina, Virginia, Vermont, West Virginia), as well as Montana (USDA 2003). It can be expected to be found elsewhere with the continued spread of naturalized populations and additional material escaping from cultivation.

Ecology.—It is not as aggressive an invader as the related Oriental bittersweet (*Celastrus orbiculatus* Thunb). It is found in disturbed habitats, such as roadsides, forest margins and woodlands that are in early stages of succession (Ma, personal observation).

Reproduction.—Hymenopterous and dipterous insects, especially bees and flies, appear to be the main pollinators, and the attractive arillate seeds are widely dispersed by birds and small mammals (Brizicky 1964). The flowers bloom in the spring and the fruit mature in the fall. The species can be asexually propagated through stem cuttings and root separation.

Growth and Management.—Winged burning bush grows in a variety of soil conditions. It is not a fast growing plant, reaching perhaps up to 1 m of growth in a single growing season. Propagation can be effected by layering or seed (Chittenden and Synge 1956). However, there is concern about the continued use of this plant in ornamental plantings, since it can be invasive in some areas (Martin 2002)

Benefit.—The foliage of winged burning bush turns bright scarlet in autumn, giving the plant its common name burning bush. The purplish capsules and seeds with orange arils add to the "burning" effect of the plant late in the year. This effect of the plant has made it a popular ornamental and horticultural species. Some specimens can be shaped into bonsai (Smith 2003).

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USDA, NRCS. 2003. The PLANTS Database. Baton Rouge, LA. http:plants.usda.gov. [not paged].

***Euonymus americanus* L.** strawberry bush

CELASTRACEAE

Synonyms: *Euonymus alternifolius* Moench.
Euonymus americanus var. *augustifolius* (Pursh) Wood
Euonymus americanus var. *sarmentosus* Nutt.
Euonymus augustifolius Pursh
Euonymus heterophylus Raf.
Euonymus muricatus Raf.
Euonymus sarmentosus G. Don
Euonymus sempervirens Marsh.

Jinshuang Ma and Gerry Moore

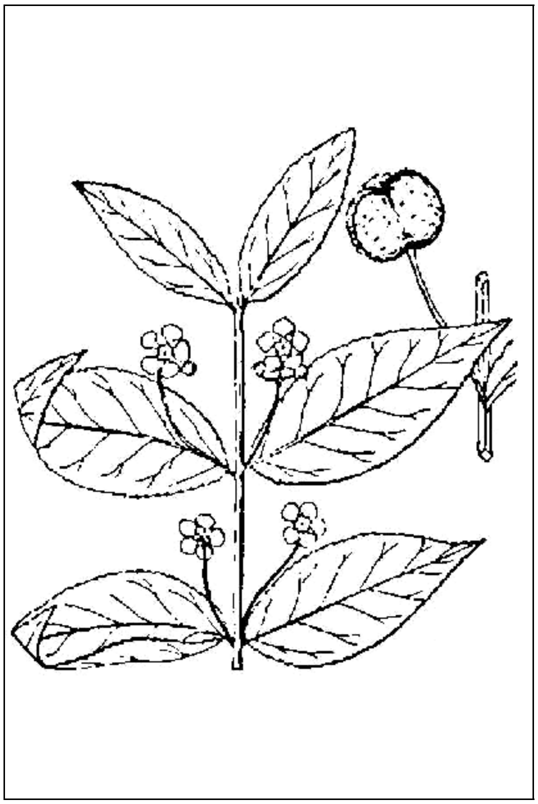

Illustration source: Britton and Brown 1913

General Description.—Strawberry bush is also known as bursting heart, hearts–a-bursting, or American burning bush. It is a low-growing, deciduous shrub, up to 2 m high. Its stems are stiff, green, glabrous, straight, round, 2 to 5 mm in diameter, and are occasionally four-angled. The pith is white, round, and continuous. The leaves of the strawberry bush are opposite (two per node), spaced somewhat evenly along stem. The petioles are short, less than 3 mm and sometimes are nearly absent, the leaves then appearing sessile or subsessile. The leaf blades are slightly leathery to papery, oblong to elliptic, 4.0 to 10 by 2.0 to 3.5 cm wide, with cuneate or attenuate bases, crenulate margins, and acuminate apices. The five to seven pairs of ascending lateral leaf veins disappear before reaching the margin. The flowers occur on the current season's growth in small axillary clusters (cymes), each cluster usually consisting of two peduncles, each with one to three flowers (often one or two of the flowers will aborte, leaving only one functional flower per peduncle). The peduncles are slender, 1.5 to 2.2 cm long. When there is more than one flower per peduncle each flower is subtended by a short pedicel, 1 to 3.5 mm long. The flowers are bisexual, about 10 mm in diameter, with the sepals and petals readily distinguishable from one another. The calyx comprises five yellow to green sepals, 1.0 to 1.5 by 1.6 to 1.8 mm. The corolla comprises of five greenish to reddish petals up to 4 mm by 4 mm wide. There are five stamens, 1.5 to 2.0 mm long. The five carpels are fused. A sticky nectarous disk is present, 3 to 4 mm in diameter. The color and shape of the fruit gives it its common names. The fruit is a plump, red globose dry, five-lobed capsule up to 1.5 cm in diameter prior to opening. The surface of the capsule is densely covered with minute spines or warts on the surface. This species is the only species of *Euonymus* L. in North America to have a capsule with a spiny or warty surface. The capsule opens along the lobes, exposing the seeds that are covered by a fleshy, scarlet aril. The seeds (sans aril) are brown, glabrous, ellipsoid, 7 to 9 by 4.0 to 5.5 mm. Some spell the specific epithet "americana" instead of "americanus" used here. This is because botanists disagree as to whether the genus name *Euonymus* should be treated as feminine ("americana") or masculine ("americanus") (Paclt 1998). In classical Greek, the generic name was treated as feminine; however, Linnaeus treated the genus as masculine. The spelling *"Euonymus"* has formally been conserved over Linnaeus's originally spelling *"Evonymus,"* which has also occasionally been used (Gilstra 1991)

Range.—Strawberry bush occurs throughout much of the Eastern United States (Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maryland, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, Virginia and West Virginia), except New England. (Shetler and Orli 2000, USDA 2003) It is also known from Ontario (Gleason and Cronquist 1991, Ma 2001, Scoggan 1978).

Ecology.—Strawberry bush grows well in many soils types, up to 1 m in a growing season. It is usually found in forests and thickets, including lowland areas and edges of streams. It occurs from sea level up to 400 m in elevation (Ma 2001).

Reproduction.—Hymenopterous insects, especially bees, appear to be the main pollinators, although wind may also be involved (Brizicky 1964). The seeds of strawberry bush are dispersed by birds and other small mammals (Brizicky 1964). Strawberry bush blooms in late spring and early summer, and the fruits mature in autumn.

Growth and Management.—Strawberry bush prefers a humus-rich, slightly acidic soil. It does well in shady situations, tolerating even full shade. It can be planted in USDA Zones 5 to 9. Propagation can be effected through stem cuttings, layering and seed (Chittenden and Synge 1956) Seeds require approximately 3 months of prechilling and stratification.

Benefits.—Strawberry bush is an excellent ornamental species. The leaves turn a dark red in autumn. The red capsules and scarlet arillate seeds add to the "burning effect" and contributes to some of its common names. Strawberry bush is best used in naturalistic settings, in the shade of larger shrubs and trees. Large specimens can have hundreds of the "bursting" red capsules. In the winter, the bright green twigs are also handsome.

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USDA, NRCS. 2003. The PLANTS Database. Baton Rouge, LA. http:plants.usda.gov. [not paged].

***Euonymus atropurpureus* Jacq.** eastern wahoo
CELASTRACEAE

Synonyms: *Euonymus carolinensis* Marsh.
Euonymus latifolius Marsh.

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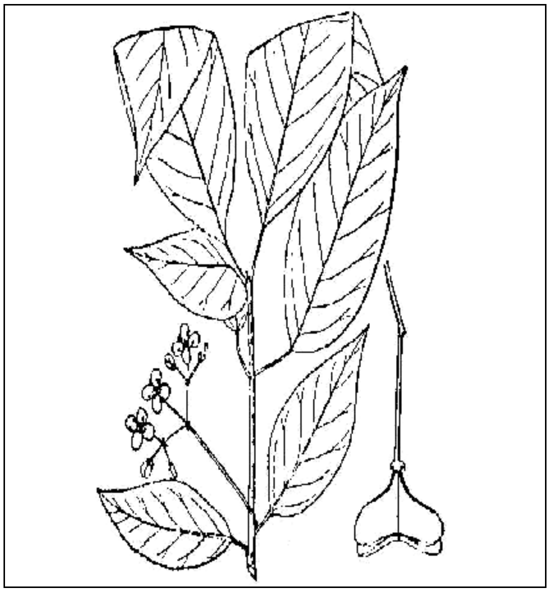

Illustration source: Britton and Brown 1913

General Description.—Eastern wahoo, also known as burning bush, is a shrub or small tree, up to 8 m high, with the main stem up to 10 cm in diameter at breast height. The stems are round, smooth, and green. The pith is white, round, continuous, and somewhat spongy. Its leaves are opposite (two per node) and spaced somewhat evenly along stem. The petioles can be up to 14 mm long. The leaf blades are elliptic to oblong elliptic, 8.5 to 11.3 by 3.2.to 5.5 cm papery, with cuneate to attenuate bases, crenulate margins, and acuminate apices. The blades have nine to 10 pairs of ascending lateral veins that disappear before reaching the margin. The flowers are formed on the current season's growth in small axillary clusters (cymes). Each peduncle is 2 to 3 cm long and can have several flowers, each one on a pedicel 5 to 7 mm long. The flowers are bisexual, 10 to 12 mm in diameter, with four greenish sepals and four brown-purple petals. There are four stamens, each 1.5 to 2.0 mm long. The four carpels are fused and a nectarous disk is present. The fruit of the eastern wahoo is a smooth reddish to pink four-lobed (sometimes one or more of the lobes aborte) obrhombic capsule, up to 1.7 cm in diameter. The capsule opens along the lobes, exposing the seeds that are covered by a bright red fleshy aril. The seeds (sans aril) are orange, glabrous, ellipsoid, 7.0 to 11.0 by 4.0 to 5.5 mm, glabrous. Some botanists spell the specific epithet "atropurpurea" instead of "atropurpureus" used here. This is because they disagree as to whether the genus name Euonymus L. should be treated as feminine ("atropurpurea") or masculine ("atropurpureus") (Paclt 1998). In classical Greek, the generic name was treated as feminine; however, Linnaeus treated the genus as masculine. The spelling "Euonymus" has formally been conserved over Linnaeus's originally spelling "Evonymus," which has also occasionally been used (Gilstra 1991).

Range.—Eastern wahoo is widely distributed throughout the Eastern United States (no records are known for Vermont) westward to the states of Kansas, Montana, North Dakota, Oklahoma, South Dakota, and Texas (Ma 2001, Shetler and Orli 2000, USDA 2003). It also is known from Ontario (Gleason and Cronquist 1991, Scoggan 1978).

Ecology.—Eastern wahoo can be found in thickets, forests, often in lowlands or near creek bottoms, riversides and along the margins of marshes. It can also be found along mountain slopes. It usually occurs in elevations from sea level to 360 m.

Reproduction.—Hymenopterous insects, especially bees, seem to be the main pollinators, although wind may also be involved (Brizicky 1964). The fruits are dispersed by birds and small mammals (Brizicky 1964). Eastern wahoo blooms in late spring and early summer and the fruits ripen in autumn. The plant reproduces asexually through rhizomes, which allows it to form large colonies.

Growth and Management.—Eastern wahoo refers well-drained loamy soils. It is a moderately fast growing but short-lived shrub or tree. It can be planted in Hardiness Zones 3 to 7. Seed requires 8 to 16 weeks cold stratification prior to sowing. The plant can also be propagated with cuttings.

Benefits.—The common name "burning bush" comes from the plant's bright red fall foliage. The red fruit and arillate seeds add to the "burning" effect. This makes the eastern wahoo an excellent shrub for horticultural use (Rehder 1940). The seeds and the vegetative organs of eastern wahoo are said to be poisonous (Brizicky 1964).

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USDA, NRCS. 2003. The PLANTS Database. Baton Rouge, LA. http:plants.usda.gov. [not paged].

Fallugia paradoxa (D. Don) Endl. ex Torr. Apache-plume
ROSACEAE

Synonyms: *Sieversia paradoxa* D. Don.
Geum cercocarpoides DC. ex Ser.

Juanita A. R. Ladyman

Drawing source: USDA-Forest Service collection, Hunt Institute

General Description.—*Fallugia paradoxa,* commonly called “Apache-plume,” is an evergreen shrub that grows up to 2.5 m tall (Stubbendieck and others 1993, Cronquist and others 1997). It is often referred to as “semi-evergreen.” In the north part of its range, seedlings are deciduous (Meyer 1974). However, the term “semi-evergreen” may be applied because the leaves take on a bronze color during some times of the year. The leaves are alternate, somewhat fascicled, 0.8 to 1.5 cm long and have three to seven deep, narrow lobes. The bark on young twigs is white, or light-colored, and hairy (villous). The bark becomes darker, hairless (glabrous), and shreddy, exfoliating in flakes, as it gets older. The showy, flowers have five white petals. There are numerous fruits (achenes) in each head. Each achene is tipped by a 2.5 to 5 cm long feathery, densely hairy, tail-like style that makes the plants appear as if they have pom-poms on the end of each stalk during the fruiting period. The length of the flowering period varies depending upon geographic location and elevation. It flowers in June through August in all parts of its range but flowering is extended from May to December in Texas (Powell 1998) and from April to October in Arizona and New Mexico (Epple 1995, Martin and Hutchins 1980). The common name for *Fallugia paradoxa,* Apache-plume, was coined because the feathery seed clusters look like Indian feather headdresses (Elmore 1976). Other common names include poñil, fallugie (Dayton 1931), feather rose, and feather duster bush (Epple 1995). *Fallugia* is a monotypic genus, that is, a genus of a single species (Cronquist and others 1997). In addition, Apache-plume shows minimal genetic variation throughout its wide range (Jones and Johnson, 1998). Hybrids between Apache-plume and cliffrose (*Purshia mexicana* (D. Don) Henrickson) have been reported (Blauer and others 1975, McArthur and others 1977).

Range.—Apache-plume occurs in western Texas, Oklahoma, New Mexico, Arizona, southern Colorado, south and central Utah, Nevada, and southern California in the U.S.A. (USDA PLANTS database 2002, Baldwin and others 2002, McGregor and other 1986, Vines 1986). In Mexico it occurs in Coahuila, Chihuahua, and Durango (Powell 1998).

Ecology.—Apache-plume generally grows at elevations between 915 and 2,430 m, but in northern New Mexico it has been found as high as 2,700 m (Dick-Peddie 1993). It grows on mesas and rocky hillsides in montane shrubland, grassland, pinyon-juniper woodland, and yellow pine in a variety of alluvial and gravel soils (Tidestrom and Kittell 1941, Dick-Peddie 1993, Powell 1998, Baldwin and others 2002). It is especially abundant along dry margins of water-courses and arroyos (author personal observation, Powell 1998). Dick-Peddie (1993) described it as a “semi-riparian” species because it tends to colonize microhabitats, such as run-off catchments and seep areas, which contain more available moisture than the surrounding area. Apache-plume is relatively drought tolerant and requires 20 to 50 cm of annual precipitation (Hayward 1990). It is tolerant of weakly saline and neutral to moderately basic soils (McWilliams 2000). Endomycorrhizae were associated with Apache-plume in New Mexico (Williams and Aldon 1976).

Reproduction.—Apache-plume reproduces sexually by seed and vegetatively by sprouts (suckers) from the roots. The feather-tailed seeds are probably primarily wind dispersed. Apache-plume seeds apparently have no dormant period (Baskin and Baskin 2001). They are small and average approximately 925,932 per kg (Vines 1986).

Growth and Management.—Seed can be sown by broadcasting it on a prepared bed and covered by approximately 5 mm of fine loam or sand. Germination rate is from 19 to 65 percent (Vines 1986). In pots, the germination rate is 30 to 40 percent, but seedlings are reported to damp off easily and require adequate air circulation (Hayward 1990). A 4-litre plant is fully established and ready for sale in 18 months for the landscape market (Hayward 1990). Plants can also be grown fairly easily from root cuttings. It is closely grazed on overstocked range and, although tolerant of grazing with "excellent recuperative powers," it is also reported to decrease under grazing pressure (Dayton 1931, McGregor and others 1986). Availability of adequate moisture may be an important factor in the degree of recovery. Apache-plume sprouts after fire (Shaw and Monson 1983, McWilliams 2000). In a pinyon juniper community it was reported to tolerate fire well (Aro 1971).

Benefits.—Apache-plume is valuable for erosion control (Dayton 1931, Stubbendieck and others 1993, Vines 1986). Its long roots provide effective soil stabilization especially in arid situations (McWilliams 2000). Apache-plume is important winter range for livestock (Dayton 1931, McGregor and others 1986, Stubbendieck and others 1993, USDAFS 1988). It is reported to have only a fair palatability for sheep, goats and cattle but closely cropped, stunted plants have been cited as evidence of high palatability (Dayton 1931, McGregor and others 1986, Stubbendieck and others 1993, Warnock 1974). It also furnishes important browse for some species of wildlife (Dayton 1931, Stubbendieck and others 1993) and makes up 1 percent to 5 percent of desert mule deer diet (Krausman and others 1997). Time of year, environmental conditions, and availability of alternate browse appears to influence palatability and use. It provides cover for a variety of small mammals and birds (Haywood 1990, McWilliams 2000). It was used for arrow shafts and brooms by many Native American peoples (Dunmire and Tierney 1995, Moerman 1998). Apache-plume brooms are specifically kept inside some Sandia Pueblo houses because there is a belief that the brooms exert a positive spiritual effect on the household (Dunmire and Tierney 1995). The long roots were used as cord to tie fencing and make ramadas (Dunmire and Tierney 1995, Moerman 1998). An infusion of leaves was used as a shampoo and hair growth stimulant by some Native American tribes, and petals are reported to prevent stomach gas (Dunmire and Tierney 1995, Moerman 1998). One tribe used it in witchcraft to cause "insanity" (Moerman 1998). Shrubs are attractive as ornamentals and are popularly used for landscaping (Hayward 1990, Phillips 1987, Morrow 1995).

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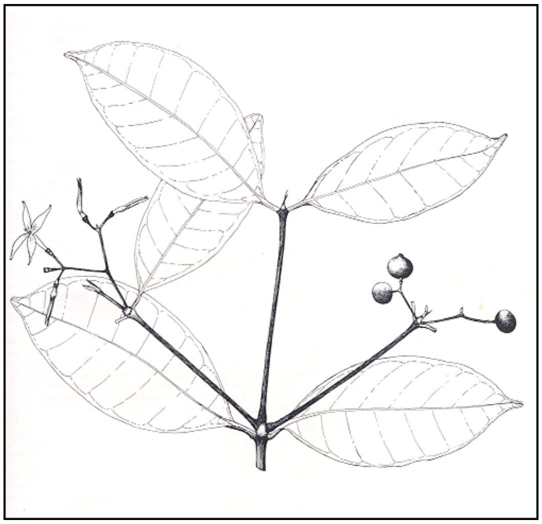
Faramea occidentalis (L.) A. Rich. cafeíllo

RUBIACEAE

Synonyms: *Coffea occidentalis* Jacq.
Faramea odoratissima DC.
Pavetta coffeoides Ham.
Tetramerium odoratissimum (Gaertn. f.) DC.
Ixora occidentalis L.

John K. Francis



General Description.—Cafeíllo, also known as false coffee, café cimarrón, palo de toro, hueso, jasmín de estrella, and bois flèche, is a tall shrub in the Caribbean islands and a small understory tree in continental tropical America. It has dark-green, opposite lanciolate leaves and straight, usually single, gray or dark-brown stems. The twigs are slender and green with rings at the nodes (Little and Wadsworth 1964). The stems are straight and often without branches for a meter or more.

Range.—The native range extends from Cuba through Trinidad and from central Mexico through Central America to Ecuador, Peru, Brazil, and the Guyanas (Little and Wadsworth 1964). The species is not known to have naturalized elsewhere.

Ecology.—Cafeíllo is tolerant and grows and reproduces in the understories and mid-stories of secondary forests. The species is most common in mid- to late-secondary forests. Cafeíllo is found in two of the Life Zones in Puerto Rico: moist subtropical forest and much of the wet subtropical forest from about 900 to 2800 mm of precipitation (Holdridge 1967). Alluvial soils and residual soils derived from sedimentary and volcanic rocks are suitable habitat. Excessively drained and very poorly drained soils are usually not colonized. Although not forming pure or dense stands, cafeíllo is common, at least in Puerto Rico and Panama.

Reproduction.—Small, white, fragrant flowers have a short tube tipped by four pointed lobes. Cafeíllo flowers generally occur in threes. The fruits are blue-black or dark-purple drupes borne singly or in pairs from the leaf axils near the twig ends. The fruits measure 8 to 10 mm in diameter (Howard 1989). Each fruit contains a single seed. A Puerto Rican collection averaged 0.825 $\pm$ 0.123 g/fruit. The seeds from the same collection numbered 3,980 seeds/kg. Ninety-six percent germinated beginning 57 days after sowing (Francis and Rodríguez 1993). In Central America, the seeds are disbursed by birds and monkeys. Rodents and a number of other animal species eat and destroy the seeds after fruit-fall (Schupp 1990). A rust, *Aecidium farameae* Arthur, which attacks the ovaries and pedicels of the flowers, results, in some years, in the destruction of 32 to 83 percent of the fruits of individual plants (Travers 1998). A high recruitment of seedlings (compared to other species) results in high population densities in the forest understorey in Panama (Schupp 1990).

Growth and Management.—Cafeíllo occasionally exceeds 20 m in height and 20 cm in diameter at breast height in Panama (O'Brien and others 1995). However, in Puerto Rico, mature shrubs usually reach 4 m in height and sometimes attain as much as 10 m in height (Liogier 1997). Total above-ground, ovendried weight of cafeíllo plants in Puerto Rico that ranged between 1.37 m in height (with diameter greater than 0) and 5 cm in d.b.h. may be predicted by the model:

$TDW = 30.045D^2L$ (adjusted R-squared = 0.962), where TDW is total dry weight in grams, D is diameter in cm at 30 cm above the ground, and L is stem length in meters. Lower stem density of Puerto Rican shrubs averaged 0.62 $\pm$ 0.04 g/cm^3 (Francis 2000). Stem density of saplings from Panama was 0.57 g/cm^3 (King 1990). Allometric relationships for cafeíllo in Panama may be found in O'Brien and others (1995) and King (1990). As an understory tree, cafeíllo is slow-growing and long lived. Based on recent growth rates, the largest individuals in a Panamanian stand were estimated to exceed 200 years in age.

There is no record of plantations or planted ornamental cafeíllo. The species is able to reproduce by sprouting after injury. Thirty-six percent of the individuals in a Panamanian stand were of sprout origin (Putz and Brokaw 1989).

Benefits.—Cafeíllo wood is heavy, hard, and tough. However, uses are mainly limited to fence posts, vegetable stakes, tool handles, and fuelwood. In herbal medicine, cafeíllo is reportedly used as an antiseptic, astringent, and for diarrhea and anemia (Liogier 1990). Birds consume the fruits. The use of cafeíllo as an ornamental or in forest restoration efforts has not been reported. Cafeíllo is a fine looking plant and could probably be used as a back-ground plant or screen under shade in yards, estates, and parks.

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***Forestiera acuminata* (Michx.) Poir.** swamp privet
OLEACEAE

Synonyms: *Adelia acuminata* Michx.
Borya acuminata (Michx.) Willd.

Kristina Connor

Drawing credit: USDA—Forest Service collection, Hunt Institute

General Description.—Swamp privet, also called eastern swamp privet, is a deciduous shrub or small, open-crowned tree, occasionally reaching 10 m in height but more often averaging 1.5 to 2.5 m (Krüssmann 1986, Johnson and Hoagland 1999). It is commonly multitrunked (Mackay and Finical 1999, U.S. Army Corps of Engineers 1997). The bark ranges from gray to dark brown in color and is either smooth or ridged (Johnson and Hoagland 1999, USGS 2002). Twigs are light brown, glabrous, and have conspicuous lenticels (Johnson and Hoagland 1999). Leaves are simple, opposite, and dull, yellowish green. They range in size from 3 to 11 cm in length, and 2.5 to 5 cm in width. Leaves have long, pointed tips (acuminate) and petioles that are slender and slightly winged at the base. While leaf margins are usually smooth, it is not uncommon for the apex half to be finely serrated.

Range.—Swamp privet is found in the wet woodlands and swamps of the Southeastern United States, from South Carolina south to Florida and westward into Texas, Oklahoma, and Kansas. It ranges as far north as Illinois, Indiana, and Missouri (Krüssmann 1986, USGS 2002).

Ecology.—Swamp privet grows primarily in wet areas, in swamps and bottomland forests, along streams, in wet woods and sloughs, and around ponds and lakes (Johnson and Hoagland 1999, USGS 2002). It will grow in either full or partial sun and is highly adaptable to various soils (MacKay and Finical 1999). The species reportedly thrives in a variety of soil types, sand, loam or clay, and at pH's ranging from acidic to basic. Swamp privet does, however, require that the soils be moist (Plants for a Future 2001). It frequently produces new stems from the base of senescing individuals, especially when soils are flooded (Mackay and Finical 1999, U.S. Army Corps of Engineers 1997).

Reproduction.—Swamp privet plants are monoecious; flowers emerge in the spring before the leaves unfold. They are yellow, fragrant and small, the males sessile or almost so, female flowers in small panicles or fascicles (Bailey and Bailey 1976, Botanical Institute 2002, Johnson and Hoagland 1999, Krüssmann 1986). They have no petals and minute or absent sepals. Male flowers have one to four stamens, female flowers have simple or two-lobed stigmas (Johnson and Hoagland 1999, Botanical Institute 2002, USGS 2002). Fruits are dark purple or black oblong drupes, 8 to 12 mm long with one, rarely two, seeds. They appear in summer and are promptly shed (Johnson and Hoagland 1999). Although no data are provided to support this, the Plants for a Future website (2001) suggests that seeds be sown as soon as they ripen and that cuttings can be taken of half-ripe wood in summer or mature wood in winter.

Growth and Management.—Swamp privet, while adaptable to many soil types, must be located in moist areas. It is moderately tolerant of heat and can tolerate full or partial sunlight (Mackay and Finical 1999). It has been reported in cultivation (Krüssmann 1986).

Benefits.—The fruits of swamp privet are considered good food for wildlife (Johnson and

Hoagland 1999). A decoction of the roots and bark has been used as a health beverage, and the wood has been used for turning (Bailey and Bailey 1976), although reports on its durability vary (Plants for a Future 2001).

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***Forestiera segregata* (Jacq.) Krug & Urban** Florida privet
OLEACEAE

Synonyms: *Myrica segregata* Jacq.
Adelia porulosa Michx.
Forestiera porulosa (Michx.) Poir.
Adelia segregata (Jacq.) O. Kuntze
Adelia pinetorum Small
Forestiera cassinoides Poir.

John K. Francis

General Description.—Florida privet, also known as Florida swamp privet, wild olive, and ink-bush, is a semideciduous shrub or small tree to 7 m in height. The plant is supported by a weak taproot and more robust, tan-colored lateral roots. The branches are slender. The opposite leaves have short petioles, 1 to 6 mm long, and narrowly elliptic to obovate blades, 1 to 7 cm long, with entire margins. Tiny, greenish-yellow flowers are borne in clusters at the leaf axils. The fruits are slightly curved, ovoid, black drupes, 6 to 10 mm long, that have a bitter, unpleasant flavor and stain cloth and skin. Each contains one greenish-yellow seed (Howard 1989, Liogier 1995, Long and Lakela 1976, Nelson 1996).

Range.—Florida privet is native to Florida, Georgia, South Carolina, the Bahamas, the Greater Antilles, the Cayman Islands and Anguilla, Barbuda, Antigua, La Désirade, and Marie Galante in the Lesser Antilles (Howard 1989, Liogier 1995, National Trust for the Cayman Islands 2002, Natural Resources Conservation Service 2002). Long and Lakela (1976) identify two varieties: var. *segregata* with glabrous stems and leaf blades more than 3 cm long in Florida and Georgia, and var. *pinatorum,* which has puberulent stems and leaf blades 1 to 3 cm long in South Florida.

Ecology.—Florida privet grows best in partial shade (Horticopia 2002). It is tolerant of drought, salt, and alkaline soils (University of Florida Cooperative Extension Service 2002). Florida privet competes well with shrubs and herbs and grows in hammocks and pinelands in Florida (Long and Lakela 1976). In Puerto Rico and other Caribbean Islands, it is most frequently seen in dry forests in limestone areas near the coast. The species is rare in the United States and has become a candidate for Federal listing (Everglades Mitigation Bank 2002).

Reproduction.—In Florida, Florida privet flowers in the spring (Nelson 1996). It is insect pollinated. A collection of fruits from Puerto Rico weighed an average of 0.1209 $\pm$ 0.0035 g/fruit. Air-dried seeds cleaned from them weighed an average of 0.0359 $\pm$ 0.0006 g/seed or 27,900 seeds/kg. Sown in moist potting mix, they began germinating in 7 days and completed 89 percent germination in 49 days (author's observation). The seeds are dispersed by birds that eat the fruits. Seedlings do not occur in large numbers.

Growth and Management.—Florida privet grows slowly in the early seedling stage but later accelerates so that seedlings are ready to transplant at the end of 1 year. Nursery production is normally from seed. Wildlings of all sizes can be successfully transplanted (Workman 1980). Beyond the seedling stage, it has a moderate growth rate (University of Florida Cooperative Extension Service 2002). The largest Florida privet recorded measures 20.2 cm diameter at breast height and 5.5 m in height (American Forests 2002).

Benefits.—Florida privet is recommended for xeriscape (unwatered) landscaping (South Florida Water Management District 2001) and is available through a number of commercial nurseries. It is useful for hedges and foundation and specimen plantings. Warblers, bluebirds, mockingbirds, and vireos feed upon the fruits in South Florida (Broschat and Verkade 2002, Cowley 2002). Honeybees, butterflies, and other insects are attracted to the flowers for the nectar (Workman 1980).

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***Fouquieria splendens* Engelm.** ocotillo

FOUQUIERIACEAE

Synonyms: none

Juanita A.R. Ladyman

Illustration credit: Tonia Masaood

General Description.—The common name for *Fouquieria splendens* is Ocotillo. This is a relative of the renowned boojum tree (*Fouquieria columnaris*) of Baja California. Ocotillo is an erect shrub with several spiny ascending stems that grow up to 3 m tall. A mature individual may have as many as 75 stems (Epple 1995). The leaves are oblanceolate to oblong-obovate and only 10 to 25 mm long. The bright scarlet flowers are showy, and an individual may flower several times during the year. The flowers are arranged in an 8 to 25-cm -long panicle. Each flower has a tubular corolla, five petals, and 10 to 15 exerted stamens. The seed capsule is ovoid and incompletely three-celled. The flat seeds are white with a fringe of hair-like filaments. Flowering is from March to June depending upon latitude (Martin and Hutchins 1980).

Range.—Ocotillo occurs in Arizona, southern California, New Mexico, Nevada, and Texas in the USA. In Mexico it occurs in Sonora, Coahuila, Chihuahua, Durango, Zacatecas, San Luis Potosí, Hildalgo, and Baja California (Mason and Mason 1987).

Ecology.—Ocotillo grows in shallow soils on mesas, outwash plains, and rocky slopes from sea level to as high as 2,050 m elevation in the Guadalupe and Del Norte mountains of the Trans-Pecos region of Texas. Soils are generally rocky, shallow, well-drained, and of limestone or granitic origin and are often underlain by caliche (Mathews 1994). Although not restricted to calcareous soils, ocotillo tends to be characteristic of a calcareous community (Schmutz and others 1992). It has a relatively shallow root system (Burgess 1995). It is often found on southern facing slopes. In Mexico it also occurs in both the Sonoran and Chihuahuan deserts. Communities in which it commonly occurs are mesquite-grasslands (Mason and Mason 1987), high desert bunch-grass (Schmutz and others 1992), desert scrub (Van Devender 1995) and mesquital (mesquite), motorral desértico microfilo (fine-leaf desert shrubland), and pastizal (grassland) defined by Flores-Mata and others (1971).

Reproduction.—Ocotillo may self-pollinate to a limited extent, but flowers are generally cross-pollinated by hummingbirds and bees. In southern Arizona flowering coincides with the northward migration of hummingbirds (Mathews 1994). Seed set per flower is greater for plants flowering during migration than for plants flowering after hummingbirds have migrated (Rathcke and Lacey 1985, Waser 1979). The winged seeds of ocotillo are probably wind dispersed.

Growth and Management.—Ocotillo is a long-lived stable element of desert vegetation but with apparently specialized requirements for seed germination that limit its capacity to exploit opportunities for population expansion (Zedler 1981). There seems to be no significant change in the distribution and abundance of this species within the recent past. Evidence suggests that ocotillo habitat has increased as grasslands have declined (Van Devender 1995). However, considering the amount of urban development within octotillo habitat, the actual area occupied by the species may not have changed significantly. It may be significant to overall species sustainability that seedlings are rarely found on disturbed soils (Yeaton and others 1977) but are found under the canopy of mature plants (McAuliffe 1988, Young and Young 1986). It is a slow-growing species, and estimates of its life span range from less than 60 to greater than 72 years (Mathews 1994). It is likely that life span is related to latitude and substrate. The leaves are winter- and drought-deciduous (Schmutz and others 1992). The leaves appear after rains and are a reliable indicator of recent rainfall (Powell 1998). They tend to mature and fall within a few weeks indicating that available photosynthate is limited and that growth is dependent upon precipitation. Ocotillo is a “water storer” in that the stems store relatively large amounts of water that buffer against drought stress (Burgess 1995). Wildfires may be detrimental to ocotillo populations. It rarely sprouts from the root crown following damage from fire, and its sprouting ability is probably dependent on fire severity (Ahlstrand 1982, McPherson 1995, White 1969). Mortality rates of 40 percent to 50 percent were reported after light to moderate fire in Arizona (Thomas 1991). Seedlings are not known to establish in recently burned areas (Mathews 1994), and its seeds are unlikely to survive for long in the soil (Zedler 1981). In fact, burning has been suggested as a control method for woody species, such as *Fouquieria splendens*, in desert grasslands (Mathews 1994).

Benefits.—The endangered Lucifer humming-bird's habitat in New Mexico centers on slopes and adjacent canyons in arid montane areas dominated by ocotillo and agave species (New Mexico Department of Game and Fish 1991). Ocotillo has no recorded forage value, presumably because its leaves are so short-lived (Dayton 1931). Ocotillo plants are popularly used for landscaping. Plants sold in reputable nurseries are obtained from private land under permit. There are typically two “types” of product. Smaller plants are sold in 1 gallon pots or larger specimens are sold “balled and burlapped.” Although the plants transplant well if there are sufficient roots attached, many that are dug are not treated well and two thirds or more of those dug up are likely not to survive. Propagation has been reported using cuttings although conversations with horticulturalists indicate that this may be less easy than the literature indicates. The plant can also be grown from seed but is a relatively slow grower. Seeds apparently collected from Mexico can be purchased in the United States (Tradewinds Import-Export Company 2002). This trade between regions where the plant is native does raise the potential for genetic modification, or “dilution,” of locally adapted genotypes by cultivated genotypes originally adapted to another region. This may pose a threat although, because of the slow growth and low turnover of individuals, the effects would be a long time in becoming apparent. For example, the cultivated genotypes may have particularly high fecundity and may be physiologically robust but do not have the genetic composition to be resistant to environmental or biological (e.g. disease or insect infestation) events that are periodic (perhaps decades apart) in the local area. Hedges or fences of living stems are common, especially in Mexico. It does not appear to be grown for its medicinal value. Historically the Mahuna Native Americans used it as a “blood medicine” (Moerman 1998). The Apache Indians used powdered roots to treat wounds and painful swellings and they also bathed in an ocotillo root mixture to relieve fatigue (Krochmal and others 1954, Powell 1998, Vines 1960). A beverage made from ocotillo flowers was used for cough medicine (Vines 1960). The Cahuilla, Papago and Yavapai tribes used the flowers in beverages, the fruits for a “candy,” and the stalks as building material (Moerman 1998). The thorns were used for ear piercing by the Papago. The resin and wax from ocotillo bark was used for conditioning leather (Krochmal and others 1954, Powell 1988, Vines 1960). It seems that all uses are localized, personal, or historic in the Southwestern United States. It is not known if ocotillo is more widely used today in Mexico.

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***Furcraea foetida* (L.) Haw.** Mauritius hemp
AGAVACEAE

Synonyms: *Furcraea gigantea* Vent.
Agave gigantea D. Dietr.

John K. Francis

General Description.—Mauritius hemp, also known as green aloe, female karata, maguey, mayuey criollo, cocuisa, giant cabuya, and aloes vert, is a robust shrub with a basal rosette about 2.5 to 3.5 m in diameter and flowering stalks 5 to 10 m in height. The plant can be called a shrub because it is perennial, because it is shrub size, and because it has a fibrous-woody sheath surrounding the core of the short stem (20 to 30 cm long) within the rosette, and a woody flowering stalk. Mauritius hemp has no taproot, relatively fine lateral roots, and many fine roots. Its green to yellow-green leaves are linear-lanceolate to oblanceolate, pointed at the tip, and are fleshy with thread-like parallel fibers. They are up to 25 cm wide, have marginal spines but lack a terminal spine. The inflorescences (panicles) are terminal and contain many pendulous, fragrant, white, greenish-white, yellowish-green, or pale blue-green, 2.5 to 3.3 long by 1.0 by 1.8 cm wide flowers. Flowers open a few at a time for several weeks. Seed development has not been observed by the author in Puerto Rico and is apparently rare elsewhere. Bulbils 1 to 16 cm long develop abundantly on the peduncles after flower dehiscence. There are 2n = 60 chromosomes (author's observation, Bailey 1941, Howard 1979, Pacific Island Ecosystems at Risk 2003, Schlegel 2003).

Range.—Mauritius hemp is native to the Greater Antilles, and from Guadaloupe south through northern South America to Brazil (Grisebach 1963, Howard 1979). The species has been widely planted. It has naturalized in Florida, Hawaii, Marquesas Islands, French Polynesia, Tonga, and is present and probably naturalized in many other places (Pacific Island Ecosystems at Risk 2003).

Taxonomy.—Mauritius hemp in Puerto Rico was known previously as *Furcraea tuberose* (Miller) Ait. f. (Liogier and Martorell 2000). The current assignment of the species to *F. foetida* is based on the statement by Howard (1979) that *F. foetida* occurred throughout the Antilles and that *F. tuberosea* is endemic to the Lesser Antilles, specifically from St. Barts southward. Characteristics given to separate the two species are unreliable by Howard's own admission. Mature plants examined by the author had maximum leaf widths of 18 to 20 cm, leaf lengths of 1.5 to 2 m, oblanceolate leaves, weak fetid smell of leaf juices, and bulbiferous reproduction. Reliable identification of the Puerto Rican and Caribbean *Furcrea* species will have to wait for further study.

Ecology.—In Puerto Rico, Mauritius hemp grows in moist areas that receive from about 1200 to 2500 mm of mean annual precipitation from near sea level to 1,000 m in elevation. The species grows in all types of well-drained soils, including poor and eroded soils, and frequently grows on rocks, cliffs, and rarely in crotches of trees. It is resistant to short-term drought and salt spray and can survive temperatures as low as -7 to -4 °C. Growth is best in full sun, which most often leads to successful flowering. Mauritius hemp also grows in partial but not heavy shade. When plants are young, competition with tall grass, weeds, shrubs, and trees is a critical limiting factor. Cattle graze and often completely uproot small plants. They are ignored by cattle once they become large (author's observation, Desert-Tropicals Nursery 2003, Pacific Island Ecosystems at Risk 2003). This species, as others of the genus, has crassulacean acid metabolism by which it fixes CO_2 during the night and incorporates it into carbohydrates during the day (personal communication with Ernesto Medina, plant physiologist, Centro de Ecología, Instituto de Investigaciones, Caracas, Venezuela).

Reproduction.—Flowering, which may occur at any time of the year, apparently begins when plants attain sufficient size and vigor to support the large flower stalk. Plants die about 1 year after the onset of flowering. The flowers are visited by honey bees (*Apis mellifera* L.). There is no record in the literature of seed weights. Fresh bulbils (n = 100) collected by the author in Puerto Rico weighed an average of 2.72 ± 0.31 g/bulbil with a range of 0.18 to 16.27 g. Placed in moist potting mix, 100 percent of them rooted within 1 week. Bulbils are formed by the thousands on single plants and can form dense thickets. Gravity is the only known natural means of dispersal. The presence of scattered individuals indicates other transport, perhaps fruit bats.

Growth and Management.—The best way to artificially propagate Mauritius hemp is to place bulbils in pots of potting mix. A group of bulbils planted in Puerto Rico grow rapidly with no mortality, reached an average of 17.8 ± 0.4 cm in height in 1 month, and were ready to outplant in 1 to 2 months. New plants need protection from weeds for a few months, but afterwards the plants need little care. Individual plants probably live from 5 to 20 years depending on growing conditions. One owner reported that an ornamental plant died after flowering at 15 years old (author's observation). Mauritius hemp is rarely common enough in its native range to need control. When control is needed, particularly in invaded areas, individual plants can be killed by grubbing them out or by spray or drizzle application of 2,4-D or triclopyr in oil (Pacific Island Ecosystems at Risk 2003).

Benefits.—Mauritius hemp helps hold the soil, furnishes cover for wildlife, and adds to the aesthetics of wildlands. The species is widely, although not heavily, used as a landscaping plant for accent and curiosity. A variegated form is available (Desert-Tropicals Nursery 2003). Mauritius hemp was once widely cultivated for fiber, hence the common name. Extracts of the roots are used as ingredients in tonics for purifying the blood, and the dried leaves are used to control swelling and to aid in wound healing (Núñez-Meléndez 1982).

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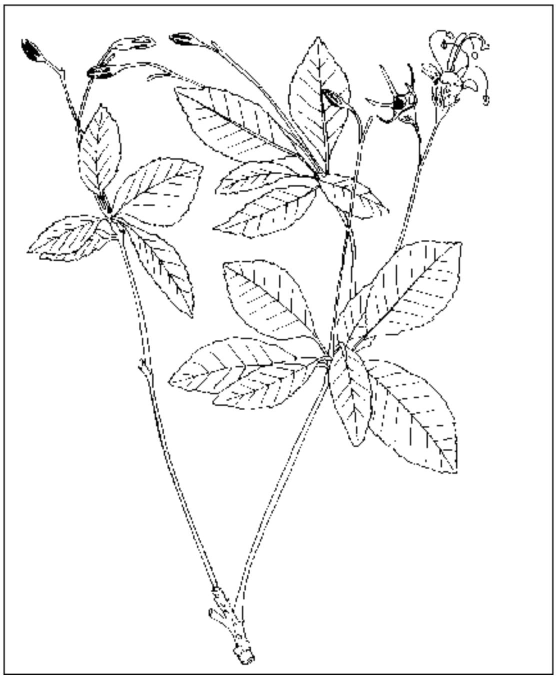
Gesneria pedunculosa (DC.) Fritsch — arbol de navidad

GESNERIACEAE

Synonyms: *Conradia pedunculosa* A.P. DC.
Gesneria exogenia Sassé & Moc. ex A.P. DC.
Pentarhaphia pedunculosa (A.P. DC.) Decne.
Codonoraphia albiflora (Decne.) Oersted

John K. Francis



General Description.—Arbol de navidad is an upright, evergreen shrub or occasionally a small tree 3 to 5 m in height and 5 to 10 cm in basal diameter. On rocks, the shrub sometimes takes a natural bonsai form. The root system, which may or may not have a taproot, takes whatever form necessary to anchor itself in the rocky ground where it grows. The numerous fine roots have clearly visible, white mycorrhizal growth. There are usually multiple stems from the base of the trunk. Arbol de navidad bark is gray or brown, furrowed and rough. The inner bark is light brown and fibrous. Twigs are slender, greenish gray, and form a relatively dense crown. The leaves, which are crowded near the ends of branches, have elliptic to obovate blades, 4 to 11 cm long, with smooth to fine serrate margins. The inflorescences usually have 2 to 4 flowers borne at the end of glandular-resinous peduncles 8 to 16.5 cm long. The five-lobbed tubular corolla is yellow-green to pinkish-white and 1.1 to 1.9 cm long. The fruit that forms is a four-valved, 6 to 9 mm capsule with five long, narrow calyx lobes that release numerous tiny reddish-brown or brown seeds (Liogier 1995, Little and others 1974).

Range.—Arbol de navidad is endemic to Puerto Rico (Liogier 1995, Little and others 1974). It has been planted elsewhere in botanic gardens and arboretums but is not reported to have naturalized. A hybrid between arbol de navidad and *G. pedicellaris* Alain, dubbed "golden oldie," has been developed for ornamental purposes (American Gloxinia and Gesneriad Society 2002).

Ecology.—Arbol de navidad is locally common and usually grows on steep slopes and shallow, rocky soils, sometimes in fractured rock. The parent materials of the soils may be sedimentary (including limestone), igneous, and metamorphic (including ultramafic) rocks. The species is found as scattered individuals or in nearly pure thickets. Plants are less common on south slopes than on north-, east-, or west-facing slopes in areas that receive from about 1000 to 3000 mm of precipitation from about 50 to 800 m above sea level. Arbol de navidad is moderately shade tolerant. It grows and flowers in openings and below forest canopies, if they are not too dense. The species does not appear to compete in dense stands of grass. It grows in remnant forest stands and advanced secondary forests, some of which are old road cuts, abandoned pastures, and fields.

Reproduction.—Arbol de navidad flowers and fruits nearly throughout the year. The flowers are probably pollinated by bats (Little and others 1974). Seed production is high and consistent from year to year. Samples of seed collected in Cayey and Susúa, Puerto Rico, in different years weighed an average of 1.78 x 10^{-5}g and 1.75 x 10^{-5}g, respectively, or 56 million seeds/kg. Both collections failed to germinate when placed on moist filter paper. The seeds are dispersed by the wind. Seedlings are relatively common on bare ground near fruiting adult plants. Adult and sapling plants sprout when cut or damaged.

Growth and Management.—Arbol de navidad is slow growing at all stages. It probably lives several decades. No plantations are known, and recommended management practices have not been published. Disturbance of the soil surface in steep, rocky terrain in moist areas near seed sources would likely result in seedling establishment.

Benefits.—Arbol de navidad is a pretty plant that adds to the aesthetics of the forest. It helps protect the soil in fragile areas and furnishes cover for wildlife. Because of the small diameters and quantities in which it is available, the wood, which is light brown and hard, is useful mainly for fuel.

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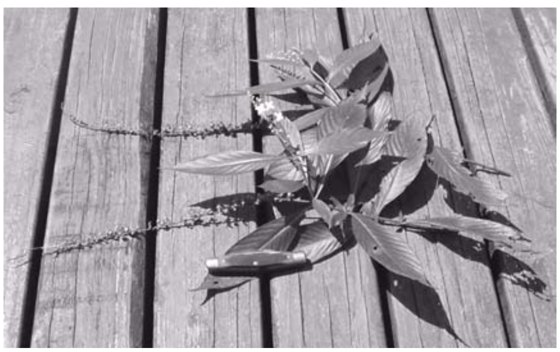
***Gonzalagunia hirsuta* (Jacq.) K. Schum.** rabo de ratón
RUBIACEAE

Synonyms: *Barleria hirsuta* (Jacq.) Jacq.
Coccocypselum spicatum (Lam.) HBK
Duggena hirsuta (Jacq.) Britton & Wilson
Duggena richardii West
Duggena spicata (Lam.) Gómez
Gonzalagunia spicata (Lam.) DC.
Gonzalagunia coccocypselum C. & S.
Gonzalia spicata (Lam.) Standl.
Heydyotis secunda Spreng. ex Schultes
Justicia hirsuta Jacq.
Lygistum spicatum Lam.

John K. Francis



General Description.—Rabo de ratón, also known as mata de mariposa, palo pelado, yerba pelada, bios-foufou, and bois colibri (Howard 1989, Liogier 1997), is a suberect, medium-sized shrub. It has membranous, opposite, ovate to lanceolate leaves, 6.5 to 19.0 cm in length and 2.0 to 8.5 cm in width (Howard 1989) with pronounced, sunken veins. Plants usually have single straight stems but begin branching near the ground. The branches and twigs are slender and sometimes extend a meter horizontally.

Range.—The natural range of rabo de ratón includes Hispaniola, Puerto Rico, the Lesser Antilles, Trinidad, Venezuela, the Guayanas, and northern Brazil (Howard 1989). The species is not known to have naturalized elsewhere.

Ecology.—Rabo de ratón is intolerant and requires disturbance to grow and reproduce. It is most frequently found in brushy pastures, in early secondary forests after abandonment of cultivation, in tree-fall gaps and other disturbed areas in advanced secondary forests, and along roads. In a Puerto Rican study (Myster and Walker 1997), rabo de ratón was the fifth most common species colonizing recent landslides. Dense thickets sometimes form. The species grows in areas receiving from about 1100 to 3400 mm of annual rainfall and at elevations ranging from near sea level to more than 600 m. Apparently, all types of soils are colonized, if not excessively well drained or very poorly drained. The root system is shallow, much branched, and extensive.

Reproduction.—Rabo de rató begins flowering near the end of its first year. The inflorescences, which arise from leaf axils, are spiciform-paniculate and up 56 cm in length. The flowers are white with four or five lobes (Liogier 1997). Flowering and fruiting begin at the base and progress toward the tip. The flowers are pollinated by butterflies and small insects. When the inflorescence is laden with fruit progressing in size from base to tip, it resembles a mouse's tail—hence the name, rabo de ratón (Vélez and von Overbeek 1950). An inflorescence may contain 100 or more fruits. The fruits are two-seeded fleshy drupes that are white, turning pink, violet, or blue (Howard 1989) and are available most of the year. The fruits in a Puerto Rican collection averaged 0.0885 $\pm$ 0.0419 g and contained seeds numbering 182,000/kg. Seeds in this collection failed to germinate (Francis and Rodríguez 1993). Another collection from Puerto Rico had between 55 and 68 percent germination in a field test. Of those failing to germinate, about 5 percent were lost to pathogens. There was no significant predation (Myster 1997). The seeds are dispersed by birds (Parrotta 1995).

Growth and Management.—Rabo de ratón is fast growing and may reach 4 m in height and 3 cm in lower stem diameter. Individual plants usually live 1 to 2 years (Vélez and von Overbeek 1950). The species can probably be established by traditional methods (planted seedlings and direct seeding), but no plantations have been reported. Natural reproduction may be encouraged by cultivation near seed sources.

Benefits.—Rabo de rató is beneficial to the environment in that it readily invades and helps to stabilize disturbed areas. Because the shrub forms a thin canopy, it does not inhibit the invasion of later successional vegetation. While probably not suitable for formal gardens, rabo de rató would contribute to wildflower gardens, forest parks, and greenbelts. The species is an abundant producer of fruits that are eaten by birds.

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***Gossypium hirsutum* L.** wild cotton
MALVACEAE

Synonyms: *Gossypium religiosum* L.
Gossypium latifolium Murry
Gossypium punctatum Schum.
Gossypium taitense Parl.
Gossypium mexicanum Tod.
Gossypium marie-galante Watt

John K. Francis

General Description.—Wild cotton, also known as upland cotton, in wild populations is a shrub or occasionally a small tree to 5 m in height and 15 cm in stem diameter. The plant is deeply rooted with a taproot and laterals. Wild cotton usually has a single trunk, unless disturbed, but may have branches arising just above the ground. The bark is gray and smooth, but tough and stringy. The stem wood of older plants is of medium density and brittle. The twigs are relatively stout. The leaves on young plants are usually without lobes; older plants usually have three lobes or occasionally are deeply incised with five lobes. The light green leaves have petioles 3 to 8 cm long and blades 10 to 15 by 12 to 15 cm. Bracteoles are pointed and may have one to seven or more teeth. The flowers of wild cotton are large and showy with cream to pale yellow petals, sometimes with a red spot at the base of the petals. The capsules have three to five valves with a smooth surface and many black gland dots and yield white or brown lint with seeds embedded. The seeds vary from black and smooth to green with tightly adhering fuzz (Howard 1989, Liogier 1994, Watt 1907). In certain instances (Little and others 1974), wild cotton has been misidentified as *Gossypium barbadense* L., which occurs today as a residual from cultivation and as a true wild plant only on the coast of Ecuador (Izuko Museums of Cape Town 2000). Wild cotton occurs in at least three botanical varieties. The most commonly seen in the West Indies is *G. hirsutum* var. *marie-galante* (Watt) J.B. Hutchinson (Liogier 1994). Doubtless a legacy of agricultural cultivation, wild populations in Puerto Rico have a wide range of leaf and bract shapes, seed characteristics, and lint length and color (author's observation). In fact, wild cotton is a tetraploid. There is a theory that wild cotton is the result of natural hybridization between Old World diploid cottons, *G. arborium* L. or *G. herbacium* L. and *G. raimondii* Ulbrich. (Bajaj 1998).

Range.—The native range of wild cotton includes Tropical Florida, the West Indies, Northern South America, Mexico, and Central America (Howard 1989, Liogier 1994, Long and Lakela 1976) and apparently several Pacific Islands including Samoa (Kohel and Lewis 1984). Because of eradication intended to control the pink bole worm, the species has become very rare and has been listed as endangered in Florida (Nelson 1996). *Gossypium hirsutum* is the principal cultivated cotton throughout the world (Vijayakumar 2002). It has naturalized in many locations, especially in island habitats, including Hawaii (Neal 1965).

Ecology.—Wild cotton is mainly a plant of the coastal strand and lower coastal plains. The species has a particular affinity for small islands. It also grows in disturbed places, particularly along roads and on river overflow areas, well inland. Wild cotton can grow in almost all types of well-drained soils. Optimum pH's are said to be from 5.2 to 7.0

(Center for New Crops and Plants Products 2002). Soil disturbance is usually necessary for its establishment. It tolerates moderate amounts of salts in the soil and salt spray. Wild cotton competes well with weeds and grasses but does not tolerate shade and cannot grow under tree cover. In Puerto Rico, wild cotton is most competitive at low rainfalls (750 to 900 mm of annual precipitation) but grows in well-drained areas that receive up to 1700 mm of precipitation at from near sea level to about 300 m elevation. Wild cotton does not tolerate frost.

Reproduction.—Wild cotton is dormant during the winter dry season and becomes vegetative as the rains begin again in early summer. At the end of the summer, vegetative growth ceases and plants begin to flower and fruit (Kohel and Lewis 1984). Three collections of wild cotton seeds of Puerto Rico from three locations averaged 0.088 $\pm$ 0.001, 0.075 $\pm$ 0.001, and 0.081 $\pm$ 0.001 g/seed or about 12,000 seeds/kg. Germination is epigeal. Seeds from two of the collections were sown without pretreatment in commercial potting mix. One collection germinated at 100 percent starting in 17 days and ending in 41 days. The second group germinated at 67 percent starting in 22 days and ending in 140 days. The wind disburses the seeds over short distances by blowing the lint until it catches on vegetation. Birds also move seeds when they use cotton lint for nest building materials. Under greenhouse conditions, seedlings may grow more than 1 m in 6 months. In wild stands, seedlings can be abundant but they naturally thin themselves quickly.

Growth and Management.—Although wild cotton in its cultivated form is managed as an annual, it is a true perennial, and if allowed to do so under favorable conditions, will live for several years (Kohel and Lewes 1984) and become tall and woody. Wild cotton in Puerto Rico grows 1 to 1.5 m in its first year. The wild variety requires 15 or more nodes to be formed along the main axis before it can flower. Consequently, the plant is rarely able to bloom during its first year (Kohel and Lewis 1984). Cotton can be transplanted using containerized nursery plants. However, direct seeding following removal of overhead competition and cultivation of the soil is recommended. Soil temperatures must be at least 18 °C before planting (Center for New Crops and Plant Products 2002).

Benefits.—About 87 percent of the cotton grown commercially is *G. hirsutum* (Vijayakumar 2002). It has been selected, bred, and, in some cases, hybridized to give the manageable and productive varieties planted today. Evidence from Mexico shows that wild cotton has been used by man for making string and cloth since at least 200 BC (Iziko Museums of Cape Town 2000). Today, cotton is the world's most widely used natural fiber. The seeds of cultivated cotton form the basis for an important oil and animal food industry. The seeds contain 7.3 g water, 23.1 g protein, 22.9 g fat, 43.2 g total carbohydrate (16.9 g fiber), and 3.5 g ash per 100 g (Center for New Crops and Plant Products 2002). Gossypol, a sesquiterpinoid, is present in vegetative parts of wild cotton as well as the cultivated varieties. It is a natural deterrent to insects but is toxic to man and nonruminant animals. It has been shown to have strong antifertility, antitumor, antiparasite, and anti-HIV properties (Bajaj 1989). Gossypol is widely used in China as a male contraceptive (Center for New Crops and Plant Products 2002). Raw cottonseed oil (containing gossypol) used alone showed promise as an insecticide (Tadas and others 1994). In herbal medicine, cottonseed and roots have been used to treat nasal polyps, asthma, diarrhea, hemorrhoids, dysentery, uterine fibroids and certain cancers, to induce abortions, and as a diuretic. (Center for New Crops and Plant Products 2002). Wild cotton is occasionally planted as an ornamental. The species contributes to biodiversity, soil stability, wildlife habitat, and scenic beauty in its beach strand and lowland habitat.

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Gouania lupuloides (L.) Urban chew-stick
RHAMNACEAE

Synonyms: *Banisteria lupuloides* L.
Rhamnus domingensis Jacq.
Gouania domingensis (Jacq.) L.
Gouania glabra Jacq.
Lupulus lupuloides Kuntze var. *domingensis* (Jacq.) Kuntze

John K. Francis

General Description.—Chew-stick, also known as toothbrush tree, bejuco de sopla, bejuco de indio, mascapalo, bejuco de fuego, liane-savon, and lyenn-savon, is a scrambling and climbing woody vine that may reach 7 to 12 m of extension. The plant is supported by an extensive system of medium and fine, white, lateral roots. The stem and branches are relatively slender and support themselves by means of coiled tendrils. The alternate leaves have petioles 0.5 to 2 cm long and thin, ovate to elliptic blades 4 to 10 cm long with a serrate or wavy-toothed margin and a pointed tip. Tiny white, yellow, or greenish flowers are borne on slender axillary or terminal racemes. Few-to-many, 6- to 13-mm, gray, three-winged fruits (schizocarps splitting into three mericarps) develop later in the season. Each mericarp contains a 3- to 4-mm dark-brown seed (Acevedo-Rodríguez 1985, Croat 1978, Howard 1989, Liogier 1994, Stevens and others 2001).

Range.—The native range of chew-stick includes Florida, the West Indies, Mexico, Central America, and South America into Brazil and Colombia (Howard 1989, New York Botanical Garden 2002, Pérez-Arbelaez 1978, Secritaria de Medio Ambiente y Recursos Naturals 2002). It is not known to have been planted or naturalized elsewhere.

Ecology.—In Puerto Rico, Chew-stick occurs in forests that receive from 750 to over 2000 mm of precipitation. It grows on soils with the entire range of textures, both poor and rich in nutrients, excessively well drained to somewhat poorly drained over sedimentary (including limestone), igneous, and metamorphic (including ultramafic) rocks. The species is found from near sea level to elevations of 1,300 m (Acevedo-Rodríguez 1985, Stevens and others 2001). Chew-stick has an intermediate tolerance of shade. It can live and grow slowly in all but dark forest understories but requires increased sunlight to flower and fruit. The species grows on roadsides, in brushy pastures, and in secondary and remnant forests. In Florida, chew-stick grows in mangroves and coastal hammocks (Nelson 1996).

Reproduction.—In Puerto Rico, chew-stick blooms from August to March, and fruit matures from November to March (Acevedo-Rodríguez 1985). In Panama, it flowers in the early dry season (November to March), and the seeds are dispersed from February to May (Croat 1978). Fruits collected in Puerto Rico averaged 0.0374 $\pm$ 0.0005 g/fruit. Seeds separated from them averaged 0.0052 $\pm$ 0.0001 g/seed or 192,000 seeds/kg. Seed should be collected by hand from fruiting vines. Hand separation is practical for small lots; larger lots could be pulverized and winnowed. Fifty-seven percent of untreated seed from the previously mentioned collection germinated between 16 and 75 days after sowing on commercial potting mix (author's observation). Seed is dispersed by its lateral tumbling action in still air or wind and by lateral extension on the vines. Seedlings and young plants are relatively common in Puerto Rico. The plant sprouts after fire and cutting.

Growth and Management.—Once established, chew-stick grows relatively rapidly. In the presence of seed sources, reproduction is usually adequate. Thinning the overstory would probably allow existing suppressed plants to grow to larger sizes and fruit.

Benefits.—Chew-stick contributes to biodiversity and biomass accumulation, helps protect the soil, and furnishes wildlife cover in forests where it grows. It is an important honey plant (Townsend 1984). In Jamaica and the West Indies, stem cuttings are used to clean teeth and gums and extracts are used to manufacture a dentifrice (Secretaría de Medio Ambiente y Recursos Naturales 2002). Triterpenoid saponins may contribute to the beneficial activity (Kennelly and others 1993). In Colombia, the plant is used for a bitter flavoring in alcoholic beverages and to treat water retention and stomach problems (Pérez-Arbelaez 1978).

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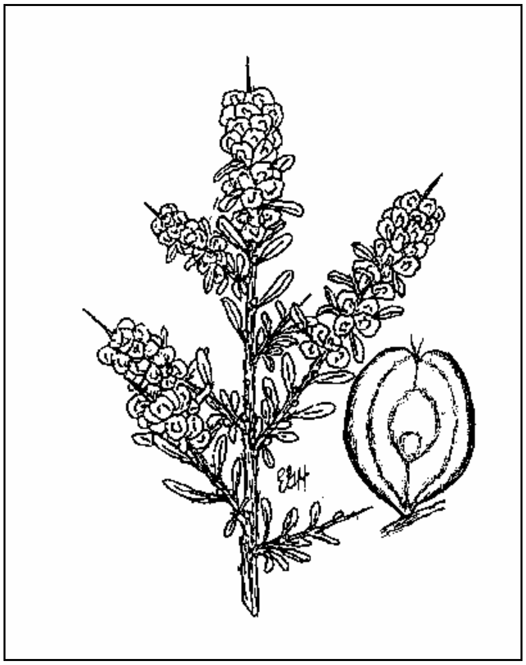
***Grayia spinosa* (Hook.) Moq.** spiny hopsage
CHENOPODIACEAE

Synonyms: *Atriplex spinosa* Collotzi
Atriplex grayia Collotzi
Grayia polygaloides Hook. & Arn.

Nancy L. Shaw, Marshall R. Haferkamp, and Emerenciana G. Hurd



General Description.—Alternative common names for spiny hopsage are grayia, Gray's saltbush, saltbrush, spiny-sage, horsebrush, and applebush (Shaw and others 2001, Welsh and others 1987). Shrubs are 0.3 to 1.2 (1.5) m tall, summer deciduous, and erect to rounded with divergent, thorn-tipped branches and gray to brownish exfoliating bark. Young twigs and herbage are scurfy to pubescent, becoming glabrous with age. Alternate, entire, gray-green, fleshy leaves, 5 to 30 (40) mm long and 2 to 13 mm wide, develop from prominent, globose, axillary buds. Blades are linear-oblanceolate with sessile or short-petiolate bases. The species is tetraploid (4x = 36) (McArthur and Sanderson 1984). Inflorescences develop on floral shoots that die back following fruit dispersal. Flowers are inconspicuous. Staminate flowers develop in glomerate spikes and consist of a four or five lobed perianth and four or five stamens. Pistillate flowers are produced on dense terminal spicate inflorescences. Some flowers are vestigial. Each flower consists of a pistil enclosed in two obcompressed chordate bracteoles united along their margins except for a minute apical opening. Bracteoles enlarge at maturity to form a papery sac, 9 to 15 mm in diameter with a dorsally winged margin. Fruits are utricles with the papery pericarp free from the seed. Seeds are 1 to 2 mm in diameter. The testa is comprised of a thin, dark brown outer layer and an elastic inner layer. A well-developed embryo with an inferior radicle encircles the perisperm (Hitchcock and others 1964, Shaw and others 1996, 2001).

Range.—Spiny hopsage is widely distributed in the interior Western United States. It occurs east of the Cascade and Sierra Nevada Mountains from central Washington to southern California and eastward from southern Montana to western Colorado and northern Arizona (Hitchcock and others 1964, Welsh and others 1987).

Ecology.—Spiny hopsage occurs at elevations from 160 to 2,130 m in Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *wyomingensis* Beetle & A. Young), salt desert shrub, Mohave Desert, and pinyon-juniper communities receiving 125 to 300 mm of annual precipitation (Welsh and others 1987). It grows on soils that are silty to sandy, frequently high in calcium, and neutral to strongly basic. It also occurs on sand dunes. Spiny hopsage generally occurs in small patches or as scattered plants. Extensive stands are rare. Plants initiate growth in early spring and rapidly complete their vegetative and reproductive cycles prior to entering summer dormancy. They are most tolerant of summer wildfires after summer leaf fall and can resprout from surviving root crowns (Daubenmire 1970). Regeneration is episodic. Germination occurs in early spring. Most seedlings establish beneath canopies of spiny hopsage or other shrubs. Growth of cheatgrass (*Bromus tectorum* L.), a highly competitive annual, however, is favored by nutrient accumulation beneath spiny hopsage canopies. This can interfere with natural regeneration of native vegetation and result in increased fine fuel accumulation.

Reproduction.—Most plants are dioecious, but the proportion varies among populations. Flowers appear in February to May and are wind pollinated. Fruits ripen in March to June (Shaw and others 2001) and are dispersed by wind, gravity, and insects. Herbage, flower, and fruit production are highly variable among years (Rickard and Warren 1981); many plants fail to produce flowers in dry years (McArthur and Sanderson 1984). During a drought, spiny hopsage in a southern Idaho wildland planting began flowering 4 years after seeding. Incubating debracted utricles at 15 and 5 ^{o}C (8 hrs, 16 hrs) or at 15 ^{o}C for 14 days provides an estimate of germination. A 30 to 60 day prechill at 3 to 5 ^{o}C is required to enhance germination of utricles from northern populations. Shaw and others (2001) reported an average of 1,030,600 debracted utricles/kg. Germination is epigeal.

Growth and Management.—Seedlings develop rapidly if adequate water is available. Mature plants are drought tolerant. Spiny hopsage is considered one of the most palatable shrubs in salt desert shrub communities in spring and early summer. Its use by wildlife and livestock declines rapidly as plants enter summer dormancy. Although fairly tolerant of grazing, some populations receiving heavy use have been replaced by less palatable species (Blaisdell and Holmgren 1984).

Benefits.—Spiny hopsage contributes to diversity on native sites that generally support few other woody species. It provides cover for birds and other small animals, spring and early summer forage for big game and livestock, and soil stabilization on moderate slopes. Litter rich in potassium and other accumulated cations enhances growth and nutrient content of plants growing beneath its canopy (Rickard and Keough 1968). Native Americans ground parched seed of spiny hopsage to prepare pinole flour (Stubbendieck and others 1986).

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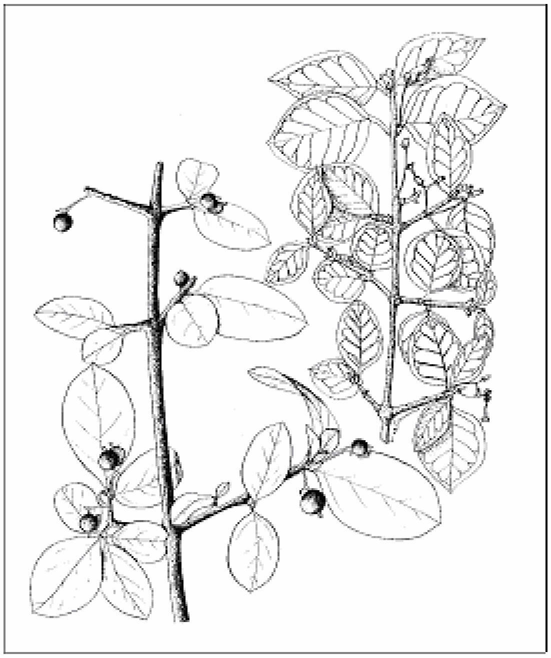
***Guettarda elliptica* Sw.** velvetseed
RUBIACEAE

Synonyms: *Guettarda bladgettii* Shuttlew. ex Chapm.
Matthiola elliptica (Sw.) Kuntze

John K. Francis



General Description.—Velvetseed, also known as Everglade velvetseed, pickle-wood, cucubano liso, cigüillo, cuero de sabana crucillo, guayabillo prieto, cabrito, and punteral, is a shrub or small tree to 6 m in height and 10 cm in stem diameter. It usually has multiple stems from below or just above the ground level. The stem bark is gray or gray-brown, smooth with light colored dots or lines. The stem wood is light brown, hard, fine-textured, and heavy with a specific gravity of 0.83 (Little and others 1974). The plant is supported by hard, brittle, dark-brown roots. Velvetseed tends to form branchy crowns of opposite, moderately fine branches and twigs. The opposite leaves have short, hairy petioles and oval to elliptic blades 3 by 7.5 cm long. Axillary, few-flowered cymes bear small tubular yellowish-white flowers. Three to 4 months later, globose, 4- to 8-mm drupes with a persistent calyx develop. They turn red to black at maturity and contain two to four seeds enclosed in a bony shell (Liogier 1997, Little and others 1974, Nelson 1996, West and Arnold 1952). The fruits have a slightly sweet, slightly sour, and slightly astringent flavor (author's observation).

Range.—The native range of velvetseed extends from southern Florida through the West Indies, from Mexico through Central America, and Venezuela and Guyana in South America (Little and others 1974).

Ecology.—Velvetseed grows in pinelands and hammocks in Florida (Nelson 1996). In Puerto Rico, it is most common in limestone areas and occasionally in areas of igneous rock, on rocky ridge sites too difficult for tall vegetation, and in coastal thickets and rocky hills (Liogier 1997, Little and others 1974). Annual rainfall varies from 750 mm to 2200 mm, and elevations range form near sea level to about 400 m. Vegetation sites include relatively pristine to highly disturbed remnant forests and late secondary forests. Velvetseed is moderately intolerant of shade. It competes well with slow-growing vegetation but not with tall grass or overtopping trees. Open-grown plants assume a symmetrical shape, but in thickets, the stems are usually crooked and the crowns asymmetrical.

Reproduction.—Velvetseed blooms in summer in Florida (West and Arnold 1952) and in the spring in Puerto Rico (Little and others 1974). Flowers require pollination to develop seeds and are ordinarily pollinated by insects (Koptur and Richards 1996). A collection of fruits in Puerto Rico averaged 0.350 $\pm$ 0.008 g/fruit. Seeds separated from them weighed (air-dried) an average of 0.0626 $\pm$ 0.0015 g/seed or 16,000 seeds/kg. Sown on commercial potting mix, 68 percent of the seeds germinated between 3 and 7 months after sowing (author's observation). Although there is usually good fruit and seed production, seedlings are relatively uncommon. Birds disperse the seeds. Velvetseed sprouts readily when cut.

Growth and Management.—The Florida champion velvetseed is 7 m in height and 29 cm in diameter at breast height (Champion Tree Project 2002). The species grows slowly, at least in the difficult habitat where most occur. Individuals probably live from two to several decades. No management experience has been published. However, long-term protection of velvetseed sites is recommended.

Benefits.—Velvetseed contributes to biodiversity and wildland biomass while it helps protects the soil from erosion and provides food and cover for wildlife. The species is listed as the larval food plant for the moths, *Calidota strigosa* Walker in Florida and the West Indies (Barns 2002) and *Hylesia lineata* Druce in Mexico (Pescador 1995). The wood is useful for fuel and stakes. Velvetseed is a pretty shrub and would make a fine foundation plant in seminatural landscaping.

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***Gundlachia corymbosa* (Urban) Britt. ex Boldingh** yambush
ASTERACEAE

Synonyms: *Baccharis dioica* sensu Duss
Gundlachia domingensis var. *corymbosa* Urban

John K. Francis

General Description.—Yambush, also known as horsebush, broombush, soldier's-bush, Jamaican trash, sereno, and bois-Guillaume, is an evergreen shrub to 1.5 m in height. Stems are typically slender, numerous, branched near the ground, and rooted at intervals where they touch the ground. The plant is supported by brown lateral and fine roots that are flexible and weak. The leaves are mostly clustered near the twig ends. The subsessile leaves are fleshy, sticky, oblanceolate to oblong-lanceolate, mostly rounded at the apex and 3 to 8 cm long by 0.5 to 2 cm wide. The terminal inflorescences are dense corymbs of heads on short peduncles. The involucre is about 5 mm long and surrounds five to nine white florets. Fruits are oblong, angular achenes with tawny pappus (Britton and Millspaugh 1962, Howard 1989, Liogier 1997).

Range.—Yambush is native to the Bahamas, Cuba, Hispaniola, Puerto Rico, the Virgin Islands, Barbuda, Saba, Monserrat, Guadeloupe, La Désirade (Guadaloupe), Curaçao, Aruba, and Bonaire (Howard 1989, Liogier 1997). It is not known to have been planted or naturalized elsewhere.

Ecology.—Seaside and small island habitat is normal for the species. Yambush mostly grows on shoreline rocks and cliffs in Puerto Rico. It was collected between rocks and gravel deposited at 40 to 50 m elevation in La Désirade (New York Botanical Garden 2003) and on calcareous silt with emergent limestone on Turks and Caicos (Darwin Institute 2002), and on rocky shores on San Salvador, Bahamas (Gerace and others 2003). Britton and Millspaugh (1962) indicate that it grows on sand dunes, pine lands, and borders of saline marshes. Yambush can grow in a wide variety of soils, gravel, and even in cracks in rocks. It is tolerant of salty soils, heavy salt spray, sea water overwash, and constant, sometimes high winds. Mean annual precipitation in its natural habitat varies from about 700 mm to 1,700 mm. It grows from near sea level to over 50 m in elevation. The species can grow with light overhead shade but generally grows where few other species can survive to avoid competition.

Reproduction.—Yambush probably blooms throughout the year. The seeds are small, produced in great numbers, and dispersed by the wind. Seedlings are uncommon, but once established in favorable environments, they layer profusely and form interconnected mats.

Growth and Management.—Yambush grows slowly. In seaside environments in Puerto Rico, it adds about 20 cm per year to its multiple stems. Individual plants and clumps apparently live for many years. The author knows of no reports of planting or management of the species. Because it is uncommon in much of its range, not aggressive, and grows in areas not normally used for agriculture or forestry, control of stands of the species should rarely be necessary.

Benefits.—Yambush adds to the aesthetics of sites where it grows, helps protect the soil, and furnishes cover for wildlife. Although there is no record of it having been used for ornamental purposes, yambush seems an excellent choice for groundcovers and borders in seaside and xeric gardens. Poultices of crushed leaves relieve and help heal allergic dermatitis (Wood 2003).

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***Gutierrezia sarothrae* (Pursh) Britt. & Rusby** broom snakeweed
ASTERACEAE

Synonyms: *Xanthocephalum sarothrae* (Pursh) Shinners
Solidago sarothrae Pursh
Gutierrezia diversifolia Greene
Gutierrezia linearis Rydb.

Juanita A. R. Ladyman

Illustration source: USDA-Forest Service collection, Hunt Institute

General Description.—*Gutierrezia sarothrae* is a woody perennial named for Pedro Gutierrez, a Spanish nobleman. The epithet "sarothrae" is a derivative of a Latin word meaning "broom." Its most popular common name is broom snakeweed, or snakeweed, but is also referred to as common matchbrush, broomweed, brownweed, yellow-top, yellow weed, resin-weed, turpentine-weed and, principally in Mexico, yerba de vibora (Dayton 1931). It has also many botanical synonyms and for a complete list see Kartesz (1994). The Navajo Native Americans call it Ch'il diilyesiitoh, "big dodge weed" (Mayes and Lacy 1994). Broom snakeweed is generally 20 to 60 cm tall with a dense crown. The young, greenish stems turn tan and then brown with age. It has linear green leaves up to 3.8 cm long and numerous small, bright-yellow flowers with two to seven rays that are 2 to 3 mm long. In its northern range it is deciduous and dies back, but within its southern range it commonly only dies back part way in winter (Cronquist 1994, Whitson et al. 1991). Snakeweed contains saponin, a toxic secondary product (Whitson et al. 1991). Details of the plant may be viewed on the Texas A&M University "Virtual Herbarium" Website (2000).

Range.—Broom snakeweed is native to the Americas. It is a very common shrub throughout Western North America, from Saskatchewan and Alberta, Canada south through western Nebraska and Kansas into Texas and central Mexico, and west to Washington, Oregon, California, and Baja California. Broom snakeweed has been described as a diagnostic climax member of desert grasslands (Dick-Peddie 1993). It is a member of both Chihuahuan and Sonoran desert grasslands (Schmutz et al. 1992). It has been estimated that it covers more acres than any other perennial plant on Navajo Tribal lands in the Southwestern United States (Mayes and Lacy 1994).

Ecology.—Broom snakeweed grows in dry, open places from 732 m to 2,898 m (Tirmenstein 1999). As its wide range suggests, it grows in a variety of soil conditions, from sandy and well-drained loam to heavy clay soils and in various plant communities, including Douglas-fir and ponderosa pine forests, pinyon-juniper woodlands, sagebrush shrublands, and desert grasslands. Broom snakeweed root systems are fairly shallow, which is unusual for a shrub adapted to semi arid and arid environments (Schmutz and others 1992). They occupy the same soil layers as those of perennial grasses and sometimes appear to compete with them (Burgess 1995). Broom snakeweed tends not to resprout after fire and frequently dies during drought (Schmutz et al. 1992). It suffers from drought to about the same extent as black grama grass, but when insect pressure is present the snakeweed mortality is much higher (Dick-Peddie 1993). However, by virtue of its high seed production and rapid seedling establishment (Osman and Pieper 1988) it often increases, or "comes in", after prolonged drought and other disturbances (Dayton 1931).

Reproduction.—Snakeweed flowers from July to December depending upon the latitude and water availability. The plant is insect pollinated (Mayeux and Leotta 1981). It is a prodigious producer of seed that can remain viable in the soil for a considerable length of time (Osman and Pieper 1988). A single plant is capable of producing 9,000 to 10,000 seeds annually (Tirmenstein 1999). The oval fruit (seeds) are achenes and covered with stiff hairs or nearly glabrous. Chaffy scales, called the pappus, are on one end of the achene and aid seed dispersal by wind (Cronquist, 1994). Seeds are dispersed by animals as well as wind, although it has been reported that they also accumulate under the shrub canopy (Mayeux and Leotta 1981). Light enhances germination, which suggests that the best position for seeds is on or near the soil surface (Mayeux and Leotta 1981).

Growth and Management.—Snakeweed is not palatable and can be poisonous to livestock and increases under grazing pressure (Cable 1975; Carter 1988; Cronquist 1994; Pase and Pond 1964). Most losses in sheep and cattle are due to abortions (Whitson et al. 1991), but the plant also apparently affects the kidneys of both sheep and horses (Dayton 1931). Data suggest that the presence of jackrabbits may reduce cattle losses from poisonous plants because, under moderate stocking rates, jackrabbits consume increased amounts of poisonous plants and shrubs such as snakeweed but have minimal forage competition with cattle (Daniel et al. 1993). When abundant, snakeweed is generally considered an indicator of overgrazing (Dayton 1931; Hatch and Pluhar 1993; Powell, 1998). Pastures are also not properly utilized when broom snakeweed is present amongst the grasses (Whitson et al. 1991). Snakeweed is killed by certain borers and other insects. Species from the genera, *Crossidius*, *Diplotaxis,* and *Mecas* have been proposed as possible biological controls (Dayton 1931). Fire can be used to reduce snakeweed (Humphrey 1949; Tirmenstein 1999). However, the success of controlled burns depends upon fuel quantity and dryness, and an absence of grazing for at least one season prior to burning has been recommended (Tirmenstein 1999). In many cases, fire may prove an ineffectual control. For example, 5 years after a wildfire snakeweed had gone from 0 percent canopy cover to over 40 percent canopy cover on monitored plots in Arizona (Pase and Pond 1964). In west-central Utah broom snakeweed was found on eight out of the nine age-classes of burns, being absent on the 71-year-old burns and most abundant on the 22-year-old burns (Barney and Frischknecht 1974). Broom snakeweed is susceptible to some herbicides (Whitson et al. 1991).

Benefits.—Broom snakeweed provides some stability to the soil against both wind and water erosion (Tirmenstein 1999, USDAFS 1988). It is fair browse for wildlife but is poisonous to livestock due to the saponin content, which is variable and depends upon both growth phase and environmental conditions (Hatch and Pluhar 1993). The vegetation is most toxic during leaf formation (Whitson and others 1991). At times when there has been no alternative forage, snakeweed has been used by livestock with no ill effects (USDAFS 1988). Presumably saponin levels have been low at these times. It has several medicinal uses among the Navajo (Mayes and Lacy 1994). It is used to heal cuts and bites in humans and animals. A snakeweed medicine is given in childbirth and is used to treat stomachaches and other internal disorders. It is reported to be a powerful diuretic (Powell 1998). It is also used in various Navajo ceremonies including as an emetic and fumigent (Mayes and Lacy 1994). A yellow dye is made from the flowers, and the stems can be used to make fire by friction. Birds, for example quail, eat the seeds (Epple 1995). Broom snakeweed also provides cover and resting sites for species of small mammals, for example jackrabbits (Daniel and others 1993) and birds, for example lesser prairie chicken (USDAFS 1988) and Columbia basin burrowing owl (Green and Anthony 1989).

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***Gynerium sagittatum* (Aubl.) Beauv.** wild cane
POACEAE

Synonyms: *Saccharum sagittatum* Aubl.
Arundo saccharoides Poir.
Airo gigantea Steud.

John K. Francis

General Description.—Wild cane, also known as bitter cane, uva grass, and caña brava, is a tall shrub with a grass-like habit. Its culms are usually 5 or 6 m in height and 2 or 3 cm in diameter but may reach 10 m in height and 4 cm in diameter in Puerto Rico. The species varies from 5 to 14 m in height in the western Amazon Basin (Kalliola and others 1992). The culms arise from underground rhizomes which also produce weak and flexible lateral roots, mostly 1 mm or less in diameter. The culms have closely imbricated woody sheaths around a hard, woody exterior, and a fibrous interior. They are usually unbranched and taper little except near the top. The older leaves are shed, leaving a plainer, fan-like group near the apex. The leaf blades are 1 to 2 m long and have sharp serrulate margins. The clonal groups of plants are dioecious. The grayish-white plume-like terminal panicles are large, up to 2 m long. The male and female inflorescences are similar in appearance, but pistillate plants have a slightly fuzzy appearance because of hairy lemmas. The fruits are brown and about 1 mm long (Croat 1978, Howard 1979, Pohl 1983, Stevens and others 2001).

Range.—Wild cane is native to the West Indies except the Bahamas, and from Mexico through Central America and South America to Paraguay (Howard 1979). It is not known to have naturalized elsewhere. Two types coexist in the western Amazon Basin: a "small" and a "large" type that differ considerably in physical form and mode of reproduction (Kalliola and others 1992). The distinction is not reported elsewhere.

Ecology.—Wild cane grows on sites with moist soils, usually high in organic matter, often with the water table near the surface. These sites are seasonally flooded areas such as lake shores, swamps, river flood planes, or sand bars. The species grows at elevations from 10 to 1,600 m above sea level in Costa Rica (Instituto Nacional de Biodiversidad 2002). Wild cane resists damage from moderate flooding and sprouts after being covered with sediment. "Large type" stands in the western Amazon region vary in density from 0.6 to 2.6 culms/m^2. Forest edges "shade out" portions of wild cane stands, and occasional trees grow up through stands and eventually suppress culms growing under their crowns. The species affects the course of forest succession (Kalliola and others 1991). Apparently, disturbance that creates bare, wet soil is necessary for seedling establishment.

Reproduction.—In some environments flowering occurs throughout the year (Croat 1978); in others it occurs near the end of the low water period (Kalliola and others 1992). The species is apparently wind pollinated (Pohl 1983). There are 1.67 million seeds/kg, and they can be expected to germinate between 3 and 7 days following sowing at temperatures between 20 and 30 °C (Association of Official Seed Analysis 2002). Almost all the seeds of the "short" type from the Amazon Basin germinated within 3 weeks, and 0 to 2 percent of the "large" type germinated (Kalliola and others 1992). Seeds are dispersed by wind and water (Kalliola and others 1992). Vegetative propagation is also important, both for expanding colonies and establishing new ones. Horizontal runners or rhizomes, surface or underground, are constantly active and establish new plants or clumps as far as

20 m from the parent plants (Pohl 1983). Segments of culm or rhizome, carried by floodwaters and covered with soil or debris, sprout and start new colonies.

Growth and Management.—Growth of wild cane is rapid. Nursery seedlings reached 20, 30, and 50 cm after 1, 2, and 4 months (Kalliola and others 1992). How long seedlings take to reach maturity and how rapidly suckers grow is unknown. Theoretically, baring catastrophes and invasion and shading by trees, clones can endure indefinitely. Culms of Amazon Basin plants produced close to 200 leaves during their lifetimes, having from 19 to 28 living leaves at a time (Kalliola and others 1992). Unbranched culms die after flowering, but only the branches of branched culms die. If not controlled, wild cane slowly invades wet bottomland pastures and eliminates forage plants. Periodic mowing appears to be adequate for control of advancing clumps.

Benefits.—Wild cane provides cover for wildlife and protects stream banks from erosion (Kalliola and others 1992). Its culms lack the strength and toughness of hardwoods and bamboo but still are used in rude construction, drying racks, vegetable stakes and fruit props, and for weaving mats, baskets, and hats (Kalliola and others 1992). In the Amazon area, arrow shafts are made from the dried culms (Russo 2002). Plumes are used for dry floral arrangements.

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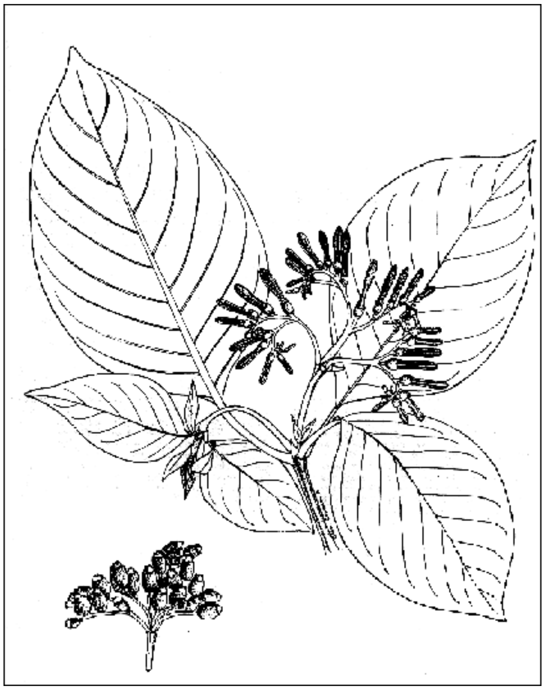
Hamelia patens Jacq. firebush
RUBIACEAE

Synonyms: *Hamelia erecta* Jacq.
Hamelia pedicellata Wernh.
Hamelia latifolia Reichb. ex DC.

John K. Francis



General Description.—Firebush, which is also known as hummingbird bush, scarletbush, bálsamo, busunuvo, pata de pájaro, Doña Julia, fleur-corail, and many other names, is a medium-sized shrub. This shrub commonly ranges from 1 to 3 m in height, but sometimes reaches 7 m in height (Howard 1989). It grows as a tree in the Atlantic tropical lowland of Costa Rica (Paciorek and others 1995). Firebush has a tap and lateral root system with abundant fine roots. The roots are red-brown. Stem bark is gray and smooth and the inner bark is light green (Little and others 1974). Plants may have single or multiple stems. The twigs are orange to purple. Leaves are opposite or grouped in threes or fours, and finely hairy to glabrous. The leaves have petioles 1 to 3.5 cm long and blades that are mostly ovate-elliptic to obovate-elliptic with an acute or acuminate tip. The lateral and especially the midveins are red or pink. In temperate areas, as the temperatures turn cool in the fall, the foliage turns to a brilliant red—hence the common name. The inflorescence is terminal, a modified dichasium with flowers that are tubular, 12 to 22 mm long, and orange to red in color. The fruit is a berry, spherical to elliptical, 7 to 10 mm long, turning red and then black at maturity. The seeds are orange-brown, 0.6 to 0.9 mm long (Howard 1989, Liogier 1997).

Range.—The native range of firebush extends from southern Florida and Bermuda, through the Bahamas, the Greater and Lesser Antilles, Trinidad and Tobego, and from Mexico through Central America and South America to Paraguay and Argentina (Little and others 1974). The species is also cultivated throughout the moist tropics and subtropics but is not reported to have naturalized outside its native range.

Ecology.—Firebush grows in deforested areas, in thickets with other brushy species, in forest openings, or in the understory of low basal-area forest stands. The species is found in moist and wet areas that receive from about 1600 to about 3000 mm of precipitation. Firebush prefers loamy or clayey soil. It grows on soils derived from volcanic and sedimentary parent materials and is most common in areas with limestone rocks.

Reproduction.—Firebush flowers throughout the year. It is a hummingbird-pollinated plant (Cunningham 1994). The flowers are also visited by butterflies (Desert-Tropicals 2001). There were 970,000 seeds/kg in a collection of seeds from Puerto Rico. Sown on wet peat, germination started after 20 days and ended at 40 days with 46 percent germinated. Although the species is a good producer of fruits and seeds in Puerto Rico, seedlings are not common. The fruits are eaten by birds (Floridata 2001), which disburse the seeds. Layering occurs whenever stems come in contact with the ground. The species can be propagated from seeds, but most commercial ornamentals are produced from cuttings. In one test, cuttings 15 cm long with four leaves, which had been taken from the shoot tip, treated with 4000 ppm of indol-buteric acid (IBA) and planted in sand, gave the best rooting (Bhattacharjee and Balakrishna 1992).

Another experiment using an auto-humid chamber obtained 100 percent rooting of softwood cuttings treated with hormones and 40 percent without hormone treatment (Maiti 1974).

Growth and Management.—In its native and other frost-free habitat, firebush grows as a typical shrub, but cultivated in warm temperate areas with hard frosts, it will freeze to the ground and sprout again in the spring. Firebush is also planted as an annual bedding plant in temperate climates. Ornamental plants need frequent watering during the establishment phase, but afterward, they are drought tolerant (Floridata 2001). Pruning of ornamental plants is recommended to keep them from becoming tall and spindly (Desert-Tropical 2001). However, pruning inhibits blooming, which occurs at the terminals.

Benefits.—Firebush is loved and planted as an ornamental almost worldwide in warm, moist areas. The fruit is edible (Little and others 1974). A phytochemical screening found firebush tissues rich in phytochemicals including alkaloids and flavonoids (Raintree Nutrition 2001). Firebush is used in herbal medicine to treat athlete's foot, skin lesions and rash, insect bites, nervous shock, inflammation, rheumatism, headache, asthma, and dysentery (Liogier 1990, Mast Arboretum 2001, Raintree Nutrition 2001). Firebush is one of the woody species foraged by sheep and goats in brushy pastures in Costa Rica. These animals consumed 1.3 percent of their body weight of this species in a free-choice test (Benavides 2001). Firebush contains 17.5 percent crude protein and has an *in vitro* digestibility of 61.6 percent (Benavides 2001).

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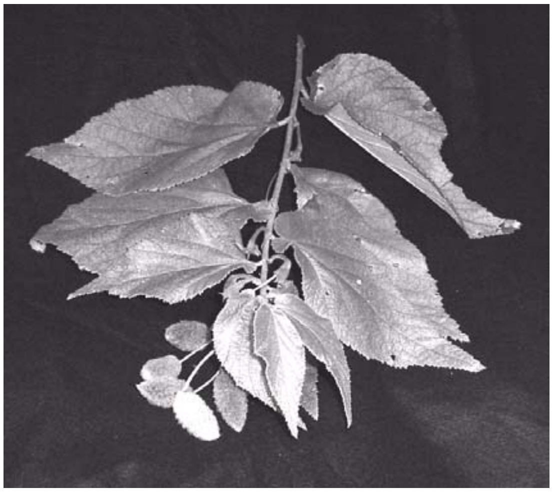
***Helicteres jamaicensis* Jacq.** cowbush
STERCULIACEAE

Synonym: *Helicteres spiralis* Northop

John K. Francis



General Description.—Cowbush is a shrub or sometimes a small tree 7 m in height and up to 20 cm in basal diameter. It is also known as cowitch, blind-eye-tree, salzbush, wild salve, screwtree, jeucon, cottonrat, cuernecillo, gato soga, huevo de gato, gato, majagüilla de costa, and tapaculo (Little and others 1974). The shrub has a dense covering of soft hairs throughout. The trunk is gray with conspicuous warts. A somewhat swollen taproot with abundant laterals and fines form the root system. The tan-colored roots are somewhat stiff and woody. There is usually a single stem unless the plant has been damaged. It develops relatively few long, stout, spreading or drooping branches. The alternate leaves have short petioles and ovate to ovate-lanciolate blades with toothed edges. Flowers are few and form in groups of one to three at leaf bases. They have five white petals. The fruit consists of five gray-green hairy carpals that twist upon themselves to form an ellipse about 2 to 4.5 cm long. The seeds are blackish and about 1 mm in diameter (Liogier 1994, Little and others 1974).

Range.—About 40 tree or shrub species of *Helicteres* are found in tropical America and Asia (Griffiths 1994). Cowbush is native to the Bahamas, the Greater Antilles, the Virgin Islands, and St. Martin (Little and others 1974). Planting or naturalization in other areas has not been reported.

Ecology.—Cowbush grows on soils of all textures that are derived from sedimentary, igneous, and metamorphic rocks, including ultramafics. In Puerto Rico, it grows between sea level and 400 m elevation and in areas that receive between about 700 and 1700 mm of annual precipitation. Well-drained soils are required. The species competes well with herbs and shrubs in early and middle secondary forest. It grows on roadsides, in openings, and in low and open forest canopies, but not under closed canopies. Some degree of disturbance appears to be necessary to perpetuate the species. It is common in many partially forested rangelands, but disappears under severe overgrazing or frequent fires.

Reproduction.—Cowbush flowers irregularly through the year. The fruits in a Puerto Rican collection averaged 1.436 g/fruit and contained an average of 152 seeds/fruit. The seeds weighed an average of 0.0032 g/seed or 312,000 seeds/kg. The carpels of the fruits open at the ends to gradually release the seeds as the fruits shake in the wind. To collect small quantities, tear the fruits apart and pick out the seeds or cut off the ends of the fruits and tap them to release most of the seeds. Larger quantities can be obtained by pulverizing the fruits and winnowing the seed. Seeds from the Puerto Rican collection were sown in commercial potting mix and germinated (99 percent) between 11 and 22 days after sowing. Germination is epigeal. Natural seedlings are usually common wherever a seed source is present. However, few progress past the small seedling stage.

Growth and Management.—Growth is relatively rapid after the early seedling stage, but the shrubs are not long-lived (5 to 15 years). The use of containerized seedlings for plantations is recommended.

Benefits.—Cowbush is occasionally planted as an ornamental. It is attractive as a large foliage or background plant and makes an interesting curiosity plant. It has been planted in revegetation projects (Reforesta 2001). The wood of the species is yellow, hard and heavy, but not available in sizes sufficient to be used for anything other than fuel.

The fibrous bark is strong and was once used for making rope (Little and others 1974). Cowbush is reported to have several uses in herbal medicine. A tea made from the wood and leaves is used to treat bilious conditions and as an emetic. A decoction of those same tissues is good for fever and cough, and the cooked root is able to stop bleeding (Liogier 1990). The hairs of the species are reported to cause serious irritation (Jamaicans 2001), but this is not reported by Little and others (1974) and was found to be untrue by the author, at least for Puerto Rican plants.

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***Hibiscus pernambucensis* Arruda** seaside mahoe

MALVACEAE

Synonyms: *Hibiscus tiliaceus* var. *pernambucensis* (Bertol.) I.M. Johnston
Hibiscus tiliaceus ssp. *pernambucensis* (Arruda) Castell
Hibiscus arboreus Ham.
Paritium pernambucense (Bertol.) Don

John K. Francis

General Description.—Seaside mahoe is also known as sea hibiscus and rope mangrove in English, emajagua and majagua in Spanish, and mahoe doux, mahaut, and bois flot in French (Howard 1989, Liogier 1994). It is a large shrub or occasionally a small tree. The species normally grows in tangled thickets formed by stems that sag until they touch the ground and form roots. Simultaneously, sprouts arise from the horizontal stems and grow upward until they in turn become prostrate. Occasionally, especially on dry ground, open-grown individuals grow in a tree-like habit. Adult plants have an aggressive lateral root system with abundant fine roots. The bark of the limbs and trunks is gray and smooth, but can become furrowed and scaly in old stems. The leaves are nearly round (10 to 15 cm in diameter) except for a deeply cordate base and a pointed tip. The petioles are long (6 to 9 cm). Seaside mahoe produces large yellow flowers that change to orange or red as they age. Soon after, 2-cm long, hairy, cone-shaped capsules develop, and upon drying, split open along five lines to release their seeds.

Range.—Seaside mahoe is native to coastal areas of Bermuda, southern Florida, the Bahamas, the Greater and Lesser Antilles, and from Mexico through Brazil on the Atlantic Coast and in Pacific coastal areas from Mexico to Peru (Little and Wadsworth 1964). Seaside mahoe is similar to and once was classified as a variety of *Hibiscus tiliaceus* L. All the New World natives are now thought to be *H. pernambucensis* (Howard 1989).

Ecology.—Seaside mahoe usually grows just inland of mangroves around brackish lakes and along rivers in the lower reaches of their floodplains. Thickets have formed from planted individuals in abandoned subsistence farms in rainy (usually above 2000 mm of precipitation) upland sites with poorly drained soils. It also grows as a beachfront tree in association with *Terminalia catappa* L. (Malavasi and Malavasi 1999). Seaside mahoe grows on hummocks and sand dunes in southern Florida (West and Arnold 1952). The sandy habitat probably has a water table within reach of the roots. Seaside mahoe suffers when there are droughts and appears to require poorly drained sites to form the characteristic thickets. Although the species grows near brackish lakes, it is definitely less tolerant of saline conditions than the mangroves. All textures of soil with a wide range of mineral fertility are represented in seaside mahoe habitat. The northern extent of the range is limited by the frost line.

Seaside mahoe grows in nearly pure stands. Even artificially established stands in upland areas maintain themselves for many decades. This can probably be attributed to its rapid growth, profuse sprouting, and the dense crowns that are formed. Seedlings of other species rarely survive for long. A number of insects have been collected from seaside mahoe (Martorell 1975). Although no insect seriously threatens the species, aphids (Aphidoidea), white flies

(Aleyrodidae), and mealy bugs (Pseudococcideae) sometimes cause chlorosis and slower growth.

Reproduction.—The principal means of reproduction is by the layering and sprouting of prostrate stems. The old prostrate stems eventually die and rot, leaving the sprouts as new, isolated individuals. Seeds are produced in relative abundance and occasionally result in seedlings that can eventually establish new clones. Streams and floodwaters are the only known effective vector of seed dispersal.

In wetter habitat, seaside mahoe flowers continuously throughout the year (Little and Wadsworth 1964). The species flowers seasonally in habitat with drought stress during part of the year. The flowers are pollinated by insects, and yield mature seeds about 1 month later. Fruits can potentially produce at least 40 seeds per fruit. In one collection from upland habitat in Puerto Rico, fruits averaged only 7.7 filled seeds per fruit. In two other Puerto Rican collections from upland habitat, the seeds averaged 0.018 ± 0.006 and 0.024 ± 0.003 g/seed. These seed collections yielded 41 and 53 percent germination, which occurred between 15 and 220 days after sowing. Germination is epigeal. Seedlings are easily raised in the nursery from seed using traditional techniques. Plants can be established from cuttings and air layers (Workman 1980). In one small planting in Puerto Rico, 40 of 140 untreated cuttings (45 cm long and 2.5 cm minimum diameter) placed directly in the planting site rooted and grew aggressively. Plants can also be started from very large cuttings as living fence posts (Little and Wadsworth 1964).

Growth and Management.—Seaside mahoe grows rapidly from sprouts and can extend its leader 3 m or more per year. Seedlings grow slowly at first. A group of 6-month-old seedlings averaged only 17 cm in height. Probably, 1 year is required before nursery seedlings are ready for outplanting. Seaside mahoe may occasionally reach 12 to 15 m in height (Workman 1980), but more typically reaches only 6 m in height and 15 cm in stem diameter. Because the species is mainly valued in natural stands for environmental protection and because it aggressively maintains nearly pure stands, little or no management is required once it is established. One unwanted upland stand was converted to timber species by slashing the seaside mahoe, piling the slash between the planting spots, and planting seedlings of *Eucalyptus grandis* Hill ex Maiden, *Terminalia ivorensis* L., and *Hibiscus elatus* Sw. in the small cleared planting spots with no other treatment. The fast-growing species that were planted overtopped the sprouting seaside mahoe and eventually suppressed them.

Benefits.—The fibrous inner bark was formerly used to make ropes, cords, fish nets, floats, cloth, and mats. It is still used for emergency ties and lashings. The wood is used for fuel in underdeveloped areas (National Academy of Sciences 1983). The flowers make a colorful and tasty addition to salads and can be cooked as a vegetable (Workman 1980). The young leaves, bark, and roots were reportedly used for food during famines in former times (Little and Wadsworth 1964). Bees make honey from the nectar. The plant is used as an ornamental and to stabilize stream banks (Workman 1980).

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***Holodiscus discolor* (Pursh) Maxim.** creambush oceanspray
ROSACEAE

Synonyms: *Spiraea discolor* Pursh
Spiraea ariaefolia Smith in Rees
Schizonotus discolor Raf.
Sericotheca discolor Rydb.

Nancy L. Shaw

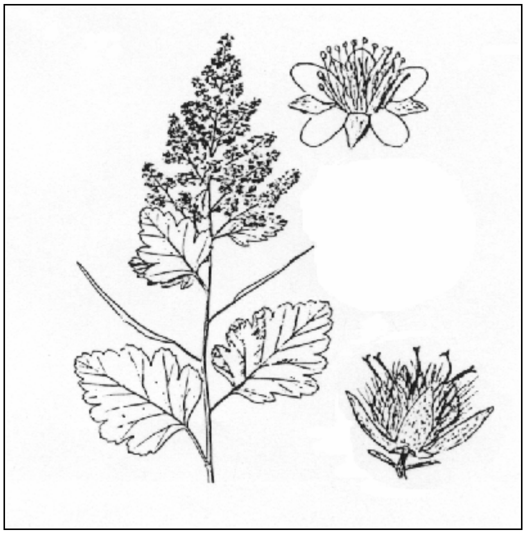

Illustration credits: Hitchcock and others 1961 and E.G. Hurd

General Description.—Creambush oceanspray, also known as arrowwood, hardhack, rock-spirea, and mountain spray, is a usually erect, deciduous shrub with multiple arching branches. Plants range from 1 to 3 (6) m in height. Large tree-like forms grow in coastal areas. Young twigs are finely hairy; bark on older stems is gray to deep grayish red. Leaves are alternate, 2 to 10 cm long, and ovate to ovate-lanceolate with lobed to doubly toothed edges and prominent veins. Upper surfaces are hirsute; lower surfaces are lanate and sometimes glandular. The common name derives from the showy, diffuse, drooping panicles that are 10 to 17 (30) cm long with numerous, tiny, white to pink flowers. Dried flowers and panicle branches turn brown and persist into winter (Hitchcock and others 1961).

Range.—Creambush oceanspray grows at elevations from sea level to 2,150 m. It is most abundant in coastal forests from British Columbia to southwestern California. It occurs eastward to Montana in drier conifer types of the interior Pacific Northwest. It is also common in riparian areas and on rocky talus slopes with shallow sandy to clay loam soils. Remnant stands are found on higher peaks of Great Basin mountain ranges (Hitchcock and others 1961, Stark 1966, USDA Forest Service 1937).

Ecology.—Creambush oceanspray is a prolific root sprouter, capable of recovering from fire, grazing, or mechanical damage. Regeneration from seed following burns is often limited, and seedlings develop slowly (Wright and others 1979). However, regeneration from seed may be important following extremely hot fires (Morgen and Neuenschwander 1988). The species is a host for vesicular-arbuscular mycorrhizae (Berch and others 1988) and *Orobanche pinorum* Geyer ex Hook. (Harrington and others 1999). It is shade tolerant and disease resistant.

Reproduction.—Flowers appear from late spring to mid summer and are insect-pollinated. Fruits ripen in late summer (Hitchcock and others 1961); seed is wind dispersed. Fruits are hand harvested and conditioned by air drying and screening larger material with a fanning mill. Number of cleaned seed/kg exceeds 11 million (King 1947, Link 1993), but few seeds are generally sound. Seed supplies are rare and costly. Moist prechilling at 1 to 2 ^{o}C for 120 days relieves dormancy (Marchant and Sherlock 1984). Natural germination may be enhanced by a heat pretreatment or microsite conditions provided by exposed mineral soils (Morgan and Neuenschwander 1988). Seed may be broadcast over a rough seedbed and covered by natural soil sloughing. It should be planted separately or included in seed mixes of other native species, particularly if broadcast seeded. It should not be seeded with competitive introduced species (Shaw and others 2001). Bareroot and container stock are easily propagated (Everett 1957). Achenes should be fall sown or artificially prechilled and spring sown in the bareroot nursery. Creambush oceanspray wildings and layers have also been used successfully (Kruckeberg 1982). Plants can be grown from cuttings, but rooting varies widely among clones, cutting type, and propagation technique (Antieau 1987, Link 1993).

Growth and Management.—Seedlings develop slowly, producing spreading, fibrous root systems (Wright and others 1979). Growth rate is moderate and protection from introduced grass and forb competition is required for one or two growing seasons. Excessive browsing is rarely a threat to developing seedlings, but they may be girdled by rodents or trampled by big game or livestock. Brush fields may be rejuvenated by prescribed burning at 10 to 15 year intervals (Orme and Leege 1980).

Benefits.—Creambush oceanspray provides habitat for a wide variety of organisms. Its palatability and forage value vary geographically but are generally low for big game and domestic livestock. Use may be greater in winter when other forage is limited. Palatability may be improved following fire. Creambush oceanspray offers considerable potential for revegetating disturbed areas. Populations capable of growing on dry, rocky, well-drained sites or exhibiting low palatability may be particularly valuable. It has been recommended for use in highway plantings, riparian areas, windbreaks, erosion control, wildlife habitat improvement, conservation plantings, and low maintenance landscaping (Antieau 1987). Native Americans ate the seeds and made digging sticks and arrow shafts from the hard, straight branches.

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***Holodiscus dumosus* (Nutt. ex Hook.) Heller** rockspirea

ROSACEAE

Synonyms: *Spiraea dumosa* (Nutt.) T. & G.
Schizonotus dumosus Koehne.
Holodiscus microphyllus Rydb.
Sericotheca dumosa Rydb.

Nancy L. Shaw

Illustration credits: Hitchcock and others 1961 and E.G. Hurd

General Description.—Rockspirea, also known as gland oceanspray, bush oceanspray, mountain-spray, and creambush, is a compact, rounded, intricately branched deciduous shrub 0.1 to 4 m tall with a crown diameter of 1.5 to 3 m (Hitchcock and others 1961, Welsh and others 1987). Leaf blades are oval and shallowly or coarsely lobed or toothed, but generally without secondary teeth. Petioles are decurrent along the stems. Panicles are showy and terminal, overtopping the shrub. Flowers are numerous, small, creamy-white, perfect, perigynous, and insect pollinated. Fruits are tiny hirsute achenes. Roots are densely fibrous and spreading. The species has n = 18 chromosomes (McArthur and Sanderson 1986).

Range.—Rockspirea grows east of the Cascade and Sierra Nevada Mountains from north central Oregon, east to Wyoming, and south to Chihuahua, Mexico at elevations ranging from 760 to 3,660 m (Harrington 1964, Hopkins and Kovalchek 1983).

Ecology.—Rockspirea occurs in a wide array of plant communities including *Artemisia* spp., *Pinus* spp.--*Juniperus* spp. L., *Cercocarpus ledifolius* Nutt., chaparral, *Populus tremuloides* Michx.--*Pinus contorta* Dougl. ex Loud., *Picea* spp.--*Abies* spp., *Pseudotsuga menziesii* (Mirbel) Franco, *Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr., and *Pinus ponderosa* Dougl. (Sutton and Johnson 1974, USDA 1937). It grows as a pioneer species in cracks and fissures on rock surfaces, as a seral species in brush fields of forested areas, and as a climax species in self-replacing, monospecific stands. Within its range it commonly occurs on well-drained, dry to moderately dry sandy or gravelly soils that may be somewhat alkaline, but it is also found on finer-textured soils. Rockspirea often grows on dry, rocky ridges, talus slopes, and basalt outcrops (Hitchcock and others 1961, Welsh and others 1987). It is a prolific root sprouter, capable of recovering from fire, grazing, or mechanical damage.

Reproduction.—Panicles and floral buds develop in early spring, but flowering is delayed until summer or early fall depending upon elevation. Fruits are wind and gravity dispersed through late fall (Hitchcock and others 1961). King (1947) determined that although there are about 12,000,000 seed/kg, only about 7 percent were sound. These required moist prechilling at 5 ^{o}C for 18 weeks to release dormancy. Heat generated by wildfires may also stimulate germination. Seed can be broadcast seeded on a rough seedbed. Planting stock can be grown by fall seeding in the bareroot nursery or planting moist prechilled seed in the greenhouse.

Growth and Management.—Excessive browsing rarely occurs as the species is present primarily in rocky, inaccessible areas and on summer ranges where other species receive preferential use. Based on results of clipping studies in Oregon, Garrison (1953) recommended a maximum of 50 to 60 percent use for sustained production. On some western juniper/big sagebrush habitat types of eastern Oregon, the species tends to increase when other species receive excessive use (Ferguson 1983, Hopkins and Kovalchik 1983).

Benefits.—Rockspirea is a potentially valuable species for revegetation as it is drought tolerant and adapted to sites with dry, rocky, unstable surface conditions in a variety of forested and nonforested communities (Stark 1966). Its use has been limited by a lack of high quality seed supplies. Palatability and forage value of rockspirea are low (USDA 1937), but it does provide food and cover for small animals. Kufeld and others (1973) reported its use by mule deer (*Odocoilus hemionus*) was moderate in fall and light during the remainder of the year. Rockspirea is used in summer by bighorn sheep (*Ovis canadensis*) and rabbits (Sutton and Johnson 1974, Todd 1975). It is an attractive, low water use ornamental. Native Americans made digging sticks and arrow shafts from the hard, straight branches (Anderson and Holmgren 1969, Daubenmire 1970, Hopkins and Kovalchik 1983). Native Americans of the Great Basin ate the seeds, and pioneers made nails from its wood.

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Hyperbaena laurifolia (Poir.) Urban limestone snakevine
MENISPERMACEAE

Synonyms: *Cissampelos laurifolia* Poir. in Lam.
Anelasma laurifolia (Poir.) Meirs
Cocculus laurifolia Eggers

John K. Francis

General Description.—Limestone snakevine is an uncommon scrambling shrub or vine-like small tree. It is also known as hyperbaena, following the convention among natural resources workers to use the Latin genus or species name as a common name. The vine develops a tap and lateral root system. Plants of the species have single or multiple smooth, gray stems with a moderate number of branches and stiff, slender, hairless twigs. Limestone snakevine has alternate, oblong to lanciolate, hairless, leathery leaves with a short petiole and blades from 7 to 16 cm long and 2.5 to 6 cm broad. The leaves are shiny, dark green above and dull, lighter green below, have smooth edges, and may be rounded or pointed at either end. Male and female flowers grow on different plants (dioecious). The individual flowers are tiny, greenish-yellow, and grow in clusters at the leaf bases. The fruits (drupes) that develop are rounded and somewhat flattened, bright red when ripe, 2 to 3 cm broad with a plum-like skin and flesh about 5 mm thick and contain a single seed. The large yellow stone within is grooved and shaped like a crescent curved back upon itself (Liogier 1985, Little and others 1974, Mathias and Theobald 1981).

Range.—Limestone snakevine is native to Puerto Rico, St. Thomas in the U.S. Virgin Islands (Liogier 1985), and Haiti (Mathias and Theobold 1981). It had been reported in Montserrat (Little and others 1974), but apparently this was in error (Howard 1988).

Ecology.—Little and others (1974) and Mathias and Theobald (1981) reported that this species is confined to limestone areas. However, the author knows of two stands near Salinas, Puerto Rico that are growing on soil residual from igneous rocks. Limestone snakevine grows from near sea level to 1,200 m in elevation (presumably in Haiti) (Mathias and Theobald 1981). In Puerto Rico, it grows to elevations of 600 m (Little and others 1974), and in areas that receive from about 800 to about 2000 mm of mean annual precipitation. Limestone snakevine grows in a variety of soils, most of which are very rocky in the currently available habitat. The species is moderately shade tolerant and grows and reproduces mainly under the crowns of trees in remnant and advanced secondary forests.

Reproduction.—Limestone snakevine flowers in the spring and bears fruits during the spring and summer (Little and others 1974). The fruits are easily detached and presumably dispersed by fruit bats. Forty fruits in a Puerto Rican collection weighed an average of 9.31 $\pm$ 0.27 g each. Seeds from that collection averaged 4.18 $\pm$ 0.12 g/seed or 240 seeds/kg. Ninety-eight percent of the seeds sown in potting mix germinated between 45 and 72 days after sowing. Two of the stones produced two seedlings each. Germination is hypogeal, a stiff, well-branched root developing considerably before the top emerges. The tops reach 10 to 15 cm in height from the reserves in the seeds. The seedlings are ready to transplant within a month of emergence. They are hardy and survive well when transplanted from nursery beds to pots. Seedlings are not common in the wild.

Growth and Management.—Limestone snakevine may reach 3 m in height, 8 m in lateral extension, and 10 cm of basal stem diameter. Established plants appear to have a moderate growth rate, and plants known to the author appear to be several decades old. However, no data on growth rate and longevity or experience on management have been published.

Benefits.—The fruits of limestone snakevine are slightly acid, bitter, and unpleasant to the taste and smell. The fruit pulp immediately stains skin and cloth a lasting reddish-brown and might be useful as a natural dye in crafts. The wood is heavy and hard and would certainly be good for small-diameter fuel. The species contributes to the biodiversity of local forests and in a minor way, furnishes wildlife food and cover, and protects against erosion.

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***Indigofera suffruticosa* P. Mill.** wild indigo
FABACEAE

Synonyms: *Indigofera anil* L.
Indigofera truxillensis HBK.
Indigofera divericata Jacq.
Anila tinctoria vera Kuntze

John K. Francis

General Description.—Wild indigo, also known as indigo, Guatamala indigo, añil, añil de pasto, and ti cafe, is a short-lived shrub that reaches 1 to 2 m in height and 1 to 2 cm in stem diameter. The shrub may have multiple stems, especially if it has been disturbed by grazing or fire. The stems are gray-brown, pubescent, and more or less straight. The light green leaves are pinnately compound with 9 to 17 narrowly oblong, pubescent leaflets that are 1.5 to 2.5 cm long and about 9 mm wide. There are 6- to 8-mm lanciolate stipules at the base of the leaves. Crimson to rust-red flowers grow in short, many-flowered racemes. The curved legumes are short (1.1 to 2.5 cm) and contain three to seven seeds that are 1.5 mm wide and 1 mm thick (Howard 1988, Liogier 1988).

Range.—Wild indigo is native to Southern United States through tropical and subtropical South America as well as the Caribbean Islands (Howard 1988). The species has naturalized in Hawaii (Neal 1965) and is present in American Samoa, Guam, and a large number of the Pacific Island groups (Pacific Island Ecosystems at Risk 2001). Wild indigo has been introduced into tropical regions of the Old World (Liogier 1988).

Ecology.—In Hawaii, wild indigo has naturalized in dry, highly disturbed areas from near sea level to 1,160 m in elevation (Pacific Island Ecosystems at Risk 2001). In Puerto Rico, the species grows from near sea level to about 700 m in elevation in areas that receive from about 750 to 1800 mm of precipitation annually. Soils derived from volcanic and sedimentary rocks in a wide range of soil textures are colonized. Good drainage is required, but not high fertility. Wild indigo is not shade tolerant and will not grow under a closed forest stand.

Reproduction.—In Texas, wild indigo flowers from July through November (Everitt and Drawe 1993). In Mexico, fruiting occurs between October and February (Moreno-Casasola and others 1994). The pods remain open on the branches, exposing but not expelling the seeds. Mechanisms of transport have not been reported. The seeds in a collection of fruits in Puerto Rico had been partially consumed by an unknown insect and averaged only 0.9 undamaged seeds per pod. These seeds averaged 0.0039 g/seed or about 257,000 seeds/kg. Of these, 17 percent germinated in 7 to 24 days after sowing. Seed from a Mexican collection gave more than 90 percent germination (in the field) when a mechanical scarification was used and nearly 100 percent when wet-dry cycles were combined with scarification (Moreno-Casasola and others 1994).

Growth and Management.—Neal (1965) reports that in Hawaii, 20,400 kg of wild indigo can be produced per hectare from which 227 kg of indigo paste can be separated. Wild indigo tested for revegetation of soil-lignite overburden varied in biomass yield from 162 to 2,432 kg/ha and maintained from 8 to 30 percent cover over a 3-year period (Skousen and Call 1987). Surface sowing at the start of the rainy season on freshly tilled ground is recommended. Plants usually live 2 or 3 years in Puerto Rico.

Benefits.—Although indigo obtained from other species of *Indigofera* was used in the Old World, the use of wild indigo by pre-Columbian natives of Mexico to dye cloth and paint in various shades of blue was passed down to the Spanish colonists (Haude 1997). *Indigofera* species became important commercial crops in various tropical and subtropical areas. The blue dye was produced by fermentation of the leaves, usually with caustic soda or sodium hydrosulfite, and the exudates processed into dry cake. The blue color developed as the cake was exposed to the air (Simon and others 1984). Indigo was used as a bluing to counter the yellowing in clothes from washing with soap (Vélez and van Overbeek 1950). In the last few decades, natural indigo has been almost wholly replaced by synthetic dyes. Poultices and extracts of wild indigo leaves, alone or in combination with other ingredients, are used in herbal medicine to treat fever, headaches, hemorrhages, convulsions, acute cough, skin parasites, and boils (HealthLink 2001, Liogier 1990). Domestic and wild ruminant animals browse wild indigo plants. It and another *Indigofera* species are reported to be the sole hosts of the false dusky wing butterfly [*Gesta gesta* (Herrich-Schäffer)] (Opler and Malikul 1992). Wild indigo is useful as a natural cover plant in disturbed areas. The species may become weedy, but is seldom aggressive or common enough to cause difficulties in croplands.

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Isocoma tenuisecta Greene — burro weed

ASTERACEAE

Synonyms: *Haplopappus tenuisectus* (Greene) Blake
Aplopappus tenuisectus (Greene) Blake

Juanita A. R. Ladyman

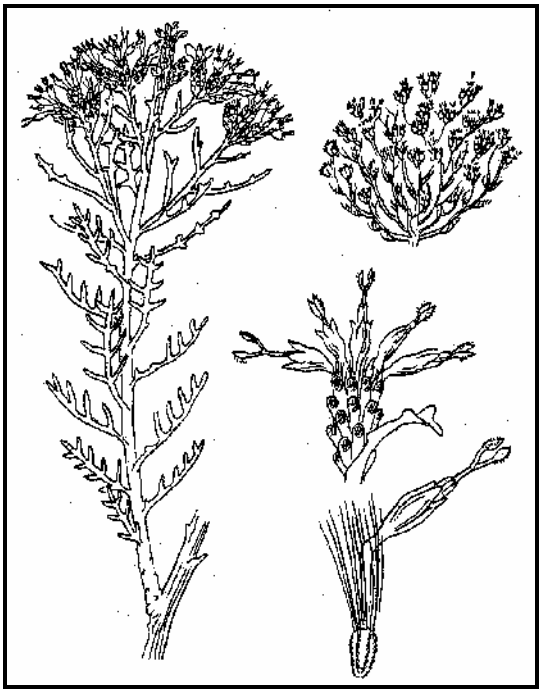

Illustration credit: Robert DeWitt Ivey

General Description.—Burro weed is a compact, rounded shrub, sometimes referred to as a sub-shrub, growing to approximately 1 m high and approximately 1 m wide. Its grayish-green, glandular leaves are pinnately cleft (deeply lobed) into four to eight linear acute lobes. The yellow flowers are discoid, having no ray flowers ("petals"), and are arranged in dense terminal clusters. The flowers dry and turn a light brown color while remaining on the stems (PCC 2001). The bracts around the flowers are also glandular (Martin and Hutchins 1980). Other members of the same genus are called golden weeds or yellow bush (Dayton 1931). Historically, *Haplopappus* was a large and variable genus that was a depository for loosely related "yellow daisies" that shared a limited number of characteristics (Taylor 1998). However, with the aid of molecular (DNA) data and more powerful computer analyses, taxonomists have placed members of *Haplopappus* into different genera, such as *Isocoma, Ericameria, Stenotus and Machaeranthera* (Nesom 1991, Lane and Hartman 1996).

Range.—Burro weed occurs in southwestern Texas, southern New Mexico, southern Arizona and northern Mexico (Kearney and others 1960, Martin and Hutchins 1980, Ivey 1995).

Ecology.—Burro weed grows on dry slopes and mesas between 600 and 2,000 m in elevation. It is a member of various vegetation communities including desert scrub, desert grassland, and pine-oak woodland (Bowers and McLaughlin 1987). Although burro weed can be moderately long lived, up to 20 years, long-term monitoring studies indicate as few as 2 percent survive more than 7 years (Goldberg and Turner 1986). Burro weed has a deep (3 to 6 m long), relatively unbranched, root system but is susceptible to drought and often dies during drought periods (Schmutz and others 1992). However, following droughts burro weed shrubs often increase in number (Schmutz and others 1992). Similar to other species within the *Isocoma* genus, fire easily kills burro weed, but burned sites will eventually become reoccupied (White 1969, Cable 1967). For example, fire reduced a pre-burn shrub density of 3,762 plants per acre to 327 plants per acre that was reduced even further to 87 plants per acre in the following year. Those plants that survived were in unburned or light burned patches within the burn area (Cable 1967). However, the numbers of shrubs gradually increased in subsequent years to number 7,175 shrubs per acre 13 years after the burn. The spatial association between different three-awn grass species and burro weed is an interesting example of the tradeoffs between protection and liability of a potentially advantageous microclimate and refuge. Santa Rita three-awn (*Aristada glabrata (*Vasey*)* Hitchc.) grows between burro weed individuals, whereas some other three-awn species, such as *Aristida hamulosa* Henr. and *Aristida ternipes* Cav., grow within the burro weed crowns. The latter species are subjected to greater heat in the smoldering, resinous crowns than in the open areas and, in combination with the shallow subsurface buds that characterize all three-awns, suffer a higher mortality rate than the Santa Rita three-awn (Blydenstein 1966, Cable 1967, McPherson 1995).

Reproduction.—Burro weed flowers from August into October (Martin and Hutchins 1980). The seeds (achenes) are partially covered by silky hairs (Martin and Hutchins 1980). The long hairs that comprise the pappus at one end of the seed aid dispersal (Parker 1990).

Growth and Management.—Burro weed is a resilient species that can flourish on highway shoulders, parking lots, dirt roads, vacant lots and other disturbed areas. It tends to be sporadically scattered on range covered by perennial bunch grasses. However, on disturbed ranges, with even a good stand of annual grasses, it can become one of the principal plant species (USDA FS 1988). Burro weed foliage is poisonous to livestock (AVDL 1998, Bowers 1993). Horses are most sensitive while sheep are least sensitive. If livestock eat large amounts of the vegetation they suffer from "trembles," "alkali sickness," or "milk-sickness" and humans can become ill after drinking the milk from affected cows (Dayton 1931, Epple 1995). The toxic substance transmitted by the milk is called tremetol (AVDL 1998, Kingsbury 1964). Many other species of *Isocoma* contain the same toxic constituent (AVDL 1998, Kingsbury 1964). As a consequence of its toxic properties, livestock avoid it unless there is nothing else to eat. In overgrazed land burro weed behaves as an invasive weed (Whitfield and Anderson 1938, Parker 1990).

Benefits.—Burro weed provides cover and stabilizes soils that are denuded by overgrazing or other disturbance. It adds to the biodiversity of communities of which it is part and may be important for pollinators and other arthropods in areas that are depauperate in native species.

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***Itea virginica* L.** Virginia sweetspire

SAXIFRAGACEAE

Synonyms: None

Kristina Connor

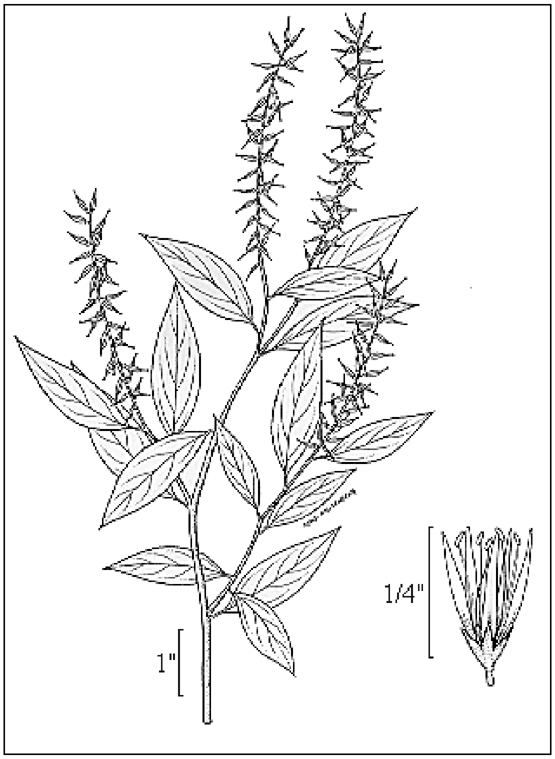

Illustration source: U.S. Department of Agriculture [No date]

General Description.—Virginia sweetspire, also known as sweetspire, tassel-white, Virginia tea, or Virginia willow, is an upright, multistemmed, deciduous or semievergreen shrub with arching branches (Bailey and Bailey 1976, Krüssmann 1984, Odenwald and others 1996). The branches are light green or brown, pubescent when young, while old stems are glabrous, gray and striated. Twigs are slender and may be red when young (Krüssmann 1984) or in the fall (Seiler and Peterson 2001). The medium to dark green, simple, alternate leaves are elliptic to oblong in shape, glabrous above and finely pubescent beneath, four to 10 cm long, and have finely toothed margins. The plants are noted for their racemes of white flowers in early summer and their brilliant red to reddish purple foliage in autumn. Leaves can remain on the plant in a mild winter or in the more southern hardiness zones. Virginia sweetspire can occasionally attain the form of a small tree but is generally multistemmed and reaches a height between 0.9 and 2.4 m. This species has also been placed in the Grossulariaceae and Iteaceae (USDA-ARS-GRIN 2001, USDA-NRCS 2001).

Range.—Virginia sweetspire is found throughout the Southeastern United States, from the Atlantic to eastern Texas and Oklahoma, although it is uncommon in the latter state (Johnson and Hoagland 1999). It can be found in wetlands as far north as Maryland, Delaware, and New Jersey and as far south as Florida. It is also found in southern Illinois and throughout the Mississippi River Valley.

Ecology.—Virginia sweetspire grows primarily in wet areas, in swamps, along stream beds and lake edges, and in floodplains where it can form thickets. However, it can thrive in a variety of soil types and pHs and also shows tolerance to droughty conditions (Bailey and Bailey 1976, Odenwald and others 1996, Ohio State University 2002). The species is tolerant of various light regimes and will grow well in both the sun and the shade; however, it can become leggy and sparse in the shade. It flowers more prolifically and has optimal fall coloration when grown in full sun. The species is highly adaptable and tough.

Reproduction.—Virginia sweetspire is named for its drooping to upright 5 to 15 cm-long pubescent, terminal racemes of fragrant, white flowers that occur from early spring to early summer. Individual flowers have five petals and five sepals and are small, only 6 to 9 mm across (Johnson and Hoagland 1999). Flowering period is fairly long, lasting from May to early July (Krüssmann 1984). Brown seeds are produced in small elongate capsules with cranesbill-like projections (The Ohio State University 2002). Capsules can remain on the plant long after leaf fall. Seeds are quick to germinate and reportedly require no pretreatment for germination to occur. Virginia sweetspire can be propagated by rooting cuttings, from seed, or from root suckers (Bailey and Bailey 1976).

Growth and Management.—Virginia sweetspire is semievergreen and fairly long lived. With its long flowering period and attractive fall foliage, the species can do well in landscape plantings. Its adaptability to both sun and shade, and to wet and dry areas, gives it a versatility lacking in some other shrub species. However, it can grow beyond desired boundaries because it spreads by root suckers, and if not pruned it will form thickets. It grows fairly rapidly and easily from basal shoots and is relatively free from insect pests and diseases (The Ohio State University 2002).

Benefits.—The dense thickets of Virginia sweetspire provide cover for wildlife (Silberhorn 1996). Although the dry fruit capsules and small seeds are not a preferred food, they are eaten by birds. The species can be used for erosion control on wet or sloped sites. The fragrant flowers are attractive to butterflies.

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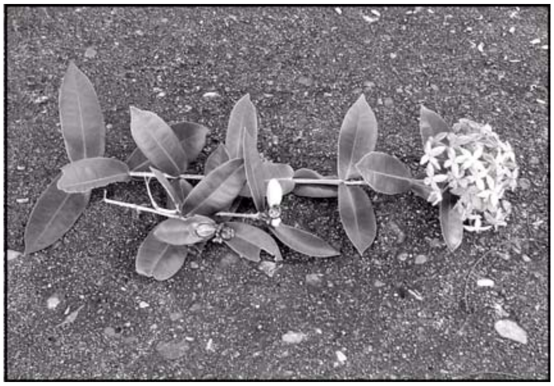
***Ixora coccinea* L.** jungle-geranium

RUBIACEAE

Synonyms: *Ixora grandiflora* Bot.
Ixora bandhuca Roxbg.

John K. Francis



General Description.—The common name of this plant, jungle-geranium, seems to be in slightly more common use than others: flame of the woods, flame of the forest, jungle flame, burning love, red ixora, ixora, amor ardiente, cruz de Malta, bola de coral, equisósea, and rajana (Griffiths 1994, Liogier 1997). Jungle-geranium is a densely branched shrub to 3 m in height and 3 or 4 cm in basal diameter. The stems and branches are gray. The plant produces a strong taproot with fine laterals. Mycorrhizal bifurcation is visible on the tips of fine roots. The dark green, oblong leaves are sessile or subsessile and hairless or nearly so (Liogier 1997). The inflorescences are terminal, dense corymbs that contain from 15 to 50 flowers (Whistler 2000). The flowers are tubular with four or five calyx lobes. The "wild" flower color is red or red-orange, but ornamental varieties may have white, yellow, salmon, or pink flowers. There are also dwarf varieties. The fruits are fleshy, globose berries that ripen to a dark red or purplish-black (Liogier 1997). When fully developed, there are two seeds per fruit. However, usually one develops and one aborts in Puerto Rican plants.

Range.—Jungle-geranium is native to India and Sri Lanka (Griffiths 1994). It is planted worldwide in tropical and subtropical climates and has naturalized in at least Puerto Rico (author's observation, Liogier 1997).

Ecology.—Jungle-geranium grows well in full sun and light to moderate shade. It competes well with shrubs and herbs but not with dense grass. Little is known about environmental conditions in its native range, but it grows naturally in Puerto Rico in areas that receive around 1800 mm of annual precipitation. Jungle-geranium grows well in all textured soils if moisture is adequate and drainage is good. The species prefers slightly acid soils with good fertility and becomes chlorotic under alkaline conditions. It tolerates mild salt spray (Watkins and Sheeham 1975). Jungle geranium is cold sensitive and will partially defoliate after chilling (Michaelia and others 1999). Frosts will kill it to the ground, but it recovers afterward (Tropilab 2001). Jungle-geranium in Florida is damaged by nematodes, root rot, leaf spots, and scale insects (Florida Gardener 2001).

Reproduction.—Jungle-geranium flowers throughout the year in full sunlight and light shade (Whistler 2000). Shrubs in heavy shade survive but rarely flower. A collection of fruits in Puerto Rico averaged 0.618 $\pm$ 0.015 g/fruit. Air-dry seeds from these fruits averaged 0.067 $\pm$ 0.001 g or 15,000 seeds/kg. Planted in commercial potting mix, 70 percent of these seeds germinated between 30 and 72 days following sowing. Jungle-geranium coppices when cut or burned and prostrate plants send up numerous vertical shoots. Frequent suckering occurs from lateral roots out to a distance of 30 cm or more from the parent plant. It also layers whenever a branch touches the ground. Jungle-geranium can be easily propagated from untreated cuttings with four leaves placed in a sand-peat mixture with bottom heat (Bailey 1941). Jungle-geranium is spreading slowly in Puerto Rico, presumably dispersed by birds.

Growth and Management.—Suckers and sprouts may grow as much as 1 m the first year, after which growth slows. Individual stems live at least 15 years; by coppicing and suckering, a plant may live almost indefinitely. Maintenance of jungle-geranium in hedges requires frequent pruning. The shrub is difficult to kill by mechanical means.

Benefits.—Jungle-geranium is one of the world's most popular tropical flowering shrubs. It is used for hedges and borders, for accent plants, in planters and as an indoor potted plant. The species may also be shaped into bonsais (Frommer 2001). In laboratory tests, extracts of jungle-geranium have shown antibacterial (Kumer and others 1997) and antitumor (Latha and Panikkar 2000, Serrame and Lim-Sylianco 1995) activity. From a methanol extract of the flowers, 13 chemicals were identified, including ursolic acid, which has known antitumor and antiviral activity (Monteath and others 2001). In the traditional medicine of India, infusions of the leaves and juice from the roots are used to treat a wide variety of ailments including dysentery, ulcers, and gonorrhea (Parrotta 2001). The flowers are visited by butterflies (Collins 2001), and birds eat the fruits.

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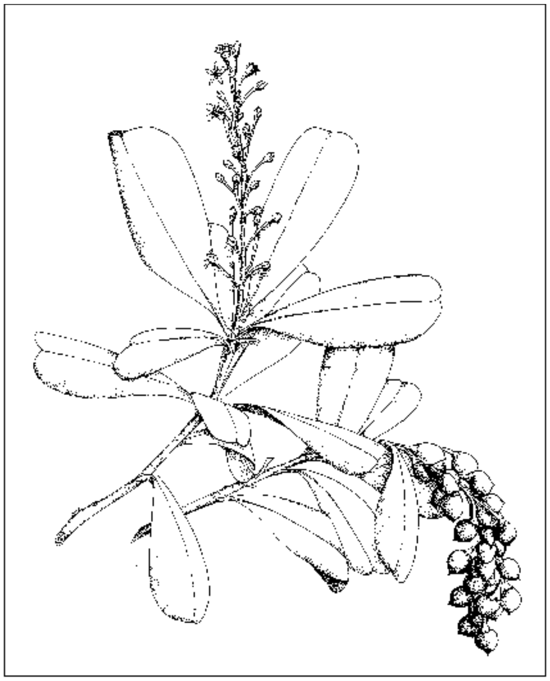
Jacquinia arborea Vahl barbasco
THEOPHRASTACEAE

Synonyms: *Jacquinia armillaris* Jacq.
Jacquinia barbasco Mez in Engl.
Chrysophyllum barbasco Loefl.

John K. Francis



General Description.—Barbasco, also known as torchwood, azúcares, and bizcocho, is an evergreen shrub or small tree to 4.5 m in height and 15 cm in stem diameter. It has a frequently thickened rootstalk and one or a few stems. The bark is dark brown and finely fissured, and the inner bark is light brown and bitter. The wood is light brown or yellowish and hard. The crowns are compact and often wind-hedged in their sea-side habitat. The thick and stiff, dull yellow-green leaves are spatulate or obovate, alternate or in threes, and clustered at the ends of the twigs. Terminal racemes are several to many-flowered. The small, white or yellowish, five-lobbed flowers are fragrant. The fruit (berries) are globose 8 to 12 mm in diameter, orange-red, and contain one to four rounded, brown seeds (Howard 1989, Liogier 1995, Little and others 1974).

Range.—There has been confusion about the botanic identity of barbasco. Stahl (1992) concluded that three species should be recognized from the *J. armillaris* group: *J. keyensis* Mez from the Northern West Indies (Florida and the Bahamas), *J. arborea* in the Central Caribbean, and *J. armillaris* Jacq. in the Lesser Antilles, northern South America, and eastern Brazil. Stearn (1992) gives the range of barbasco as the Cayman Islands, Jamaica, Hispaniola, Puerto Rico, the Virgin Islands, the Lesser Antilles, Trinidad, and Curaçao. He has *J. arborea* and *J. armillaris* coexisting in the Lesser Antilles. The Missouri Botanical Garden Herbarium lists specimens for Jamaica, Puerto Rico, the Virgin Islands, Quintana Roo, Mexico, and Honduras (Missouri Botanical Garden 2002). Barbasco is reported to have naturalized on Key Largo, Florida (Nelson 1996).

Ecology.—Barbasco is relatively common along undisturbed coasts. Because the species is intolerant of shade and not very competitive, it usually grows on rocks and rocky headlands, exposed ridges and slopes, and dry coastal forests. In Puerto Rico, barbasco grows in areas that receive from 750 to 1700 mm of annual precipitation at elevations from near sea level to 100 m. It is tolerant of heavy salt spray and moderately salty soils. Barbasco grows on well-drained, mildly acid to mildly alkaline soils of all textures derived from both sedimentary and igneous rocks. It is frequently seen growing out of cracks in limestone rocks. The species appears to have no major insect or disease problems.

Reproduction.—Barbasco flowers from winter to summer and matures fruits from spring to fall (Little and others 1974). Fruits collected in Puerto Rico averaged 0.254 ± 0.005 g/fruit. Air-dried seeds cleaned from those fruits averaged 0.0363 ± 0.0007 g/seed or 27,500 seeds/kg. Sown without any pre-treatment in commercial potting mix, 100 percent of the seeds germinated between 40 and 60 days of sowing. Seeds are easily collected by hand and can be cleaned by maceration and wet sieving. The seeds are probably dispersed by birds. Seedlings are not common.

Growth and Management.—Growth of barbasco seedlings in the nursery is very slow. A group of seedlings averaged only 6.2 cm 1 year after pricking into containers. However, survival was relatively good (82 percent). Growth of native-grown plants of all ages is also believed to be very slow. They seem to be long-lived. Probably the best strategy for management of native stands is strict protection from fire, harvesting, and development.

Benefits.—Barbasco helps hold the soil in topography where there is little soil to lose and contributes significantly to the aesthetics of island coastlines. The fruits were once used to poison or stupefy fish and because of that are suspected to be poisonous to humans (Little and others 1974). The sister species *J. keyensis* is used as an ornamental (Nelson 1996), and probably barbasco has been used as well. It is a pretty and well-shaped plant, suited for borders and low backgrounds.

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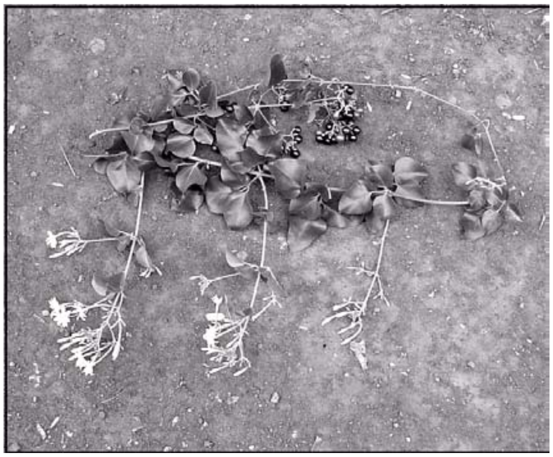
***Jasminum fluminense* Vell.** Brazilian jasmine
OLEACEAE

Synonyms: *Jasminum azoricum* auct., not L.
Jasminum bahiense DC.

John K. Francis



General Description.—This plant became known as Brazilian jasmine because it was first described from Brazil. It is of African origin, having been introduced earlier by Portuguese settlers (Florida Exotic Plant Council 2001). The species is also known as jasmine, Gold Coast jasmine, jasmín oloroso, jasmín de canario, jasmín de trapo, jasmin à bouguet, and jasmin blanc (Acevedo-Rodríguez 1985, Howard 1989, Pacific Islands Ecosystems at Risk 2001). Brazilian jasmine is a woody evergreen scrambling and climbing shrub (vine) that may extend as much as 12 m along the ground or into the crowns of trees. The cylindrical stems, which are commonly about 1 cm in diameter but may grow to 5 cm, have gray, fine-furrowed bark and are flexible and strong. There are often multiple stems from a root crown. Foliage is borne only on the current year's growth. The opposite, compound leaves have three leaflets, the central one being larger than the lateral two. The inflorescences are cymes that arise from leaf axils. The tubular white flowers are fragrant, especially at night. The fruits, which form in groups of two, are globose, 8 mm in diameter, and dark purple or dark blue to almost black when ripe (Acevedo-Rodríguez 1985, Howard 1989, Liogier 1995). The fruits have a bitter, disagreeable flavor. Each fruit contains one spherical gray seed.

Range.—The African and Middle Eastern native range of Brazilian jasmine includes Mauritius, the Seychelles, Arabia, Ethiopia, southern Zimbabwe, Malawi, Mozambique, Angola, Nigeria, South Africa (Miami-Dade County 2001), the Azores, and the Canary Islands (Acevedo-Rodríguez 1985). The species has naturalized and escaped throughout much of the tropics and subtropics including southern Florida (Florida Exotic Plant Council 2001), Puerto Rico (Liogier 1995), Hawaii, and Guam (Pacific Island Ecosystems at Risk 2001).

Ecology.—Brazilian jasmine occurs in Puerto Rico in areas that receive from about 750 to 1800 mm of annual rainfall. It grows from near sea level to more than 600 m in elevation. Soils of all textures and parent material are colonized. However, it does not tolerate poorly drained soils. The species is restricted to areas with minimum temperatures above 1.7 °C (Florida Exotic Plant Council 2001). It will grow on the coast in areas that do not receive salt spray (Florida Exotic Plant Council 2001). Brazilian jasmine will grow in partial shade and climb upward to better light. It can survive but is not aggressive in the denser shade of unbroken forest canopies. Most plants grow in natural and artificial openings in the forest such as fencerows, river banks, roadsides, brushy pastures, and logged or burnt-over forest.

Reproduction.—Brazilian jasmine blooms throughout the year (Miami-Dade County 2001). Under favorable conditions, fruits are produced in abundance by open-grown plants. Shaded plants produce few or no fruits. A collection of fruits of Brazilian jasmine from Puerto Rico weighed an average of 0.413 ± 0.066 g each. Air-dried seeds from those fruits averaged 0.164 ± 0.002 g/seed or 6,000 seeds/kg. Sown on commercial potting mix, 100 percent of the seeds collected from this sample germinated between 18 and 52 days after sowing. Brazilian jasmine roots (layers) whenever stems come in contact with the ground. The seeds are dispersed by birds and mammals (Miami-Dade County 2001) and by the lateral extension of the stems. Seedlings are common in suitable habitat in Puerto Rico. Ornamental plants are propagated by means of cuttings (Florida Exotic Plant Council 2001).

Growth and Management.—The stems of established plants may extend as much as 2 or 3 m in 1 year. Seedlings grow much more slowly. Brazilian jasmine can engulf shrubs, small trees, and fences and can ascend power poles. Control of thickets and mats is often needed. Young plants can be pulled up by hand. Older plants should be cut at the ground level and the stumps treated with herbicide. Follow-up treatments will probably be required (Pacific Island Ecosystems at Risk 2001).

Benefits.—Brazilian jasmine has been widely planted as an ornamental, both in greenhouses and outdoors (Bailey 1941, Liogier 1995). Because of its invasive nature, the species should not be planted where it might escape to the wild (Nelson 1996). It is a food source for birds and mammals. The fruits are heavily consumed by raccoons in Florida (Miami-Dade County 2001). Goats browse the foliage.

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***Jatropha gossypiifolia* L.** red physic nut

EUPHORBIACEAE

Synonyms: *Adenoropium gossypifolium* Pohl
Jatropha elegans (Pohl) Klotzsch in Seemann

John K. Francis

General Description.—Red physic nut, also known as belly-ache bush, figus nut, wild cassava, higuereta cimarrona, tautuba, túatúa, purga del fraile, médicinier noir, médicinier bâtard, médicinier rouge, is a short-lived perennial shrub 0.5 to 2 m in height and 1 to 3 cm in basal diameter. It may be evergreen or deciduous, depending on climate. The plant usually has a single stem and is woody at the base. The small number of branches are stout, green, and semi-woody. A cloudy, yellow sap collects when stems and branches are cut. Red physic nut has a short taproot, robust laterals, and many fine tertiary roots and is usually not deeply rooted. The opposite leaves are three- or five-lobed, 3 to 13 by 3 to 19 cm, reddish or purplish tinged when young and green when fully developed. Small red or purple flowers are borne in terminal corymbose cymes. The fruits that follow are oblong, three-lobed capsules that are green, turning tan at maturity. Within are three mottled, gray-brown or grayish-red seeds (Burkill 1994, Howard 1989, Liogier 1988, Parrotta 2001).

Range.—Red physic nut is a native of the New World (Burkill 1994). The original range is not known, but today it grows wild from Florida through the West Indies and from Mexico through tropical South America (Howard 1989). It has naturalized in most tropical areas of the world (Burkill 1994).

Ecology.—Red physic nut grows on nearly all types of soils within its range. In Puerto Rico, it may be found in areas receiving from 750 to about 2000 mm of annual precipitation. The species is more common in soils with high base saturation, such as dry areas, sites near the ocean, and soils derived from limestone. Red physic nut usually requires disturbance to establish itself and does not compete well with tall grass or heavy weed growth. It is intolerant of shade. Although plants may survive for a season in moderate shade, they need full or nearly full sun for longer-term survival and fruiting. Cattle and horses generally avoid red physic nut, except in extreme shortages of forage, so that the species in often abundant in overgrazed range and poorly managed pastures. It is also common in waste lands, roadsides, poorly tended agricultural fields, and river overflow areas.

Reproduction.—Flowering in India occurs from February through July (Parrotta 2001). Sometimes both flowers and fruits will be present at the same time on plants. Upon drying, the capsule valves spring open propelling the seeds a few centimeters. It is not known if there are other seed dispersal mechanisms. Seeds collected in Puerto Rico averaged 0.017 ± 0.001 g/seed or 59,000 seeds/kg. The seeds of this collection were highly variable in weight (C.V.= 53.7 percent) and just 4 percent germinated. Collecting seed in quantity is difficult because capsules are mature for only a short period before discharging their seeds, and there are only a few capsules per large plant at any time.

Growth and Management.—Red physic nut usually grows without branches during its first year and adds adventitious branches in the year or two following. Growth is about 0.5 m per year and plants usually live 2 or 3 years. The species is considered an agricultural weed but can be suppressed by common weed-control practices.

Detriments and Benefits.—Red physic nut contains toxins in the seeds, sap and other tissues, capable of killing humans (Marcano-Fondeur 2002). Apparently, poisoning cases are rare. Extracts of the plant are used as a purgative and emetic, and to treat headache, diarrhea, venereal disease, skin sores, mouth sores, and cancer (Burkill 1994, Parrotta 2001). The use of the seeds in herbal medicine is advised against because of their high toxicity (Liogier 1990). Phytoactive chemicals found in tissues of red physic nut include the protease curcain, the alkaloid jatrophine, the cyclic heptapeptide, cyclogossine A, saponins, and numerous fatty acids (Burkill 1994, Horsten and others 1996, Marcano-Fondeur 1992, Ogbobe and Akano 1993). The seeds contain 36 percent oil (Ogbobe and Akano 1993) and are used as an illuminant in Africa (Burkill 1994). Swaths of plants are frequently established around villages in Africa as fire barriers. The species is also attributed magical powers that protect against lightning, snakes, and violence (Burkill 1994). The wood is soft and weak and of little use. A red-leafed variety is used as an ornamental (Howard 1989).

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***Juniperus communis* L.** common juniper
CUPRESSACEAE

Synonyms: *Juniperus canadensis* Lodd. ex Burgsd.
Juniperus alpina (Sm.) S.F. Gray
Juniperus sibirica Burgsd.

Juanita A. R. Ladyman

Illustration source: USDA-Forest Service collection, Hunt Institute

General Description.—Common juniper is known by a variety of common names: dwarf, low, mountain, alpine, prostrate or Siberian juniper, ground cedar, genevrier commun, and enebro (Elmore 1987, FNA 1993). There are several sub-species or varieties, each having several synonyms. For a list of the synonyms consult Kartesz (1994). Common juniper is a low shrub, with spreading or ascending branches, that generally grows no more than 1 m high. Larger individuals, up to 10 m, have been observed. It typically forms dense mats 1 to 4 m in diameter. The brown fibrous bark is smooth on small branches (<1 cm diameter) but exfoliates into thin strips on larger branches. The leaves are awl-shaped, in groups of three and tend to be "prickly" standing out from the stems. Common juniper is listed as extremely rare or critically imperiled in many Southeastern States, including Georgia (Georgia Natural Heritage Program 2001) and Alabama (Alabama Natural Heritage Program 1996), or of likely rarity in South Carolina (South Carolina Heritage Trust 2000).

Range.—The range of common juniper is extensive. It is the only circumpolar conifer in the northern hemisphere (Pojar and Mackinnon 1994). It is found across the U.S.A. and Canada to Greenland, through Europe, across Siberia and Asia. However, within its range there are at least five sub-species or varieties (FNA 1993). For example, var. *depressa* occurs throughout much of Canada and the United States where it occurs in the Southwestern States of Arizona, New Mexico, Colorado, and Utah and extends west to California and east to North Carolina through Arkansas; var. *megistocarpa* occurs in Nova Scotia, Newfoundland, and Quebec; var. *montana* occurs in Greenland, British Columbia, and California, Oregon and Washington States (FNA 1993); var. *communis* and var. *nana* occur in Britain and Ireland (Stace 1997). Larger specimens of var. *depressa* in the United States have frequently been misidentified as var. *communis* (FNA 1993).

Ecology.—Common juniper is a hardy shrub that grows in a wide range of ecological conditions. Typically it grows on dry, open, rocky slopes and mountainsides but may be found in stressed and acid environments where competition with other plants is almost non-existent (Ward 1982). It also often grows in partial shade. Depending upon the latitude it can be found from lowland bogs at sea-level to sub-alpine ridges and alpine tundra at over 3,600 m (FNA 1993; Lanzara and Pizzetti 1977; Pojar and Mackinnon 1994). It is also a common shrub in abandoned lowland fields in Northern United States (Steele 1982).

Reproduction.—Common juniper has berry-like female cones that mature in 2 years in Mediterranean climates and every 3 years in cooler climates (Lanzara and Pizzetti 1977). Male and female cones are on separate plants. The dark blue seed (female) cones are globose to ovoid in shape, 6 to 13 mm in diameter and are resinous to obscurely woody with two to three triangular-shaped seeds. From pale green the female cones ripen to dark blue in late summer and then tend to whiten with a waxy “bloom.” The staminate cones are 3 to 6 mm in diameter (Cronquist and others 1972). Although the cones are generally terminal in other species of juniper, in *J. communis* the cones are axillary (FNA 1993). The fruits are of relatively low nutritional quality and on average number 80,500 seeds/kg (Stiles 1980). The seed is dispersed by birds, at least in North America, and commonly require a long maturation and germination period (Crane and Fischer 1986; Stiles 1980). Because seeds do not readily germinate, the establishment of seedlings, for example for re-vegetation projects, can be a problem (Dietz and others 1980, Stiles 1980). As well as poor germination, poor seed dispersal has been blamed for the relative rarity of juniper in areas where the majority of potential habitat is not occupied (Diotte and Bergeron 1989). Plant age also affects reproduction; 40 to 60 percent of old individuals are sterile and up to 94.8 percent of seeds of seed-producing old plants are non-viable. In contrast, 80 percent of seeds produced by young plants are viable (Diotte and Bergeron 1989).

Growth and Management.–Common juniper is often killed by fire (Crane and Fischer 1986). It has been described as having minimal “fire-surviving regeneration properties," and resprouting after fire is rare (Mallik 1995). The foliage is resinous and flammable (Diotte and Bergeron 1989). Mortality depends upon fire intensity. For example, in eastern Canada, older common juniper shrubs will survive fires of low severity, and some fire regimes allow common juniper to survive several fires; individuals of more that 170 years old have been observed to survive in areas exposed to fire (Diotte and Bergeron 1989). However, it should be noted that the patchy nature of fires leads to refugia for juniper shrubs, and so particular individuals can escape from harm and provide seed for re-vegetation of the burnt areas (Diotte and Bergeron 1989). Re-establishment of common juniper as a browse species after disturbance and fire has had varying success (Dietz and others 1980). In the Black Hills, South Dakota, the only successful means for establishing common juniper was from nursery stock, and seed germination was particularly poor.

Benefits.—Common juniper has low value for short-term re-vegetation projects but moderate to high value for long-term rehabilitation projects and is useful in preventing soil erosion (Tirmenstein 1999). Common juniper provides important cover and browse for wildlife such as mule deer (Dusek 1975). The cones are eaten by several species of birds and are important food sources for wild turkeys (Decker and others 1991), Cedar and Bohemian waxwings (Catling and Brownell 1998), and others. Domestic livestock rarely utilize common juniper (Tirmenstein 1999). The seed cones of common juniper are used to flavor gin, and the word for this alcoholic beverage was derived from the Latin “iuiperus” through the Old French and Dutch words “genevre” and “genever” respectively (Elmore 1987). The seed cones are also used as a flavoring for foods. Many Native American tribes used common juniper for medicinal and ceremonial purposes (Moerman 1998). It has been used medicinally for childbirth and to treat urinary infections (Pojar and Mackinnon 1994). However, it can also cause miscarriages. The different varieties of common juniper make excellent, vigorous landscaping shrubs, which are readily propagated by cuttings in the horticultural trade (Cronquist and others 1972).

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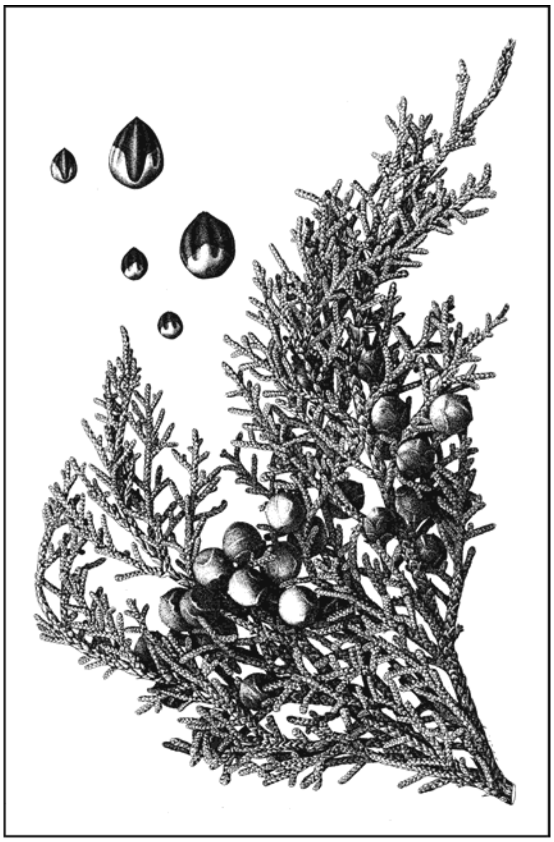
***Juniperus osteosperma* (Torr.) Little** Utah juniper

CYPRESSACEAE

Synonyms: *Juniperus utahensis* (Engelm.) Lemmon
Juniperus californica Carr. ssp. *osteosperma* (Torr.) E. Murr.
Juniperus californica Carr. var. *utahensis* Engelm.
Juniperus knightii A. Nels.
Juniperus megalosperma Sudworth
Juniperus occidentalis Hook. var. *utahensis* (Engelm.) Kent
Sabina osteosperma (Torr.) Antoine

John K. Francis



General Description.—Utah juniper, also known as cedar, desert cedar, sabina, and sabina morena, has a habit between that of shrub and tree. Although slow-growing and long-lived, rare individual plants attain large diameters (record tree: 217 cm diameter breast height and height 11.6 m, American Forests 1998). The species is short statured, (mainly 2 to 4 m tall), (Welsh and others 1987), usually has multiple stems (limbs arising near the ground that become codominant with the original central stem), and becomes reproductively mature at small sizes. The bark is gray-brown or gray, thin, fibrous, and shredding. Sapwood is white and the heartwood is yellow-brown with narrow annual rings. It is relatively soft, brittle, and has a dry-weight specific gravity of 0.553 g/cm^3 (Paettie 1953). The wood and all other parts are aromatic. Crowns tend to be branchy, rounded to flat-topped, and sometimes dense; old trees often have bleached, dead limbs. Utah junipers have deep taproots and lateral roots that may extend as much as 30 m, a few cm below the soil surface. The roots are colonized by vasicular-arbuscular mycorrhizae. The photosynthetic organs are yellow-green branchlets with opposite (or whorled), reduced scale-like leaves. The species is monoecious with small, separate male and female flowers. Fruits are subglobose, 6- to 12-mm diameter, leathery cones ("berries"), brownish to blue-purple at maturity. They have a strong, resiny flavor and contain one (sometimes two) hard seed (Abrams 1940, Welsh and others 1987, Zlatnik 1999).

Range.—Utah juniper occurs as large populations and scattered disjuncts in southern Idaho, southern Montana, Wyoming, western Colorado, Utah, Nevada, Arizona, eastern and southern California, northeastern New Mexico, and Chihuahua and Durango in Mexico (Natural Resources Conservation Service 2003, Secretaría de Medio Ambiente y Recursos Naturales 2003, Tree Guide 2003). The species is not known to have naturalized outside its native range. It hybridizes with *J. occidentalis* Hook. where the species grow together (Terry and others 2000).

Ecology.—Utah juniper grows on a wide variety of well-drained soils. It accommodates all the soil textures, pH's of 6.5 to 8.2, high free calcium carbonate, but does not tolerate salty soils (Natural Resources Conservation Service 2003). It is commonly found on rocky, gravely, and sandy sites, usually originating from igneous (Stuart and Sawyer 2001) and sedimentary (sandstone and limestone) rocks, at 900 to 2,500 m above sea level (Zlatnik 1999). Mean annual precipitation varies from 300 to 510 mm, but the species can withstand severe droughts (Natural Resources Conservation Service 2003) and is a fierce competitor for the little available moisture in its habitat. It has a specific leaf area of 18 cm^2/g (Grier and others 1992). Utah juniper also tolerates cold and heat well. However, the species is intolerant of shade and does not survive under the canopy of taller vegetation. It is alleged to exert an allelopathic effect on some understory grass species. Utah juniper is a climax species in many vegetation types with species such as *Artimisia tridentata* Nutt., *Pinus edulis* Engelm., and *Pinus monophylla* Torr. & Frém. The range of Utah juniper is known to have expanded since European colonization, and stands have changed from open, savanna types to dense stands probably because of reduction of fine fuels by livestock grazing, fire suppression, and changes toward warmer and drier climates (Tausch 1999). Utah juniper is easily killed by fire, both by scorching the top or heat-girdling through the thin bark. However, the habitat seldom has sufficient fine fuels to sustain a fire. Stands most at risk are young stands with scattered trees in brush and grass, and continuous stands of large, decadent trees during high winds (Zlatnik 1999). Utah juniper is sometimes heavily infested by the mistletoes, *Phoradendron juniperinum* Engelm. ex Gray and *P. bolleanum* (Seem.) Eichl. (Zlatnik 1999). The larvae of *Eurytoma juniperina* Marcovitch attack the seeds (Bonner 2003).

Reproduction.—Utah juniper flowers from January to April (depending on site) and is wind pollinated. Fruits ripen in the second year and germinate the following spring or the second spring after dispersal (Zlatnik 1999). Fruits may be collected by hand from the shrubs or low trees or picked up by hand after they have fallen. Seed should be extracted by maceration with water before the fruits dry out. Cleaned seed from Arizona ranged from 7,900 to 15,700 seeds/kg. Seed should be dried to about 10 percent moisture and can be stored at 5 to -18 °C for several years. Moist stratification at 3 to 5 °C for 30 to 180 days is necessary for good germination. Drilled or broadcast in a nursery bed, seeds should be covered with 6 mm of fine soil or sand. Germination ranges from 50 to 64 percent (Bonner 2003).

Growth and Management.—Utah juniper grows slowly, usually only 0.13 cm/year in diameter. An 86-year-old stand in Utah had 17.2 percent canopy cover and a basal area of 7.7 m^2/ha (Zlatnik 1999). Poor site conditions may result in 15 cm-tall plants over 50 years old. Individuals of the species may live 650 years or longer. Closing Utah juniper stands eliminate most forage plants; killing trees can result in a doubling of herbaceous cover (Zlatnik 1999). Controlling Utah juniper has been attempted with fire, but fires on these sites are difficult to start under humid, still conditions and hard to control under dry, windy conditions. Controlled burns can be done with the greatest precision in late winter or early spring when the wood is low in water content (personal communication with Stanley Kitchen, Shrub Sciences Laboratory, USDA Forest Service, Provo, UT). The shrubs and trees can be killed with chainsaws or herbicides, but the preferred method is "chaining," dragging sections of anchor chain between two bulldozers. Many young trees are not killed, but the treatment does open stands and allows greater shrub and herbaceous growth (Plummer and others 1968, Stevens 1999).

Benefits.—Utah juniper is a major constituent of semidry ecosystems of the West. It protects the soil from wind erosion but in some instances may aggravate sheet erosion from rains by suppressing understory grasses, forbs, and shrubs. The species furnishes cover and reproductive habitat for many species and is a major source of food for wildlife, especially during winter. Many birds, rodents, as well as jackrabbits (*Lepus californicus*) and coyotes (*Canis latrans*) eat the fruits and mule deer (*Odocoileus hemionus*), and elk (*Cervus elaphus*) browse the foliage when better food is not available. It is not eaten by cattle and is browsed to a limited extent by domestic sheep (Stuart and Sawyer 2001, Zlatnik 1999). The forage is of low quality because of low digestibility (44 percent) and low protein content (6 to 8 percent) (Zlatnik 1999). The wood is used for firewood, charcoal, and novelties (Secretaría de Medio Ambiente y Recursos Naturales 2003). The bark is used as tinder and formerly was used as a "slow match" to maintain and transport fire (Plants For a Future 2003). Native Americans used the bark to make sandals, mats, bedding, baskets, thatch, and cordage, and they made meal from the fruits (Peattie 1953). The wood is highly decay resistant, which makes it desirable for fence posts and rude construction despite its poor form (Zlatnik 1999). Tissues of Utah juniper are not high enough in cedarwood oil to be commercially valuable. Heartwood contains 1.19 percent oil, principally thujopsene (40 percent) and cedrol (13.2 percent) (Adams 1987). The species was used by Native Americans to treat bladder and kidney troubles, wounds, and mouth sores (Plants for a Future 2003). Utah juniper has been used to a limited extent in revegetation projects and xeriscape gardening.

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***Kalmia latifolia* L.** mountain laurel
ERICACEAE

Synonyms: *Kalmia latifolia* var. *laevipes* Fern.

W. Henry McNab and Barton D. Clinton

General Description.—Mountain laurel, known also as calico-bush, ivy, ivybush, kalmia, laurel, and spoonwood, is a medium to large (2 to 9 m in height) evergreen shrub, often with contorted stem and branching habit. The thick, flat, leathery leaves are shiny, dark-green above and pale-green below; margins are entire. Leaf length ranges from 5 to 12 cm and width from 1.5 to 5 cm. The yellowish green petioles range from 0.7 to 3 cm long. The thin, reddish-brown bark shreds and subdivides into ridges. In the absence of disturbance (usually fire), the species is long-lived: 40 to 60 years (Chapman 1950). Botanical characteristics of the genus *Kalmia* have been studied intensively (Ebinger 1974). *Kalmia* is the state flower of Connecticut and Pennsylvania.

Range.—Mountain laurel is primarily a shrub of the Appalachian Mountain region in the eastern U.S. It also occurs in the Atlantic Coastal Plain from Maine to Virginia, throughout the Appalachian Piedmont, southwest into Mississippi, and west into much of Tennessee, Kentucky, and southern Indiana and Ohio. Reports of native mountain laurel in Canada have not been confirmed and are likely ornamentals or large-leaved specimens of sheep laurel [*Kalmia angustifolia* (Small) Fernald] (Jaynes 1997). *Kalmia* has been planted widely as an ornamental in the western United States, throughout Europe, and in New Zealand and Australia.

Ecology.—Mountain laurel occurs most commonly on dry sites of acid soils, although it occasionally occurs on well-drained floodplain soils, and it will tolerate clay soils that are not waterlogged. Mountain laurel forms dense, almost impenetrable patches known as "laurel hells" or "ivy thickets," particularly on upper slopes and ridges where the tree canopy is sparse or lacking. In the southern Appalachians, mountain laurel occurs at elevations to 1500 m and the probability of its occurrence increases on sites with a thin soil A horizon (McNab et al. 1999), and likely low available water capacity. Lipscomb and Nilsen (1990) found that mountain laurel has high water-use efficiency, which could give it a strong competitive advantage on relatively hot and dry southwest slopes. Mountain laurel adapts to a range of light regimes, from little to moderately dense shade, typically beneath an oak (*Quercus* spp.) or pine (*Pinus* spp.) canopy. The ratio of foliage chlorophylls a to b is lower (1.5) in *Kalmia* than for most understory species and may benefit this adaptation (Al-Hamdani and others 2002). Rosebay rhododendron (*Rhododendron maximum* L.) is a common associate of mountain laurel on subxeric/submesic ecotones in the southern Appalachians. A mycorrhizal association has been demonstrated for seedlings of mountain laurel (Flemer 1949). Natural stands of mountain laurel are little affected by insects, although at epidemic levels caterpillars of gypsy moths (*Lymantria dispar* L.) and elm spanworms (*Ennomos subsignaria* Hubner) will feed on the foliage. The most serious disease is phytophthora root rot (*Phytophthora cinnamomi* Rands), which can infect damaged plants (Jaynes 1997). Foliage of mountain laurel near roadsides is particularly sensitive to sodium chloride (NaCl) used for de-icing roads in New England (Bryson and Baker 2002). Although not shown in mountain laurel, other *Kalmia* species are allelopathic. Waterman and others (1995) found that *Kalmia* thickets do not exclude tree seedlings but inhibit their growth by reducing light and increasing competition for water.

Reproduction.—The showy, white to pink 2- to 3- cm saucer-shaped flowers form convex clusters at the ends of branches and appear after the foliage, from March to July, depending on latitude and altitude (Olson and Barnes 1974). Purple spots mark 10 anther pockets in the petals. The method of pollen dispersal in *Kalmia* is unusual in that the anthers are under tension as the flower matures, and they spring forward when disturbed by an insect, forcefully and effectively transferring grains of pollen to the insect (Jaynes 1997). The flowers are pollinated by more than a dozen insects, primarily bumblebees, but generally not honeybees, likely because the flowers produce little nectar (Jaynes 1997). Glandular hairs on the flower stalk, calyx, and corolla may deter nonflying insects. Flowers are most abundant on plants in full sunlight and occur rarely on plants in dense shade (Kurmes 1961). Fruit ripens in late summer and consists of a brown, erect, five-celled, globular capsule, 4 to 7 mm wide. Each capsule contains about 600 seeds, which are 0.8 to 1 mm long and average about 27 million per kilogram (Olson and Barnes 1974). The nonwinged seeds are dispersed by wind, but only for distances of less than 15 m (Robinette 1974). Seeds remain viable for more than a year under field conditions. Light, cold stratification, and moisture enhance germination (Olson and Barnes 1974). Seeds germinate on mineral soil and on moss (Robinette 1974). *Kalmia* may also regenerate by layering, sprouts, or suckers (Robinette 1974). Techniques for commercial production of mountain laurel plants have been well developed (Jaynes 1997).

Growth and Management.—Growth rate of mountain laurel is relatively slow; young plants (< 15 years) add about 12 cm in height and 9 cm in width annually, depending on site moisture relations (Monk and others 1985). Older mountain laurel stems may attain heights up to 9 m and diameter at ground level of 15 cm (Jaynes 1997). Mountain laurel stem density can range from sparse on mesic sites to over 26,000 per ha in thickets on upper, southwest slopes; basal area at 3 cm above ground level can exceed 25 m^2/ha. Herbicides may be used to control mountain laurel on sites where establishment of tree seedlings is desired (Neary and others 1984). It is sensitive to juglone, a substance produced by black walnut (*Juglans nigra* L.) trees. Mountain laurel generally does not present a problem to timber management activities on submesic to mesic sites.

Benefits and Detriments.—Mountain laurel has long been cultivated as an ornamental--since about 1740 when American naturalist John Bartram sent plants to England (Jaynes 1997). Cultivars of mountain laurel are particularly valuable as ornamentals and are propagated commercially by many nurseries. Nearly 100 horticultural varieties of have been selected for variation in flower color, leaf variegation, and growth habit (Jaynes 1997). Mountain laurel burls have been used for making pipes for smoking tobacco, and early European settlers in America used the fine-grained wood for making eating utensils and weaver's shuttles, and produced a yellow dye from its foliage. Tinctures of fresh *Kalmia* leaves have been used for home medical remedies of skin disorders. An unidentified anticancer compound has been extracted from its sap (Jaynes 1997). Mountain laurel provides cover and stability to thin soils, however its presence can reduce water yields (Johnson and Kovner 1956). Foliage of mountain laurel is toxic to domestic cattle and sheep but provides subsistence winter food for ruffed grouse (*Bonasa umbellus* L.) and white-tailed deer (*Odocoileus virginianus* Boddaert) (Robinette 1974). Foliage from new sprouts of burned mountain laurel provides greater potential benefit to wildlife diets compared to unburned foliage (Thackston and others 1982).

Fire.—Mountain laurel contributes to intensity of fires in mountainous terrain and is classified as "extreme" in rate of spread when it occurs in dense thickets beneath hardwood stands (Jemison and Keetch 1942). Flame length can exceed 30 m in fires burning in Table Mountain pine (*Pinus pungens* Lambert) stands with mountain laurel (Waldrop and Brose 1999). Moisture of *Kalmia* foliage is lower than other species and is little affected by seasonal changes of soil moisture (Reifsnyder 1961). The high flammability of Mountain laurel thickets results from low foliate moisture (Richards 1940) and a high proportion of total biomass in small (<5 mm) dead twigs. Caloric content of foliage is estimated at about 5,000 cal/g based on similar vegetation (Hough 1969). Allometric equations for estimating dry biomass of 6- to 8-year old open-grown mountain laurel stems were developed by Boring and Swank (1986), which can be used to predict fuel loadings of leaf ($\log_{10}Y = -0.754 + 1.882 \log_{10}X$), branch ($\log_{10}Y = -1.222 + 2.359 \log_{10}X$), and bole ($\log_{10}Y = -0.636 + 1.948 \log_{10}X$) components of individual plants, where Y is dry weight (g) and X is stem diameter (mm) at 3 cm from the ground. *Kalmia* is killed more readily by headfires than by backfires

(Hooper 1969), but almost all topkilled stems recover by producing basal sprouts (Clinton and others 1993, Johnson and Kovner 1956). Equations for estimating stem, foliage, and total biomass of young mountain laurel sprouts on recently burned areas were developed by Elliott and Clinton (1993).

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***Koanophyllon polyodon* (Urban) King & H.E. Robins.** polyodon
ASTERACEAE

Synonyms: *Eupatorium polyodon* Urban

John K. Francis

General Description.—The name polyodon is assigned according to the convention that if no common name exists, the species (or sometimes the genus) Latin name is used as a common name. Polyodon is a somewhat spindly, upright or arching shrub usually 1.5 to 3 m (occasionally to 6 m) in height and 2 to 3 cm (sometimes 5 cm) in basal diameter. The shrub may have a single or multiple stems, straight lower sections 0.5 to 1 m long, then curving and branchy with fine twigs above. The plant is supported by an extensive lateral and fine root system. The opposite leaves are papery and rough with short petioles and three main veins arising from or near the base. The leaf blades are ovate with a heart-shaped or nearly heart-shaped base, pointed tip, and serrate edges. The inflorescences are terminal corymbs of white or rose compound flowers (heads). Each develops several, five-ribbed, 3-mm achenes tipped with numerous, 3 to 4 mm hairs (pappus) (author's observation, Liogier 1997).

Range.—Polyodon is endemic to Puerto Rico (Liogier 1997) and is not known to have been planted or naturalized elsewhere.

Ecology.—Polyodon grows on moderately and well-drained but rarely excessively drained soils of loamy and clayey textures with pH's ranging from about 5 to 7. Both sedimentary (including limestone), igneous, and metamorphic (including ultramafic) parent materials are colonized. The species is found in areas that receive from about 1000 to 2500 mm of mean annual precipitation at elevations ranging from near sea level to 900 m. Polyodon grows as scattered individuals, diffuse stands (under forest canopies), or in thickets. The species has an intermediate tolerance for shade and is able to grow and reproduce under shade if not too dense. It depends on taller vegetation for support in order to reach heights of more than about 1.5 m. The species is occasional to common in open forest, brushlands, abandoned pastures, and old road cuts and banks.

Reproduction.—Polyodon flowers near the end of the wet season (November-January) and fruits during the dry season (March-May). It is insect pollinated. A collection of seeds averaged 0.00019 g/seed or 5.2 million seeds/kg. Placed on moist filter paper without any pretreatment, 67 percent germinated between 12 and 68 days after sowing. Germination is epigeal. The fruits are dispersed by the wind. Seeds are produced in abundance, but seedlings are scattered. Plants will resprout when damaged.

Growth and Management.—Individual stems may live for 6 years or more. Plants can survive longer by producing sprouts. Sprouts grow at least 1 m in their first year. No management experience has been published. However, maintaining areas in early and middle secondary forest would probably encourage populations of polyodon.

Benefits.—Polyodon contributes to biodiversity in its wildland habitat, helps protect the soil from erosion, and furnishes wildlife cover. It is browsed to some extent by cattle and goats.

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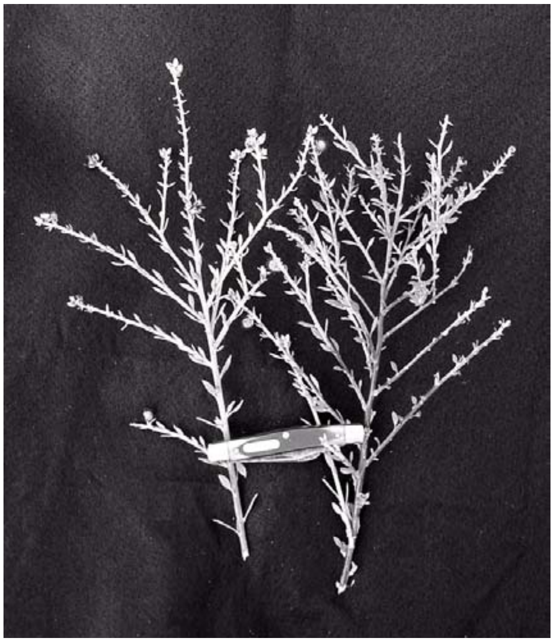
Krameria ixine L. abrojo colorado

EUPHORBIACEAE

Synonyms: *Krameria cuspidata* C. Presl.

John K. Francis



General Description.—Abrojo colorado, sometimes known as retama falsa, is a shrub or sufruticose shrub to 1 m in height and 1 cm in stem basal diameter. The stems are stiff and woody, the twigs flexible and less woody. Older plants have lateral roots with a small or no taproot and many fine roots. The roots are brittle, dark brown outside, with red inner bark. There are multiple stems from the root crown. The branches and leaves are covered with white hairs, giving the whole plant a gray-green color. The leaves are narrowly oblong to oblong-lanciolate, 1 to 2.5 cm long, with a spiny-acuminate tip. The inflorescences are compact lateral or terminal racemes bearing several flowers. The pink- to purplish-red flowers are about 1.2 cm in diameter, from which develop globose 5 to 6 mm, woody capsules (burrs) covered with orange or red, hooked spines. The seeds are light tan and 4 mm in diameter (Howard 1988, Liogier 1988, Stevens and others 2001).

Range.—Abrojo colorado is native to Hispaniola, Puerto Rico, the Lesser Antilles, Mexico through Costa Rica, Colombia, Venezuela, and Guyana (Liogier 1988, Missouri Botanical Garden 2002, New York Botanical Garden 2002, Stevens and others 2001). It is not known to have naturalized outside its native range.

Ecology.—In Puerto Rico, abrojo colorado grows in areas that receive from 750 to about 1000 mm of mean annual precipitation and at altitudes from near sea level to about 400 m above sea level. Because the shrub is intolerant of shade and low in stature, it does not withstand serious competition. It will grow in almost any well-drained, nonsaline soil. It is most frequently seen on rocky ridges and south slopes, disturbed sites, and overgrazed range. It is rarely browsed by cattle or horses.

Reproduction.—Abrojo colorado flowers and fruits throughout the year in Costa Rica where both flowers and fruit may be present (Instituto Nacional de Biodiversidad 2002). Both flowers and fruits are often present in Puerto Rican plants (author's observation). Fruit and seed production is moderate to abundant. A collection of air-dried fruits in Puerto Rico weighed an average of 0.0516 ± 0.0009 g. The seeds are transported as they cling to passing animals or humans. After drying sufficiently, the capsules open, releasing the seeds. After disturbance, the plants regenerate by sprouting.

Growth and Management.—Individual stems of abrojo colorada grow about 0.5 m/year in the first year from sprouts and live 3 or 4 years. By continual sprouting, established plants live much longer. Although no management experience has been published, it probably is safe to say that overgrazing and disturbance encourages the species, and that reestablishment of tree, tall shrub, or heavy grass cover discriminates against or eliminates it.

Benefits.—Abrojo colorado contributes ground cover, soil stability, and scenic beauty in rocky and often disturbed terrain where it grows. On the other hand, the burrs can be a nuisance to both humans and animals.

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***Lantana camara* L.** lantana

VERBENACEAE

Synonyms: *Lantana aculeata* L.
Lantana antillana Raf.
Lantana camara L.var.*aculeata* (L.) Mold.
Lantana scabrida Soland.

John K. Francis

General Description.—Lantana has many common names including cariaquillo, filigrana, mille fleurs, sauge, red sage, yellow sage, prickly sage, and lakana. It is a medium-sized aromatic shrub with quadrangular stems, sometimes having prickles. The posture may be suberect, scrambling, or occasionally clambering (ascending into shrubs or low trees, clinging to points of contact by means of prickles, branches, and leaves). Frequently, multiple stems arise from ground level. The leaves are generally oval or broadly lance-shaped, 2 to 12 cm in length, and 2 to 6 cm broad, having a rough surface and a yellow-green to green color. The flat-topped inflorescence may be yellow, orange, white, pale violet, pink, or red (Howard 1989, Liogier 1995). The small individual flowers of wild Puerto Rican shrubs darken with age so that inflorescences are yellow in the center and orange toward the perimeter. Fruits form in clusters similar in appearance to a blackberry.

Range.—The native range of lantana extends from Bermuda, the Bahamas, the Greater Antilles, the Lesser Antilles, through Trinidad and Aruba. On the mainland, it is native to coastal areas of the United States from Georgia through Texas and from northern Mexico to South America including Brazil and Peru and probably Bolivia, Paraguay and northern Argentina. Lantana has naturalized in most suitable habitats in tropical and subtropical Africa, Asia, and Australia. Most of the world's tropical and subtropical islands including the Hawaiian Islands, Guam, Pitcairn Island, Madagascar, the Juan Fernandez archipelago, Reunion, and the Galapagos have naturalized populations. This colonization has occurred largely during the last century.

Ecology.—Lantana grows on all types of well-drained soil in areas that receive from about 250 mm to 2900 mm of rainfall. It resists droughts very well and tolerates salt spray. Aerial portions of the plant are killed by temperatures of –2 °C, but quickly grow back (Anonymous 2000). Large and vigorous plants survive fires and cutting well, although less vigorous plants are often killed. Lantana is an intolerant pioneer that colonizes disturbed areas. It will grow under an open forest canopy but quickly disappears when the shade becomes heavy. Many pests and diseases lightly and incidentally affect the species across its broad range.

Reproduction.—The inflorescence is a capitate, many-flowered head. The corolla may vary widely in color depending on the variety but characteristically changes colors between the center flowers and older, outer flowers. Lantana blooms almost continuously under favorable conditions. Somatic chromosome numbers of 33, 44, and 55 were recorded in India, the latter tetraploid being the most common (Sinha and others 1995). Insects, especially butterflies, pollinate the flowers. Clusters of drupes are produced abundantly. The fruits are blueblack when ripe and contain one seed each. They are eaten by birds and are widely scattered. If not eaten, they dry and remain on the shrub for weeks. A sample of seed collected in Puerto Rico contained 100,700 seeds/kg of which 75 percent germinated within 7 weeks of sowing. Early growth is rapid. Also, lantana can be propagated with cuttings and air layers.

Growth and Management.—Ornamental plants are established as potted seedlings. This is probably also the best method to establish plants for environmental protection projects such as reclamation of mine spoils. Lantana may reach 3 m in height within 3 or 4 years. In naturalized habitat, the species often forms dense thickets. These brush stands may be eliminated at considerable expense from pastures and tree plantations by cutting and herbicide application. The preferred methods are to cut the clumps and drench the stumps with herbicide or to later spray the tender regrowth with postemergence herbicide. Once established, tree plantations with closed canopies will keep lantana from reestablishing itself.

Benefits.—Lantana, in many horticultural varieties, is planted the world over as a flowering ornamental. It is grown as an annual bedding plant in temperate areas. Lantana oil, an aromatic mixture that varies by local plant variety, is exported from at least Brazil (Weyerstahl and others 1999). In herbal medicine, infusions of the leaves and other plant parts are used as an antiinflammatory (Oyedapo and others 1999), a tonic and expectorant, and added to baths as an antirhumatic. Lantana extracts have also been shown to be a powerful febrifuge (Liogier 1990). Because the leaves and some other parts of lantana are poisonous, care must be taken when it is used medicinally. The ripe fruit is benign and heavily consumed by birds and frequently eaten by humans in some countries (Herzog and others 1994). Extracts of lantana leaves have shown strong insecticidal and antimicrobial activity in numerous experiments. Storing potatoes with lantana leaves nearly eliminates damage by *Phthorimaea operculella* Zeller, the potato tuber moth (Lal 1987). Stems and leaves are used as mulch. Although of inferior quality because of size and form, lantana stems are widely used as fuel in less developed countries.

Detrimental Effects.—Lantana has become a weedy invader of disturbed forest land and neglected pasture in much of its naturalized range. In some areas, competition by lantana results in a reduction of biodiversity (Kumar and Rohatgi 1999). Despite the establishment of a number of natural enemies of lantana into exotic populations, control of lantana populations has been usually limited or a failure (Day and others 1999, Hill 1999). In thick stands, the shrub increases costs in forest management by inhibiting access in stands for thinning and felling, competes with reproduction, and increases fire hazards (Graaff 1986). Lantana leaves contain poisonous triterpines and lantadenes A and B that cause death of horses, cattle, sheep, goats, and rabbits by failure of the liver and other organs (Morton 1994, Munyua and others 1990). However, most animals carefully avoid eating this plant when given a choice. Green fruits also contain the poisons and have caused illness and death in children (Morton 1994). Lantana leaves and their leachates exert alelopathic effects in vetro and to a lesser extent in soil on seed germination, root elongation, and plant growth of many species (Casado 1995, Sahid and Sugau 1993).

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***Lantana involucrata* L.** wild sage
VERBENACEAE

Synonyms: *Lantana odorata* L.

John K. Francis

General Description.—Wild sage, also known as button sage, common sage, sea sage, white sage, orégano, terete, peonía colorada, contite, and frutilla, is a shrub commonly 1 to 2 m in height with showy flowers. The plant is supported by many stiff lateral roots and abundant fine roots. The roots are light brown with a corky bark. Older plants, often with a basal diameter of 5 cm or more, have several main branches arising at or near the ground line and a branchy crown. The bark is yellowish and the wood is brittle. Petioles are 3 to 5 mm long and the leaf blades are 1 to 4 by 1 to 2.5 cm wide and broad, rotund to narrowly elliptic-oblong, rough and stiff with a crenate or toothed margin. The leaves are aromatic with a spicy, sage-like smell. The small tubular flowers form compact terminal heads. The corolla may be white, pink to pinkish purple, or pale blue. The infrutescences are clusters of purple to blue-black drupes 3 to 4 mm in diameter containing one seed each. The chromosome number is 2n = 36 (author's observation, Howard 1989, Liogier 1995, Long and Lakela 1971, Nelson 1996).

Range.—The native range of wild sage includes southern Florida, the West Indian islands, Mexico through northern South America bordering the Caribbean, and the Galápagos Islands (Howard 1989, Liogier 1995). It is naturalized or possibly native in Bermuda (Britton 1918). Wild sage is now widely planted as an ornamental and probably has naturalized in additional areas.

Ecology.—Wild sage grows on most well-drained soil types derived from both sedimentary (including limestone), igneous, metamorphic (including ultramafic) rock types. Mean annual precipitation in areas where it grows in Puerto Rico varies from 750 to about 1700 mm. The species grows from near sea level to 600 m or more in Puerto Rico. In Mexico, wild sage is reported to occur from 1,000 to 2,000 m above sea level (Secritaría del Medio Ambiente y Recursos Naturales 2002). It requires disturbance to become established and full or nearly full sun to grow and reproduce. Wild sage is especially common in over-grazed range and poorly managed pastures, and may be found in abandoned farmland and early secondary forest as well as road cuts, cliffs, and rocky sites. It grows in pinelands, hammocks, and shell mounds in Florida (Long and Lakela 1971, Nelson 1996).

Reproduction.—Wild sage blooms all year (Nelson 1996) and also is a good fruit and seed producer. The seeds number about 110,000 seeds/kg (air-dried). They may be cleaned by maceration and wet sieving. No pretreatment is necessary, and germination begins in about 15 days. Wild sage sprouts when cut. Seedlings are fairly common in favorable habitat near seed sources.

Growth and Management.—The growth rate is moderate and plants live for 10 years or more. Propagation may be by seed, by rooting of softwood cuttings, or by transplanting wildlings. Wildlings transplant well if the roots are not badly damaged and about one-third of the top is pruned away. Periodic pruning of ornamental plants is necessary to prevent them from becoming lank (Workman 1980).

Benefits.—Wild sage contributes to biodiversity, helps protect the soil, and furnishes wildlife food and cover. The wood is useful for fuel, but it is generally too small for anything but campfires. The species is used as a foundation plant and to form low hedges (Workman 1980). It is listed as one of the best butterfly nectar plants (Malone 2002). The leaves are used as a condiment in cooking, and the essential oil is used in cosmetics and liquors (Secritaría del Medio Ambiente y Recursos Naturales 2002). Leaves are added to baths to ease heat rashes and mild insect bites (McNary-Wood 2002). Extracts of the plant are also said to have a sedative effect (Beattie and others 2002). Teas and decoctions of leaves and twigs are used to control colic, vomit, cough, fever, and congestion (Secritaría del Medio Ambiente y Recursos Naturales 2002). It is reportedly not as poisonous as the more widespread *L. camara* L. (Workman 1980).

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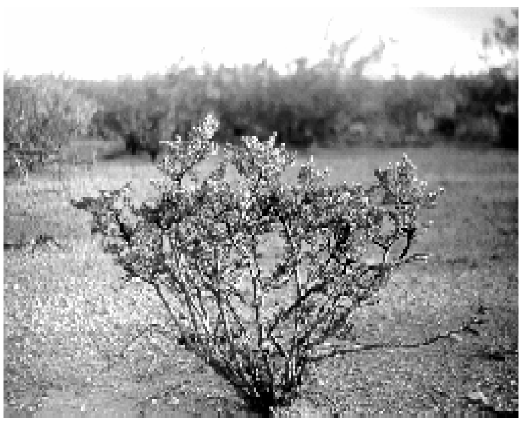
Larrea tridentata (Sesse' and Moc. ex DC.) Coville creosote bush
ZYGOPHYLLACEAE

Synonyms: *Covillea tridentata* (Sesse' & Moc. ex DC.) Vail
Covillea glutinosa (Engelm.) Rydb.
Larrea divaricata Cav.
Larrea glutinosa Engelm.
Larrea mexicana Moric.

James E. Nellessen



General Description.—Creosote bush is also know by the names gobernadora, hediondilla (Spanish for little stinker), and guamis. It is sometimes erroneously referred to as greasewood. It is an evergreen resinous shrub of warm deserts. It is a well branched shrub with no defined trunk, typically reaching heights of 1 to 1.5 m, but can grow as high as 3 m. It is strongly scented, especially noticeable after a rainstorm. The stems are gray with black, somewhat swollen bands at the nodes; the twigs and young branches are relatively flexible. The leaves are opposite, bifoliately compound, each leaflet joined at the base, divergent, but the tips often point toward each other. Leaflets generally are olive green in color, to 1 cm in length, 3 to 4 mm wide, asymmetrical, oblong to obovate in shape, and broader away from the base (Carter 1997, Correll and Johnston 1970, Hickman 1993, Kearney and others 1951, Martin and Hutchins 1980-81). The leaves are often glossy with a thick resinous coating. Stipules are persistent. The South American *L. divaricata* is so similar to *L. tridentata* that some researchers have considered them the same species (Mabry and others 1977). These two species have been demonstrated to hybridize in experimental gardens. South America is the likely origin for the genus, with creosote bush ancestors arriving in North America 8.4 to 4.2 million years before present (Lia and others 2001) with current distribution occurring since the last glaciation. Creosote bush is believed to be a migrant through possible bird dispersal of the *L. divaricata* populations (Mabry and others 1977). There is a ploidy gradient from east to west (from moister to dryer deserts) across the Southern United States: Chihuahuan Desert populations are diploid, Sonoran tetraploid, and Mojave hexaploid. From a study of plant remains in packrat middens, the plants appear to have spread slowly from lower Rio Grande refugia in Texas north and west, reaching the Southern Mojave about 8,500 years ago, the Northern Sonoran about 6,400 years ago, and the Northern Chihuahuan about 4,000 years ago (Hunter and others 2001). *Larrea divaricata* and diploid *L. tridentata* have homologous genomes (Mabry and others 1977). Two varieties have been recognized by one author: *L. tridentata* var. *tridentata* and *L. tridentata* var. *arenaria* L. Benson (Kartesz 1994).

Range.—Creosote bush occurs from Southern and Western Texas through Southern New Mexico (with a band up the Rio Grande valley to Albuquerque), into Arizona, and Southern California, as far north as Southern Nevada and Southwestern Utah, and south well into Mexico. Its elevational range is from below sea level (Death Valley, CA) to about 1,700 m.

Ecology.—Creosote bush is a characteristic dominant evergreen shrub of the Southwestern warm Chihuahuan, Sonoran, and Mojave deserts. On the northern fringes of the Mojave its range just touches the Great Basin Desert (Mabry and others 1977). It grows best in gravelly to sandy, well drained soils of desert plains, benches, mesas, alluvial fans, and rocky slopes. It does not occur on alkali flats or pans. It roots deeply, to 3 m or more, but most roots occur in the upper soil layers (but below about 10 cm), and it will tolerate a caliche layer. The shallow roots are able to utilize small rainfall events. Creosote roots inhibited further elongation of the roots of both adjacent creosote bushes and the shrub *Ambrosia dumosa* (A. Gray) Payne (Mahall and Callaway 1992). Stem angle facilitates water stemflow to the roots, which is maximal with stems greater than 65° and almost none less than 45°. Creosote bushes in the driest part of their range, for example, Death Valley, generally have steeper angles, while there is more variability in stem angle in the Chihuahuan Desert. Shrubs with shallower stem angles take on a more hemispherical shape as opposed to an inverted cone shape. Shrub canopy architecture also affects soil characteristics creating "islands of fertility." Shrubs with hemispherical shapes collect much more litter underneath, hence soil nitrogen is greater under hemispherical shrubs than under inverted cone shaped shrubs (Whitford 2002). Creosote bushes often require a nurse shrub such as the small shrub *A. dumosa* for seedling/sapling establishment, and creosote bush itself will serve as a nurse plant for certain other species (Whitford 2002). Creosote bush often forms monotypic stands that extend for miles, although its density varies greatly from site to site, with the greatest densities occurring in the Chihuahuan Desert (up to 8,000 plants/ha), and lesser densities in the Sonoran (up to 4,000 per ha) and the Mojave (up to 1,800 per ha) (Mabry and others 1977). Above-ground standing crop biomass tends to reflect these density trends. Chihuahuan Desert populations tend to show a greater size or age class structural diversity than those in other deserts (Mabry and others 1977). The resinous coating on the leaves helps retard water loss. During extreme droughts creosote bush will produce smaller, tougher leaves, and will also shed many of its older leaves. It quickly produces new shoot growth after substantial summer rains. Creosote bush has the C3 photosynthetic pathway, with peak photosynthetic activity (Pmax) in the spring and during summer monsoon seasons especially when pre-dawn water potentials are high (Whitford 2002). Pmax is as high as that found in C4 plants (Fitter and Hay 1987), and creosote shrubland has a similar community energy balance as the C4 desert grasslands they have invaded (Dugas and others 1996). Creosote bush has demonstrated a threshold for stomatal closure at -5.8 MPa, has maintained full turgor at -3.0 MPa, with positive net photosynthesis occurring at -8 to -16 MPa (Fitter and Hay 1987, Mabry and others 1977). It can tolerate leaf water potentials below -50 MPa. It is able to maintain a relatively stable photosynthetic rate all year in Death Valley, with increases associated with spring temperatures and moisture availability (Mabry and others 1977). It has high water use efficiency and ability to resorb some nutrients, especially phosphorus, 72 to 86 percent, while nitrogen resorption is within the general range for other evergreen shrubs, 47 to 57 percent. Creosote bush stem and leaf orientations maximize light collection during cooler and moister early morning periods. Creosote bush has a greater ability to withstand xylem cavitation during droughts than riparian species (Pockman and Sperry 2000). An Arizona population of creosote bush experiences freezing-induced xylem vessel cavitation and consequent disruption of water transport at temperatures from -11 to -20 °C (Pockman and Sperry 1997). These temperatures correspond to 20+ year minimum isotherms and also correspond with the northern distribution in both the Sonoran and Mojave Deserts. A few studies have examined the effects of environmental pollutants on creosote bush. Foliage demonstrates leaf injury when exposed to acute levels of sulfur dioxide (SO_2) (Olyszyk and others 1987) and elevated CO_2 concentrations may ameliorate the effects of heat stress (Hamerlynck and others 2000). Creosote foliage may accumulate heavy metals from industrial pollution as demonstrated in a 1980 to 1995 study from El Paso, TX, and Ciudad Juarez, Mexico (Mackay and others 1998).

Reproduction.—Creosote bush blooms periodically during the growing season, blooming correlated first with seasonality, secondarily with the timing of moisture availability and other local environmental factors. Peak blooming periods occur in spring (February to May) and again in late summer into the fall (August to December). A single mature shrub may produce more than 2,000 flowers (or about 50 g of flowers) during the growing season. Numerous insects visit the flowers, but bees are the most effective pollinators. Many species of bees are known to visit the flowers; some are generalists but some are specialists and forage solely on creosote bush (Minckley and others 2000). It is an outcrossing species but is always self-compatible (Mabry and others 1977) with localized populations having higher levels of inbreeding in the Chihuahuan Desert. The flowers are borne solitary in the axils, are 2 to 3 cm in diameter, are perfect, with five yellow clawed petals, obovate to spatulate, 6 to 10 mm long, and 5 mm wide. There are five yellowish green, unequal, deciduous sepals, 5 to 8 mm long. There are 10 stamens with winged filaments, and the ovary has five locules. The petals twist at a 90 degree angle after pollination. The fruit is a roundish capsule, about 5 to 7 mm in diameter, covered with a dense concentration of white to reddish hairs, and separates into five indehiscent one-seeded carpels at maturity (Carter 1997, Correll and Johnston 1970, Kearney and others 1951, Martin and Hutchins 1980-81). Both fruits and flowers are commonly found on the plant at the same time. Flowering may begin on plants as young as 4 to 6 years, although heavy flowering and fruiting generally occurs after 8 to 13 years. Greenhouse-raised seedlings may flower at 2 years of age. Fruit production ranges from 39 to 278 fruits per 100 g of branches or 120 to 1,710 per plant (Young and Young 1992). There are about 370 seeds/g. The seeds have mechanical dormancy and scarification aids germination (Young and Young 1992). Germination success varies by population, latitudinal and local environmental conditions with reported success rates of 2 to 70 percent. Salt (NaCl) at 10,000 ppm (-0.78 MPa) resulted in 0 percent germination, and seed germinated equally well at pH's from 7 to 10 (Barbour 1968), although some studies have shown some variation from these pH's (reviewed in Baskin and Baskin 2001). Leachates from fruit coats inhibit germination of some plant species [*Bouteloua eriopoda* (Torr.) Torr. but not *Muhlenbergia porteri* Scribn. ex Beal], but not of creosote bush seeds (Baskin and Baskin 2001). Seeds stored dry in paper bags at room temperature for as long as 8 years showed some germinability (Barbour 1968).

Growth and Management.—Growth response and productivity can be rapid after rain, but there is not a strong pattern of productivity and rainfall, while nitrogen has been shown as an important factor in creosote bush productivity (Whitford 2002). Maximum leaf longevity is 16 months. Maximal root growth occurs in the fall. Branches will root if covered with soil. Ring counts of stems have indicated that creosote bush is long-lived, at least 30 to 50 years, but ring counts may not be reliable. Individual shrubs may sometimes reproduce by fragmentation or separation of the root crowns along with new basal sprouting, causing the plant to spread out and away from the center. Such fragmentation may contribute to long-term survival estimated at more than 100 years to several thousand years. Creosote bush shrubland has been expanding over the past 100 years or more due to overgrazing of desert grasslands by livestock, although climate trends have also been implicated. One experiment to test this involved transplanting seedling creosote bushes into fertilized, irrigated, or unmodified ungrazed black grama (*B. eriopoda*) grassland, a creosote shrubland, or a heavily grazed grassland. The only site in which seedlings survived was in the heavily grazed grassland (Whitford 2002). Prior to heavy livestock grazing creosote bush was generally restricted to well-drained gravelly or sandy soils of steep slopes. Creosote bush and mesquite (*Prosopis glandulosa* Torrey) invasion likely occurred in episodes in conjunction with both reduced grass cover and drought (Grover and Musick 1990). Localized decreases have also been reported. In an area of Big Bend National Park, previously overgrazed by livestock, the dry period from 1960 to 1967 showed increased creosote bush cover, while the wetter period from 1967 to 1981 showed a decrease in creosote bush cover and increased cover of perennial grasses, forbs, and most other shrubs (Wondzell and Ludwig 1995). At a site in southern New Mexico creosote shrub size has decreased over a 10-year period, possibly due to longer term climate change (Miller and Huenneke 1996). Certain creosote bush populations in the Sonoran Desert of Mexico declined by 50 to 90 percent, perhaps due to prolonged droughts from 1936 to 1964 (Turner 1990). Creosote bush shrublands have been experimentally treated with a variety of herbicides for shrub management. Several liquid-applied herbicides (2,4-D, dicamba, picloram, 2,3,6-TBA) either singly or in combination with other herbicides have demonstrated greater than 50 percent root kill (Herbel and Gould 1995). But individual shrub treatment with dry herbicides (bromacil, fenuron) or aerially applied tebuthiruon pellets have given greater control, 80 to 90 percent. Perennial grass and annual forb production increased substantially on tebuthiuron-treated plots.

Benefits and Disadvantages.—Creoste bush is unpalatable as livestock forage and is usually toxic, sometimes causing death (Gay and Dwyer 1998, Kearney and others 1951, Stubbendieck and others 1997, USDA 1937). Jackrabbits are one of the few mammals that will consume the plant to a certain degree, largely based on the water content of a particular plant (Whitford 2002). Some woodrat populations will also consume creosote bush, demonstrating differentially developed tolerances to the resin (Mangione and others 2000). Woodrats consume creosote leaves and stems in the Mojave Desert when necessary to maintain water balance but suffer ill effects such as loss of body mass (Karasov 1989). Both rabbits and woodrats will peel open the stems to get water.

Once a particular shrub is browsed by a jackrabbit, that same shrub is much more likely to be browsed again than another shrub that has never been browsed (Ernest 1994). Younger leaves have a higher concentration of resins that affect relative leaf palatability and digestibility. Resin content may be as high as 26 percent in young leaves, dropping to 11 to 16 percent in older leaves, with insects showing preference for the older leaves (Mabry and others 1977). A phenoloxidase system in the leaves appears to make digestibility of the resinous leaves even more difficult. Chemical treatment of creosote foliage to remove the resins results in nutritious edible forage, but due to economics this practice is not often implemented (Mabry and others 1977). Numerous species of arthropods set up habitation in creosote bush. In particular males of the grasshopper species, *Ligurotettix coquilletti* McNeil, select a particular shrub as their territory and defend it against other male grasshoppers (Mabry and others 1977). The mounds created by kangaroo rats (*Dipodomys* spp.) appear to have a positive effect on creoste bush survival, flowering, and fruiting, while creosote bush itself has a negative effect on kangaroo rat populations (Chew and Whitford 1992). Creosote bush exposure to 0.1 to 0.2 ppm ozone consistently reduced the toxic nordihydroguaiaretic acid content of leaves, which could result in potentially greater levels of herbivory (Gonzalez and others 1988). Powdered creosote leaves added to stored pinto beans made them significantly less attractive to the bean weevil (*Zabrotes subfasciatus* Boheman) (Cortez-Rocha and others 1993).

Pharmaceutical Chemistry.—Although a toxic plant for livestock and many wildlife, it has value due to this same toxicity because of antiseptic and other potential medicinal uses. Native Americans of the Southwestern deserts have used this plant in teas, tinctures, and salves, as a poultice to retard bacterial growth, as an emetic, expectorant, and diuretic to treat venereal disease, tuberculosis, bowel cramps, and rheumatism (Kearney and others 1951, Mabry and others 1977). It has been used for stiff limbs, sores, skin ailments, snakebites, menstrual cramps, and chicken pox (Bowers and Wignall 1993, Mabry and others 1977). Creosote bush may cause dermatitis in certain people with allergic skin sensitivity. Secretions and contents of the lac scale insect found on creosote bush have been used for repairing pottery, fastening arrow points, water proofing baskets, and making mosaics (Kearney and others 1951, Warnock 1974). One of the principal compounds in creosote bush resin is the anti-oxidant nordihydroguaiaretic acid (NDGA). This is a phenolic aglycone and comprises 5 to 10 percent of leaf dry weight, 80 percent of all phenolics in the resin, and once was used as an anti-oxidant in foods, pharmaceuticals, and industrial materials (Mabry and others 1977). NDGA has demonstrated an ability to inhibit tumors and cancers but does have toxic side effects to both animals and humans. Its use as a chemoprevention for skin cancer and protection against the effects of ultaviolet light has been investigated (Gonzales and Bowden 2002). The botanical dietary supplement "chapparal" has been associated with nonviral toxic hepatitis and contains lignans similar to estrogens (Obermeyer and others 1995) and may cause acute liver damage (Sheikh and others 1997). NDGA has shown potential to inhibit the human immunodeficiency virus (HIV) (Gnabre and others 1995). NDGA (masoprocol) lowered glucose and triglyceride levels in rats and may have potential in Type II diabetes treatment (Reed and others 1999). Numerous flavanoid aglycones, flavanoid glycosides, wax esters, saponins, and volatile constituents such as terpenes, have been identified from creosote bush.

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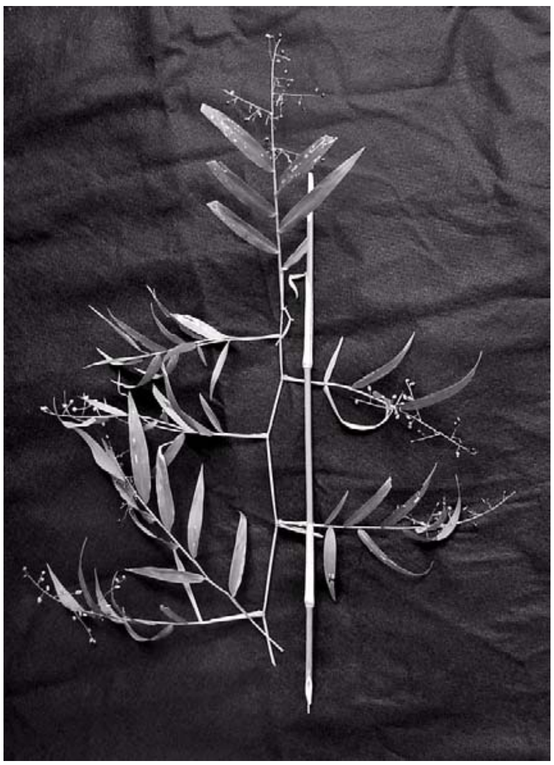
Lasiacis divaricata **(L.) A.S. Hitchc.** wild bamboo
POACEAE

Synonyms: *Panicum bambusoides* Desv. ex Ham.
Panicum chauvinii Steud.
Lasiacis harrisii of Britton and Wilson
Lasiacis sloanei of Britton and Wilson
Panicum divericatum L. var. *glabrum* Kuntze
Panicum divericatum L. var. *stenostachyum* Griseb.

John K. Francis



General Description.—Wild bamboo, also known as smallcane, pitillo de monte, tibisí, and chico, is an evergreen, slender, woody, climbing or scrambling shrub that sometimes reaches 5 m in length and is commonly about 6 mm in basal stem (culm) diameter. There are usually several stems from the root crown. The plant develops an extensive and abundant system of fibrous roots. The whole pant is more or less glabrous. The culms are hollow between nodes, thin-walled, brittle, and tough, so that they have low bending strength but high tensile strength. The lower internodes are greenish yellow and smooth. There are few or no branches on the culms until near the ends. Relatively few leaves are located on recently grown branches. The alternate leaves are narrowly lanceolate, 5 to 20 cm long and 5 to 15 cm wide. Inflorescences are terminal panicles with few branches. The fruits are ovoid, about 4 mm long, and covered (at maturity) with a thin, black pericarp (Hitchcock 1935, Nelson 1996, Stevens and others 2001). There are 2n = 36 chromosomes (CromoPar 2002).

Range.—Wild bamboo is native to southern Florida, the West Indies, and from Central Mexico to northern Argentina (Stevens and others 2001). Stevens and others (2001) report two varieties, *divaricata* and *leptostachya* (Hitchc.) Davidse, in Nicaragua. The species is not reported to have naturalized outside its native range.

Ecology.—Wild bamboo is intermediate in its tolerance to shade. It normally grows in the understory of medium to low-density forest, in small openings, and in brushy areas. It is common along shady forest trails and roads, and sometimes invades brushy pastures. In Puerto Rico, it grows from near sea level to about 800 m in elevation in areas that receive from about 1000 to 2400 mm of mean annual precipitation. Wild bamboo grows up to an elevation of 1300 m in Nicaragua (Stevens and others 2001). The species colonizes soils with the full gamut of textures and pH's from about 5.5 to 7.5 in areas of sedimentary (including limestone), igneous, and metamorphic (including ultramaphic) rocks. The soils are usually well drained.

Reproduction.—Wild bamboo flowers throughout the year except during periods of high drought stress. The flowers are assumed to be wind pollinated. Collections of air-dried seeds from two areas in Puerto Rico in different years yielded averages of 0.0064 ± 0.0001 and 0.0156 ± 0.0001 g/seed or roughly 90,000 seeds/kg. Some pretreatment is probably needed: one lot yielded 0 percent germination and the other 11 percent. The seeds are somewhat delicate and probably damaged by scarification. The pericarp can be removed by rubbing with great care with unknown effect on germination. It is assumed that birds and possibly rodents are seed dispersers. Seedlings are not common. Culms layer (root) whenever they come in contact with the ground and are covered with litter. Wild bamboo sprouts when cut or damaged to renew damaged culms.

Growth and Management.—Growth of wild bamboo from sprouts is rapid. Sprouts from mature plants may reach most of their eventual length during the first year. Thereafter, branches are added for 1 or 2 years. After old culms die, new ones grow from the root crown. It is not known how fast seedlings grow. Wild cane seldom forms thickets and mostly grows in forests and brush lands so that control does not seem warranted. If it should be needed, grubbing out the root crowns or cutting and spot-spraying the resulting sprouts with glyphosate would probably be effective.

Benefits.—Wild bamboo furnishes food and cover for wildlife and helps protect the soil. The leafy and more succulent portions are browsed by horses and cattle. The species seems resistant to light and moderate browsing. The tough stems, which often run across low brush, make it difficult to walk through the forest.

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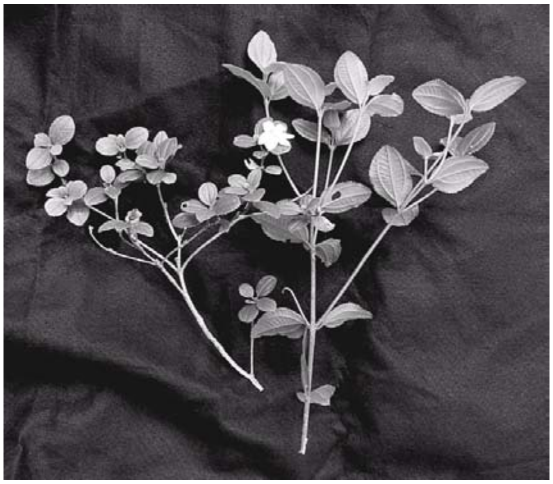
***Leandra krugii* (Cogn.) Judd & Skean** leandra
MELASTOMATACEAE

Synonyms: *Calycogonium krugii* Cogn.

John K. Francis



General Description.—Leandra is an evergreen shrub usually 1 to 1.5 m in height and 1 to 3 cm in basal diameter, but rarely reaching 3 m in height and 6 cm in basal diameter. Multiple stems from basal sprouts are the rule and stems are covered with finely furrowed brown bark. Young plants have deep taproots; older plants have deep and extensive root systems. Branches and twigs are stiff, slender, and tend to grow vertically. Trichotomous branching is common. The green to dark-green leaves are opposite, usually oval to elliptic, rough, and coriaceous. They are 2 to 5.5 cm long and have a 6-mm petiole. Edges are serrulate. Five nerves are raised on the underside, the three principal ones radiating from a point above the base of the leaf. The six-parted white flower is about 3 cm across. Fruits (berries) are globose, bright red, and about 12 mm in diameter. They are edible and contain many minute seeds (author's observations, Liogier 1995).

Range.—Leandra is endemic to central and western Puerto Rico (Liogier 1995). It is not known to have been planted or naturalized outside Puerto Rico.

Ecology.—Leandra is intermediate in tolerance. As single plants and in thickets, it grows naturally in small openings and in the understory of low to moderate basal-area remnant and secondary forests, and in plantations. It occurs at elevations of about 600 to 1000 m in areas that receive from about 1800 to 3000 mm of mean annual precipitation. The soils it grows on are usually moderately acid, loamy or clayey, deep or rocky, well drained to somewhat poorly drained Ultisols, Alphisols, and Inceptisols. These soils develop from sedimentary, igneous, and metamorphic (ultramaphic) rocks. Leandra is most common on side slopes and ridge tops, in forest plantations, secondary forest, and primary remnants (author's observations).

Reproduction.—Leandra blooms during the late spring and early summer (April through June) and fruits during late summer and fall (August through October). The flowers appear to be insect pollinated. There are several million seeds per kilogram. They germinated profusely when smeared on the surface of potting mix and placed in a mist bed. The minute seedlings did not survive, however. The plant can be propagated by air layering. Thirty-nine of 46 air layers treated with 0.3 percent IBA on wild plants rooted in 6 months. Wild plants layer whenever branches come in contact with the ground. Woody cuttings treated with IBA (indol-butyric acid) and misted failed to successfully root. Apparently, birds are the principal dispersers of seeds. Reproduction can be abundant in shaded areas that have been disturbed (author's observations).

Growth and Management.—Leandra grows slowly as a seedling and at a moderate rate from sprouts. Plants appear to be relatively long-lived. Management experience is lacking or has not been published. Disturbance of the understory of forests in suitable habitat with low to moderate basal area in which mineral soil is exposed should result in the establishment of seedlings. Stands could be thickened by ground-layering existing plants.

Benefits.—Leandra adds to the aesthetics of the forests where it grows, helps protect the soil, and furnishes food and cover for wildlife. The convenient size, pretty flowers, and foliage (W^{3}Tropicos 2002), as well as the attractive fruits suggest leandra as an ornamental.

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W^{3}Tropicos. 2002. *Calycogonium krugii* Cogn., flowering shrub.http://digitalis.mobot.org/mrsid/bin/mosid/mosid.pl?client=203&image=MOA-06799_001.sid&title=Calycogonium+krugii+ Cog... 1 p.

***Ledum groenlandicum* Oeder** Labrador tea
ERICACEAE

Synonyms: *Ledum palustre* L. ssp. *groenlandicum* (Oeder) Hulten
Ledum palustre L. var. *latifolium* (Jacq.) Michx.
Ledum latifolium Ait.
Rhododendron groenlandicum (Oeder) Kron & Judd

James E. Nellessen

General Description.—Labrador tea is an evergreen, well branched, spreading shrub up to about 1 m in height. The twigs are densely hairy and the buds scaly. The leaves are simple, alternate, entire (not toothed), lanceolate, somewhat narrowly elliptic to oblong, 1.5 to 5 cm long, about 0.7 to 2 cm wide, thick, leathery and evergreen with rolled margins, dark green above, densely off-white to rusty hairy beneath, and fragrant when crushed (Gleason and Cronquist 1963, Britton and Brown 1913). Several synonyms, as given above, may be found for this species (Kartesz 1994, Britton and Brown 1913). The genus *Ledum* appears to be monophyletic, and cladistic analysis places it as most closely related to genus *Rhododendron* subsection Edgeworthia, hence its synonym placing it in the genus *Rhododendon* (Kron and Judd 1990).

Range.—This shrub occurs from Greenland, across Canada from Labrador to British Columbia, north to Alaska, south to New Jersey, Pennsylvania, Massachusetts, Michigan, Wisconsin, Minnesota, and Washington, with isolated sites or occurrences in Ohio and South Dakota (Gleason and Cronquist 1963, Britton and Brown 1913, Great Plains Flora Association 1986, McCance and Burns 1984). Labrador tea has been classified as an endangered species in Ohio, where one population occurs in a bog habitat in the northeastern corner of the state (McCance and Burns 1984). One isolated collection has occurred in the Black Hills of South Dakota (Great Plains Flora Association 1986).

Ecology.—This species grows in acidic soils of bogs, especially sphagnum (*Sphagnum* spp.) bogs, and other swampy and wet shoreline habitats in association with *Picea mariana* (Mill.) BSP (black spruce), *Chamaedaphne calyculata* (L.) Moench. (leatherleaf), and *Kalmia* spp. (laurels). Labrador tea will also grow on some drier upland soils with a reasonable moisture regime in association with *Pinus* spp. (pines) and *Vaccinium* spp. (blueberries). Stands of Labrador tea appear to retard black spruce growth and regeneration (Inderjit 1996). Labrador tea has been reported as an undergrowth species on serpentine substrates on mountain tops in eastern townships of Quebec, Canada. It has also been observed in shrub and sedge dominated serpentine ecotonal communities of Newfoundland with a soil pH of 6.27, and exchangeable soil mineral concentrations: calcium, 13 μg/ml, magnesium 237 μg/ml, and nickel 0.72 μg/ml (reviewed in Brooks 1987).

Ecology in Human Impacted Environments.—Exposure to sulfur dioxide has been shown to cause visible foliar symptoms and significantly reduce photosynthetic net assimilation rates, but the rate of reduction was significantly slower than that in deciduous species (Addison and others 1984). In a radionuclide study, lead-210 and polonium-210 tended to accumulate in lichens and mosses, while radium-226 tended to accumulate in shrubs such as Labrador tea (Sheard 1986). Labrador tea may be an indicator of lead contamination in the environment in the vicinity of lead/zinc mines (Pugh and others 2002). Labrador tea was among four ericaceous shrub species naturally revegetating an abandoned vacuum-mined peatland, despite the absence of new sphagnum moss colonization (Berube and Lavoie 2000).

Reproduction.—Labrador tea flowers are relatively small, about 1 cm wide and 2 cm long, white, with five to seven stamens, and are grouped in terminal clusters. It blooms from May to July, sometimes as late as August. The fruit is a slender capsule, oval in shape, about 5 to 8 mm long and 2 to 3 mm wide, with a persistent style (Gleason and Cronquist 1963, Britton and Brown 1913). The seeds are elongated, numerous and small. For germination, they should be placed onto a good moisture-supplying substrate and covered with a clear plastic film (Young and Young 1992). Seeds germinate best after a 30-day cold stratification period, with optimal germination temperatures of 20 to 25 °C, and light is required (Calmes and Zasada 1982, Baskin and Baskin 2001). The seeds are considered to have non-deep physiological dormancy because of the relatively shorter cold periods needed and that some seeds can germinate shortly after ripening. The cold stratification period can decrease the germination temperature requirement. Full sunlight and high soil moisture seem to be requirements, including a low soil pH, e.g. 5.5 (Karlin and Bliss 1983, Baskin and Baskin 2001). Apparently winter-time cuttings will root well (Dirr and Heuser 1987, Young and Young 1992).

Growth and Management.—This shrub is generally considered a slow growing, late successional, pre-climax or climax species. The low shrub stratum consisting of Labrador tea and leatherleaf was estimated to have an aboveground productivity of 0.4 and 2.0 t/ha/yr on perched and raised bogs, respectively, in northern Minnesota (Grigal and others 1985). Rust fungi of the genus *Chrysomyxa* alternate between spruce and members of the Ericaceae such as Labrador tea. *Chrysomyxa reticulata* sp. nov. may spread from *Ledum* spp. to cultivated rhododendrons (Crane 2001).

Benefits.—As the name implies, the dried leaves have been used for tea. Native Americans, such as the Chippewa, have used this shrub for various purposes. The root has been used for medicinal purposes to treat ulcers and the leaves for making tea (Densmore 1928). As a tea this plant has been used for treating asthma, colds, stomach aches, kidney problems, scurvy, and fevers (Foster and Duke 1990). Externally it has been applied as a wash for burns, ulcers, and stings. It has been used as a folk remedy for lung ailments, dysentery, indigestion, and to kill lice and treat leprosy. Successful traditional use for gout treatment may be due to the presence of phenolics and tannins within the plant (Owen and Johns 1999). This species, as well as others in the genus, has generally been regarded as having low palatability, being unpalatable, or even slightly poisonous (USDA 1937). Since this species often grows in wet boggy habitats, it is generally not accessible to most livestock. The plant may serve as reindeer forage in Alaska. Its unpalatability may also be due to essential oils of the monoterpene family (sabinene and limonene) and the sesquiterpene family (alpha- and beta-selinene and germacrone) (Belleau and Collin 1993). Germacrone has been shown to be a feeding deterrent for snowshoe hares (*Lepus americanus* Erxleben), although they do eat the plant to some extent (Reichardt and others 1990, MacCracken and others 1988).

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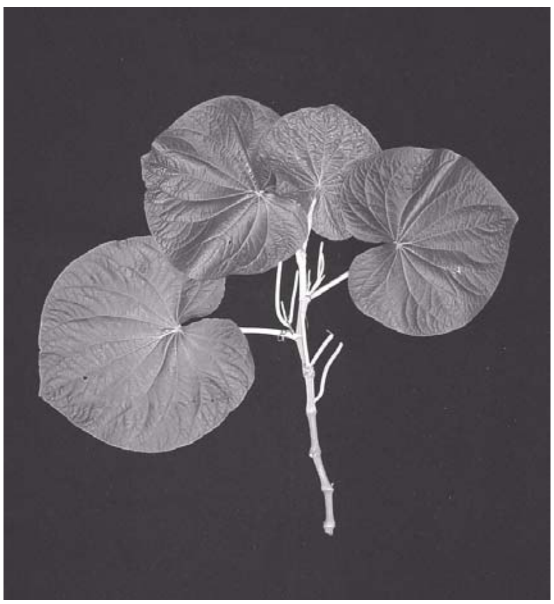
***Lepianthes peltata* (L.) Raf.** monkey's hand
PIPERACEAE

Synonyms: *Lepianthes umbellata* (L.) Raf.
Piper peltatum L.
Heckeria peltata (L.) Kunth in L.
Pothomorphe peltata (L.) Miq.
Piper umbellatum L.
Pothomorphe dussii Trel. in Stehlé

John K. Francis



General Description.—Common names for monkey's hand include cowheel bush, cow-foot leaf, baquiña, chapeau g'leau, bois-anisette, fèy a kè, and many others. It is a weak-stemmed shrub up to 2 m in height and 3 cm in basal diameter. This plant usually has a single stem, but may produce multiple sprouts from the root collar if the top is damaged. The stems have a vertical habit with no branches until the stems reach 0.5 to 1.0 m in height and then form only second order branches. A taproot does not develop in clayey soil, but the plant develops many robust, semi-fleshy lateral roots. Adventitious roots may form at the lower nodes. The stems may be glaberous or pubescent. The leaves have petioles 8 to 20 cm long. The leaf blades may be sub-orbicular to ovoid, peltate or not, and about 15 to 35 cm long and broad. They have a cordate base and an acute tip, with 11 to 15 palmate veins. Spikes of minute flowers in small groups are born on peduncles 1 to 7 cm long. In these "fruits," after development, have numerous 0.5 mm-long druplets embedded (Howard 1988, Liogier 1985). The stems, leaves, and young fruits have a pine-like aromatic smell. However, overripe spikes, have a smell reminiscent of oysters or cow's breath.

Range.—Monkey's hand is native to Mexico, Central America, tropical South America, the Greater and Lesser Antilles, and Trinidad in the Americas, and Guinea, Sierra Leone, Ivory Coast, Ghana, and Nigeria in Africa (Burkill 1997, Howard 1988, Liogier 1985, Liogier and Martorell 2000). The species is also reported as naturalized in Florida (Langeland and Stocker 2001).

Ecology.—Monkey's hand grows in full sunlight and in light to moderate shade. Continually moist soil is imperative. Rainfall may vary from about 1500 to over 3000 mm of annual precipitation. The plant usually grows on loamy or clayey soils with relatively good fertility. In Puerto Rico, monkey's hand grows from near sea level to over 1,000 m in elevation. Plants may grow singly or in clumps along streams and roads, in old fields and other disturbed areas, in forest tree-fall gaps, and on nursery benches. Disturbance and bare soil are necessary for successful establishment.

Reproduction.—Monkey's hand shrubs bloom and fruit continuously after reaching about 0.5 m in height. A collection of fresh fruits from Puerto Rico weighed an average of 0.95 ± 0.11 g. Seeds separated from these fruits weighed an average of 0.000061 g/seed or 16,400,000 seeds/kg (air-dried). For unknown reasons, germination on moist filter paper failed entirely (author's observations). Seeds are produced in large numbers and disbursed by fruit bats and birds. Apparently, only a small percent of the seeds germinate and develop, because seedlings are scattered and rarely abundant. Monkey's hand plants are easy to propagate from cuttings. A small group of stem cuttings were treated with IBA and placed in a mist bed. After about 5 weeks, 85 percent had rooted. Because rooting takes place at the nodes, a node should be included in the buried portion of the cutting.

Growth and Management.—Monkey's hand plants live about 2 years but may perpetuate themselves by sprouting from the root collar. Plants also root at the nodes when nodes are buried with soil or leaf mold, or if laid prostrate. The plant is a common weed in plantations of cacao and oil palm in Africa (Burkill 1997). Monkey's hand may be controlled by hand pulling. It is important to remove the pulled material from the site to prevent it from rerooting. If hand pulling is not possible, plants may be killed by spraying with a 20 percent solution of Garlon[1] applied as a basal bark spray or by cutting the plants and applying a 50 percent solution to the cut stumps (Langeland and Stocker 2001).

Benefits and Medicinal Use.—Monkey's hand plants are browsed by cattle and other ruminants. The species is pretty enough to be used as a border or background plant in landscaping, but there are no current reports of its use in landscaping. In several parts of Africa, the leaves and stems are cooked and eaten as a vegetable with meat and fish. It is also used as a condiment and as an ingredient in sauces. The fruits and leaves are used as bait in trapping fish and small birds (Burkill 1997). In Haiti, monkey's hand leaves are used in combination with other natural products in a treatment for hypertension (The Temple of Yehwe 2001). In Africa, it is used in various ways in magical rites to promote good things and ward off the influences of evil fetishes. Leaves, root, and fruits of the plant are also used to control migraine and general pain, as an antiseptic, to control tapeworms, gonorrhea, urinary problems, and rheumatism (Burkill 1997). Monkey's hand is used in many of the same ways in the West Indies (Liogier 1990).

[1]Garlon is named here for identification purposes only. The Forest Service does not endorse any commercial product.

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***Lepidospartum burgessii* B.L. Turner** gypsum scalebroom
ASTERACEAE

Synonyms: none

Juanita A. R. Ladyman

General Description.—The common name for *Lepidospartum burgessii* is gypsum scalebroom or Burgess's broomshrub. The botanical name comes from the Greek, "lepidotus" meaning scaly and "spartium" meaning broom (Gledhill 1992). There are two other species in the genus *Lepidospartum* but neither is sympatric with gypsum scalebroom (Baldwin and others 2002). The range of *Lepidospartum latisquamum* S. Wats. extends from southern California to Utah and that of *L. squamatum* (Gray) Gray ranges from central California to Baja California (Baldwin and others 2002). Gypsum scalebroom was relatively recently described (Turner 1977). Prior to that time, it is likely to have frequently been mistaken for rabbitbrush, *Chrysothamnus nauseosus* (Pallas *ex* Pursh) Britt. Gypsum scalebroom is a woody shrub with numerous stems growing up to 1.2 m tall. The stems have multiple branches and are covered with silvery, matted, felt-like hairs out of which protrude numerous small oil blisters. The leaves are needlelike, alternate, and 5 to 12 mm long. There are three or four terminal flower heads on stems with three, rarely four, bright yellow flowers per head. The achenes are covered by dense white hairs and topped by a pappus of many slender bristles. Although gypsum scalebroom has been mistaken for rabbitbrush, the three rounded bracts of the involucre on the flower heads clearly distinguish it from any species in that genus.

Range.—Gypsum scalebroom is both a geographic and substrate endemic being restricted to certain gypsum soils in an approximate 1,000 square km area in northern Culberson County, Texas, and southern Otero County, New Mexico.

Ecology.—Gypsum scalebroom is found only on the gypsum flats at the fringe of the northern Chihuahuan Desert. Dick-Peddie (1993) designated the region Chihuahuan desert scrub whereas some authorities have regarded the whole area as part of the desert plains grassland (Humphrey 1958). The latter designation may be more appropriate for the relatively small areas where gypsum scalebroom occurs because creosote bush, which is the dominant shrub of the Chihuahuan desert scrub vegetation type, does not occur with gypsum scalebroom. Shrubs and sub-shrubs associated with Gypsum scalebroom include *Atriplex canescens* (Pursh) Nutt., *Opuntia leptocaulis* DeCandolle, and *Yucca elata* (Engelm.) Engelm. as well as *Tiquilia hispidissima* (Torr. & Gray) A. Richards. *Poliomintha incana* (Torr.) Gray is a common associate, and *Allenrolfia occidentalis* (S. Wats.) Kuntze is also observed to a lesser extent in Texas. Associated grasses include *Bouteloua breviseta* Vasey, *Sporobolus nealleyi* Vasey, and *Sporobolus airoides* (Torr.) Torr. *Gallardia multiceps* Greene, *Senecio warnockii* Shinners and species of *Mentzelia* and *Isocoma* are common forbs associated with gypsum scalebroom, although their contribution to the ground cover is low. Plants colonize two habitats, semistabilized gypsum dunes and relatively compacted gypsum soils at the edge of dry alkaline lakes (Powell 1998). In New Mexico the plants generally grow on stabilized, microbiotic-covered, gypsum soils with approximately 5 percent basal vegetation/litter cover. In Texas and at one site in New Mexico, shrubs grow on more mobile gypsum dunes with an average of 20 percent basal vegetation/litter cover (Ladyman and Gegick 2001). The plants occur singly or in scattered colonies. The climate in this area is relatively extreme with summer temperature highs between 34 °C and 41 °C and winter temperature ranging from lows of –2 °C and highs of 14 °C. Freezing is common during this time. Precipitation comes primarily during the summer (ranging from 13.1 to 46.8 cm). However, substantial spring rains have been reported, and there is a high degree of year-to-year variability characteristic of most arid and semiarid climates (Noy-Mier 1973).

Reproduction.—The peak of flowering is during late July through early September, but within a population, flowering can extend from late April to early October. The number of flowers per shrub is highly variable; from one flower to literally hundreds of flower heads on any given shrub. There does not appear to be a close relationship between the size of the plant and the number of flowers because the largest shrubs are often in a decadent condition, that is, with more than 50 percent dead wood. In 1991/1992 and 1997 plants were counted in seven colonies in New Mexico (Huenneke 1991, Ladyman and others 1999). Approximately 15 percent of the individuals counted within those colonies in 1991/1992 were dead in 1997. The number of juvenile plants had also declined. Recruitment is only by clonal propagation. No seeds have been observed despite abundant yellow flowers and apparently adequate pollinators (Ladyman and others 1999). The results of studies on pollen germination on stigmas indicate an incompatibility system is operating (Ladyman and others 1999). The prematurely stunted pollen tube growth observed by florescent microscopy is indicative of sporophytic incompatibility, which is typical of members of the Asteraceae and other species with trinucleate pollen (Ladyman and others 1999, de Nettancourt 1977).

Growth and Management.—Gypsum scalebroom responds to irrigation and fertilization and can grow to over 1.5 m with luxurious silvery foliage in cultivation (author's personal observation). Transplantation is possible, but the success rate is not known. In 1998, two potential disease problems were identified. *Corythuca marmorata*, a known pathogen of some Asteraceae species, caused leaf loss and stem necrosis. A potential pathogenic fungus, *Alternaria alternata*, was observed within some flowers (Rotem 1994, Ladyman and Gegick 2001). Genetic diversity appears to exist between the Texas and New Mexico populations. The involucre length of plants growing in Texas was significantly longer than from those in New Mexico (Ladyman and Gegick 2001). It is unknown if individuals between these two populations are reproductively compatible. Some protective measures, including erecting exclosures, have been made for some colonies growing in an Area of Critical Concern and managed by the Bureau of Land Management (BLM 1997). This species appears to be facing relatively imminent extinction. From a simple model that assumed the rate of death was linear, extinction is predicted within 35 years (Ladyman and others 1999).

Benefits.—Gypsum scalebroom is visited by a wide variety of arthropods and possibly provides cover and food for small wildlife species. It is unlikely to be palatable to livestock, but they do appear to brush against it even if they do not use it as food (anecdotal information from ranchers in area and author's personal observation). This is likely due to the absence of other large shrubs in the region. It is a beautiful silvery ornamental shrub. It has been suggested that one way to slow its eventual extinction is to introduce it into the horticultural and landscape trade.

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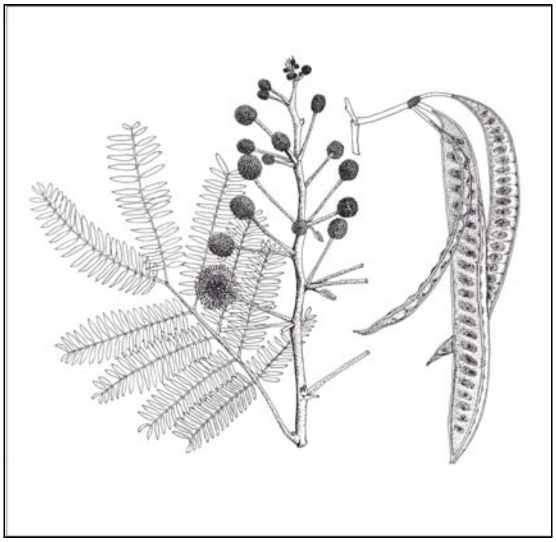
Leucaena leucocephala (Lam.) de Wit leadtree

FABACEAE

Synonyms: *Leucaena glauca* Benth.
Mimosa leucocephala Lam.
Leucaena latisiliqua (L.) Benth.
Mimosa glauca L.
Acacia glauca Willd.

John K. Francis



General Description.—Leadtree occurs in three forms or types known as the "Hawaiian" or common type, the "Salvador" or giant type, and the "Peru" type. The common type is widespread and shrubby and will be dealt with in this document. Leadtree is also known as white leadtree, leucaena, tantan, wild tamarind, koa haole, ipil-ipil, zarcilla, guaje, monval, macata, and a host of other names. It commonly reaches 2 to 5 m in height and 5 to 10 cm in stem diameter at breast height. Undisturbed, closed stands usually are of single-stemmed plants; disturbed plants, especially dispersed ones, almost always develop multiple stems. Leadtrees are supported by tap and lateral root systems. They root deeply and extensively and form nodules when appropriate strains of *Rhizobium* bacteria are available. The stem bark is gray or brownish gray, more or less smooth with many lenticels. The sapwood is light yellow, and the heartwood is brown, hard, heavy (specific gravity 0.7), and has visible annual rings. The branches and twigs are grey-green to gray-brown and somewhat brittle in older shrubs. Bipinnate leaves 9 to 25 cm long are borne alternately. There are three to 10 pairs of pinnae each with 9 to 20 pairs of leaflets that are linear-oblong to lanceolate and 8 to 15 mm long. Solitary or paired inflorescences are 12- to 20-mm diameter, axillary heads on 2- to 3-cm-long peduncles. The heads contain numerous fragrant, greenish-white flowers. Usually four to 10 flattened, brown legumes, 10 to 15 cm long, develop per inflorescence. Each legume contains 15 to 20 hard, shiny, brown seeds that are flattened and tear-drop shaped. Leadtree is a polyploid with 2n = 104 chromosomes (Brewbaker 1997, Howard 1988, Liogier 1988, Little and Wadsworth 1964, Pennington and Sarukhan 1968, Stevens and others 2001).

Range.—Leadtree is native to southern Texas and the lowlands of Mexico from about 20° N. south to Nicaragua at about 12° N (Parrotta 2000). The Mexican state of Oaxaca derives its name from the Native American word "Uaxia," which means the "place where *Leucaena* grows" (National Academy of Science 1977). Most authors treat the range in vague terms or state that it is uncertain. The species is established so completely in the West Indies and the tropical lowlands of Central and South America that apparently all adapted sites are occupied and the population supports many natural enemies. While it is assumed that leadtree was spread to these areas through early Spanish commercial activity (Parrotta 2000), earlier introductions by humans or animals cannot be ruled out without archeological evidence. From the mid-1500's onward, leadtree has been spread intentionally and unintentionally throughout the Tropics and the frost-free and lightly frosted subtropics including Florida, Georgia, Arizona, Hawaii, and the U.S. Territories in the Caribbean and Pacific (Natural Resources Conservation Service 2002, Pacific Islands Ecosystems at Risk 2002).

Ecology.—Leadtree can grow on most soils derived from most parent materials in a wide variety of site conditions. It grows fairly well on disturbed, eroded, and partially compacted soils. However, the species does not grow well in poorly drained soils or periodically flooded soils, in soils with high salinity or those below pH 5.0 or above pH 8.0, at temperatures below 10 °C, and in areas with mean annual rainfall below 750 mm or above 2500 mm (Skerman and others 1988). Leadtree is intolerant of shade. It does best in the open, but competes aggressively in low stands of weeds and grass and will grow in low forests with low basal areas. It often forms thickets that briefly eliminate nearly everything underneath but soon self-thin to fairly open stands with normal understory vegetation. Leadtree is drought tolerant. It folds its leaves under water stress preventing water loss and, under severe conditions, will defoliate until the rains return (National Academy of Sciences 1977).

Reproduction.—Leadtree blooms throughout the year (Pennington and Sarukhan 1968) and may begin blooming as young as 4 to 6 months of age (National Academy of Sciences 1977). The flowers are largely self-compatible and self-fertilized. It takes about 4 months after flowering for pods to mature and liberate seeds (Binggeli 1997). From 10,000 to 21,000 seeds/kg are reported although it is sometimes unclear from what variety they were sampled (Brewbaker 1997, Parrotta 2000). A sample of seeds from shrubby plants from the north coast of Puerto Rico averaged 0.0392 ± 0.0006 g/seed or 25,500 seeds/kg (author's observation). Leadtree seeds have a hard coat that requires scarification for reliable germination. This can be done by abrasion, or treatments with hot water or concentrated acid. Germination of scarified seed is usually between 50 and 98 percent in 6 to 10 days after sowing. Seed can be stored for up to 5 years at temperatures of 2 to 6 °C (Parrotta 2000). Pods open while still attached to liberate their seeds and are dispersed by granivorous and herbivorous animals (Pacific Island Ecosystems at Risk 2002) and machinery. Detached pods are blown some distance by wind and occasionally retain attached seeds. Reproduction is common in disturbed sites near seed sources. Plants aggressively coppice when burned, cut, or broken off. The plant can be propagated vegetatively from cuttings (Parrotta 2000).

Growth and Management.—Leadtree grows moderately rapidly (not as fast as the giant variety for which most of the data are available). Seedlings may add about 1 m of height in the first year and 0.5 to 0.75 m for 2 or 3 years thereafter. Diameter growth may vary from 2 to 10 mm per year. Individual shrubs live 10 to 20 years or more. Plantations are relatively easy to establish with containerized seedlings or by direct seeding scarified seed into prepared seedspots at the beginning of the wet season. Because of its aggressive nature, it is not advisable to introduce leadtree into areas where it does not already occur. Within the native or naturalized range, disturbed wildlands are usually quickly colonized by leadtree from the soil seedbank or from nearby seed trees. However, where seed is not present, planting the species may be an excellent way of rehabilitating damaged sites. Grass swards should be cultivated or burned or sprayed followed by cultivation before planting. About 5,000 to 10,000 plants/ha should be established for erosion control and sward conversion. Dense stands of leadtree needing control may be slashed and grazed or sprayed with broadleaf herbicide.

Benefits.—Leadtree quickly invades disturbed areas and prevents further erosion while allowing succession to secondary forest cover. It is one of only a few species that can invade and rehabilitate dense tall grass swards such as *Panicum maximum* Jacq. and *Imperata cylindrica* (L.) Raeusch. (author's observation, National Academy of Sciences 1977). Leadtree furnishes food and cover for wildlife, especially browsing animals. The species has been planted widely in agroforestry applications. It is useful for forming erosion barriers, windbreaks, for shade and support, green manure, and cut fodder. It is known to fix useful quantities of nitrogen (Parrotta 2000). Plantations are established for pasture and cut for hay. The foliage is highly digestible (60 to 70 percent) (Brewbaker 1997). Young leaves are reported to contain 68 calories/100 g and 80 percent moisture (Duke 1983). By dry weight, leaves contain 21 percent crude protein, 18 percent crude fiber, 8 percent ash, 6 percent fat, and 46 percent total digestible nutrients (FAO 2002). Cattle readily eat the forage but suffer symptoms of mimosine toxicity if given a pure diet of the species. Pigs and chickens must not be given more than 5 to 10 percent in their diet, but goats have no difficulty with the forage, and sheep can become accustomed to diets rich in leadtree foliage (National Academy of Sciences 1977). The wood is a preferred fuel that burns slowly with little smoke or ash and makes an excellent charcoal (Brewbaker 1997). The stems are used for stakes and tool handles. The seeds are widely employed for making jewelry and placemats (Howard 1988). The young pods and green seeds are cooked as a vegetable, and the mature seeds are used as a coffee substitute and parched for snacks (Duke 1983). The flowers are a pollen source for honeybees (Little and Wadsworth 1964). Extracts of the roots and bark are a powerful emetic and have been used as an abortifacient (Liogier 1990).

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***Lindera melissifolia* (Walt.) Blume** pondberry
LAURACEAE

Synonyms: *Lindera melissaefolium* (Walt.) Blume
Benzoin melissaefolium (Walt.) Nees
Laurus melissaefolia Walt.

Margaret S. Devall and Nathan M. Schiff

General Description.—Pondberry, also known as southern spicebush (Morgan 1983), a member of the Lauraceae, is a stoloniferous, deciduous, aromatic shrub up to 2 m tall. Pondberry usually occurs in clones of numerous stems with erect or ascending shoots and few branches. The alternate drooping leaves are subcordate with prominent venation and pubescence on the lower surface (Klomps 1980). *Lindera benzoin* var. *pubescens* also is pubescent beneath. The species is dioecious, with small yellow flowers that bloom in spring before leaf-out. The fruit is a red drupe about 1 cm long that matures in late summer or fall. Female clones are often smaller than male clones and are sometimes absent from stands (Wright 1989, 1990). As in many clonal species, seedlings are rarely observed (Wright 1990, Devall and others 2001).

Range.—Pondberry occurs in the Southeastern United States. At present there are populations in Arkansas, Georgia, Mississippi, Missouri, North Carolina and South Carolina; it has apparently been extirpated from Alabama and Louisiana and possibly Florida.

Ecology.—Pondberry has probably always been a rare species (Radford and others 1968, Kral 1983), and knowledge of its ecology is limited. The species occurs in lowland habitats with hydric soils (Morgan 1983), in areas that are usually flooded in winter. In Mississippi pondberry occurs in bottomland hardwood forests. In northeastern Arkansas and southeastern Missouri pondberry is found on the bottoms and edges of shallow seasonal ponds in old dune fields, but in southeastern Arkansas it occurs in low habitat along a river. In South Carolina the species occurs in areas with karst topography, around the edges of sinkholes, and in Georgia it occurs along the borders of sphagnum bogs. Ambient light at the different sites ranges from deep shade to almost full sun. It appears that pondberry can occupy different habitats as long as its requirements for water are met (Devall and others 2001). The distribution and abundance of pondberry have been affected by habitat destruction and alteration, such as timber cutting and clearing of land. The species was listed as endangered by the U.S. Fish and Wildlife Service in 1986 (U.S. Fish and Wildlife Service 1986). Many of the existing colonies are small, and occupy only a portion of the apparently suitable habitat. Although the pondberry recovery plan states that there are 36 extant populations (U.S. Fish and Wildlife Service 1993), new colonies have been discovered since 1993, some in new locations and some near known populations. Some populations that were thought to be separated by enough distance to preclude interbreeding (as on the Delta National Forest, MS) may be linked by recently discovered colonies.

Reproduction.—Stems flower in the second to fourth year of growth (U.S. Fish and Wildlife Service 1993). The flowers are pollinated by several species of small bees and are visited by numerous insect species. Flower and fruit production are highly variable (Morgan 1983, Tucker 1984). Some years the flowers are damaged by late frosts, while other years flower and fruit production may be heavy, with up to 100 fruits per plant.

Growth and Management.—Seedlings are rarely observed (Devall and others 2001). Stems usually live 6 or 7 years, and when a stem dies it is almost always replaced by a new stem that grows from the base of the plant. Clones expand vegetatively, and a mature colony often includes numerous leafy stems along with some dead stems (U.S. Fish and Wildlife Service 1993). Most pondberry colonies occur in light shade, but a few grow in almost full sun. In unshaded conditions, competition may be a problem. More knowledge is needed about management, and studies are currently being conducted on the Delta National Forest in Mississippi and at other locations. The U.S. Fish and Wildlife Service (1993) states that pondberry should be protected from forestry and agricultural management actions and protected from grazing and browsing animals.

Benefits.—The fruits are eaten by hermit thrushes (*Catharus guttatus*), cardinals *(Cardinalis cardinalis)* and other birds (Smith and others 2003). Steyermark (1949) reported that the fruits are used as ammunition in pop guns, tubular contrivances constructed from elderberry [*Sambucus nigra* L. ssp. *canadensis* (L.) R. Bolli] twigs.

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Lonicera japonica **Thunb.** Japanese honeysuckle
CAPRIFOLIACEAE

Synonyms: *Nintooa japonica* (Thunb.) Sweet

John K. Francis

General Description.—Japanese honeysuckle, also known as woodbine and Chinese honeysuckle, is a semi-evergreen woody vine that forms mounds and mats on open ground and by twining, climbs shrubs, low trees, windfalls, and fences. The ropy stems, which have gray-brown, fissured to shredding bark, can extend 5.5 m or more and reach 10 cm in diameter in old plants. The wood is white, soft, and fine-grained. Young stems are reddish brown to light brown and about 3 mm in diameter with hollow pith. Roots are extensive, reaching 2.5 m laterally and 15 to 100 cm in depth. Opposite, light-green leaves are 2.5 to 12 cm long, ovate to oblong, entire to lobbed, with short petioles. The leaves are evergreen in tropical and subtropical settings and become late deciduous to deciduous in cooler temperate climates. The paired axillary flowers are 2 to 3 cm long, white (sometimes tinged with pink or purple) turning yellow, tubular with five lobes, fused in two unequal lips. The fruits are black, glossy, globose berries 4 to 6 mm in diameter containing two to 10 black seeds (Miller 1999, Munger 2002, Stephens 1973). Japanese honeysuckle is a diploid plant with 2n = 18 chromosomes (Schierenbeck and others 1995).

Range.—Japanese honeysuckle is native to Japan, Korea, China, and Taiwan (Bravo 2003, Pacific Island Ecosystems at Risk 2003). The species has naturalized in much of the United States except Alaska and a few states in the Northwest, northern Midwest, and Vermont (Natural Resources Conservation Service 2003). It has also naturalized in Puerto Rico (Liogier and Martorell 1982), Ontario, Canada (Munger 2002), Juan Fernandez archipelago, Chile (Sharma and others 1997), Australia, New Zealand, Christmas Island (Pacific Island Ecosystems at Risk 2003), England, Portugal, Corsica, Brazil, and Argentina (Nuzzo 2003). There are two generally accepted varieties, *chinensis* and *hilliana*. The latter is the variety commonly encountered in naturalized populations (Nuzzo 2003).

Ecology.—Japanese honeysuckle grows well in a wide variety of soils with a few exceptions such as coarse sands and poor peat soils (Munger 2002). It invades fencerows, roadsides, vacant lots, forest openings, understories of open forest stands, and abandoned pastures and fields. The species is present in nearly all the forest associations in the Southeastern U.S., the region where it is most common. Japanese honeysuckle is adapted to climbing small-diameter stems and sometimes smothers or strangles small trees. It cannot ascend trees with trunks larger than 15 cm in diameter (Nuzzo 2003). It grows best under full sunlight but can still survive with 25 percent of sunlight in a forest understory. Retaining leaves and photosynthesizing through all or part of the winter after canopy forest trees have defoliated helps plants survive through the summer in low-light conditions (Nuzzo 2003). Northern distribution of naturalized Japanese honeysuckle is limited by short growing seasons and late spring frosts, and is generally south of an isotherm where mean January temperature is -1 °C. It has not generally naturalized west of the 1000 mm mean annual precipitation limit (except where exogenous water is available), roughly corresponding with native hardwood forests. Japanese honeysuckle survives fire by sprouting from stem tissue buried under litter and mineral soil. It generally disappears from communities (such as longleaf pine) where fires are frequent (Munger 2002).

Reproduction.—Japanese honeysuckle in the U.S. flowers from April through July (sometimes through October) varying by local climate (Nuzzo 2003). The flowers open in late afternoon and remain open for about 3 days (Nuzzo 2003). The flowers are pollinated by hummingbirds and insects (nocturnal hawkmoths and diurnal bees). The species requires pollen from genetically distinct individuals for successful pollination and as a result is pollinator limited. Naturally-pollinated flowers produced seeds in 17.4 percent of the resulting fruits while hand-pollinated flowers produced seeds in 78.7 percent of the fruits (Larson 2001). The seeds are dispersed primarily by birds. Germination of most seeds appears to occur in the spring following dispersal and occurs at similar rates in mineral soil and under leaf litter (Munger 2002). Japanese honeysuckle regenerates vegetatively by sprouting from underground stems and by the layering of above-ground stems that come in contact with the soil. Discarded prunings will also take root.

Growth and Management.—Seedlings grow slowly for the first 2 years but afterwards may extend their stems 1.5 m/year (Nuzzo 2003). The species begins bearing fruit at age 3 in full sun and at age 5 when growing in the shade. Fruit production generally peaks between ages 4 and 6 (Munger 2002). By fertilization, researchers were able to increase browse produced by Japanese honeysuckle by over 2,000 kg/ha and increase crude protein as well (Dyess and others 1994). The species is easy to propagate with cuttings and most ornamental plants are multiplied in this fashion. The greater challenge is to eliminate infestations of Japanese honeysuckle. Pulling and grubbing individual plants and small infestations can be effective but will require repeat visits to eliminate missed sprouts and new seedlings. Tethered goats can provide effective control for spot infestations (Bravo 2003). Over-the-top spraying with glyphosate, Dichlorprep + 2,4-D, picloram + 2,4-D, tebuthiuron, sulfometuron, or triclopyr will kill it (Nuzzo 2003) but also tend to eliminate most other plant species as well. A more selective method is to cut stems and apply the above mentioned herbicides to the cut surfaces (Bravo 2003). Mowing is ineffective (Nuzzo 2003).

Benefits and Detriments.—In spite of the invasive and weedy tendencies of the species, Japanese honeysuckle is still widely used as an ornamental. It is especially desirable in arid areas where it has little tendency to spread. Managed for screens and ground cover, Japanese honeysuckle is beautiful in and out of flower and especially captivating because of the strong and pleasant aroma of its blooms. Some gardeners favor it because it attracts hummingbirds. The fruits are toxic to humans if large quantities are eaten and result in vomiting, diarrhea, rapid heartbeat, respiratory failure, and coma. However, children suck the nectar from flowers without ill effects (Russell 1997). The species was formerly planted for erosion control and wildlife benefits. Planting is currently discouraged or prohibited because the species has dominated large areas and threatens sensitive native species (Nuzzo 2003). Japanese honeysuckle is important wildlife cover and an important, sometimes the most important, browse species for white tailed deer in Eastern and Southern United States. It is also eaten by cottontail rabbits, cattle, sheep, and goats. The leaves yield 8 to 12 percent crude protein and have an *in vivo* dry matter digestibility of 35 to 70 percent. Wild turkeys, northern bobwhite, and a number of songbirds eat the fruits (Munger 2002). Japanese honeysuckle tissues contain anti-complementary polysaccharides and polyphenolic compounds. Used in herbal medicine, extracts are reported to protect against cellular injury, help maintain vascular health, and prevent infections (Nuzzo 2003)

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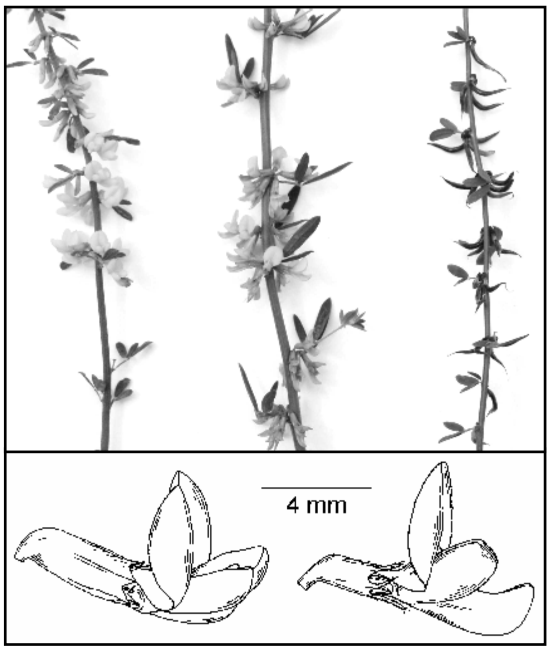
***Lotus scoparius* (Nutt.) Ottley** California broom
FABACEAE

Synonyms: *Hosackia scoparia* Nutt. in T. & G.
Syrmatium galbrum Vogel
Hosackia glaber Greene
Hosackia crassifolia Nutt., not Benth
Lotus glaber Greene, not Mill.

Arlee M. Montalvo



General Description.—California broom is a diverse and widely distributed subshrub (Munz and Keck 1968, Isely 1981, Hickman 1993). The Latin name "scoparius" refers to the broom-like form which is also evident in the common name "California broom." The other common name, "deerweed," refers to its use as browse by deer. Of five previously recognized subspecific taxa (Ottley 1923, Munz and Keck 1968), the three from the Channel Islands were reassigned to *L. dendroideus* (Greene) Greene by Isley (1981). His treatment of the genus recognizes two varieties of *Lotus scoparius* (*L. s.* var. *scoparius* and *L. s.* var. *brevialatus* Ottley) and has been adopted in Hickman (1993). In the former, the keel of the corolla is about as long as the wings and the calyx has broad triangular teeth (figure: top left and bottom left). In the latter, the keel is longer than the shortened wings and the calyx has narrow teeth (figure: top center and bottom right). The erect suffrutescent shrubs grow from 0.4 to 1.5 m tall but prostrate forms often occur along the coastal strand. A spreading, prostrate ecotype occurs on coastal sand dunes at Monterey Bay. The many flexible green branches arise from a woody base, and are mostly glabrous except toward tips. The soft, alternate leaves are pinnately compound with three (occasionally four to five) oblong to oblanceolate leaflets, usually 4 to 10 mm long with short, sparse, appressed hairs, and are subtended by small, gland-like stipules. The sessile, usually two- to seven-flowered, umbellate inflorescences are in the axils of leaves. The yellow pea-like flowers are 7 to 10 (occasionally to 15) mm long, have short pedicels, and sometimes bear a red splotch of varying intensity on the back of the banner. Depending on the plant, flowers fade to dark orange or red following pollination. Plants bear hundreds of inflorescences and are an attractive flag for native bees. The small indehiscent pods (figure: top right) bear one to two (rarely three) seeds that vary from brown to greenish brown with or without dark brown mottling. Seeds of var. *scoparius* are narrow bean-shaped, 1.2 - 2mm long. Seeds of var. *brevialatus* are narrower (ca. 3 x longer than wide). Both varieties have 2n = 14 chromosomes (Munz and Keck 1968, Grant 1995).

Range.—California broom occurs primarily after fire or in open areas of coastal sage scrub, chaparral, desert scrub, washes, coastal strand, or along roadsides. The var. *scoparius* is distributed in cismontane California below 1,500 m from Humboldt and Plumas Counties, south into Baja California, primarily in shrublands and associated open areas, and primarily in the coastal regions of California and north of Los Angeles. In addition to the distinct differences in floral form between the two varieties, there is variation in floral form within var. *scoparius* that is associated with coastal verses inland habitats from the Transverse Range of California, northward (author's observation). Variety *brevialatus* occurs from Los Angeles Co., south into Baja California primarily in the hotter and drier interior regions of Riverside, Los Angeles, western San Bernardino, and eastern San Diego Counties. Although the two varieties have somewhat different geographic distributions and are easily distinguished by floral characters (Isely 1981, Steppan 1991), they overlap and hybridize in some areas of Los Angeles, Riverside, and San Diego Counties. Putative hybrids have been observed in contact zones between the two varieties (Isely 1981, Steppan 1991, Montalvo and Ellstrand 2001). Flowers of synthetic F1 hybrids are somewhat intermediate, but have wings as long as the keel. Many areas of overlap may be due to natural secondary contact, but some are clearly due to seeding projects along highways and utility corridors. The various floral forms are maintained when plants are grown from seed in a common environment (Montalvo and Ellstrand 2000, 2001).

Ecology.—In nature, seeds typically germinate after scarification by fire but some germinate in open, disturbed sites (Munz and Keck 1968, Keeley and Keeley 1984). Between 2 to 3 years after fire in sage scrub vegetation, following a burst of herbaceous species, California broom can become the dominant canopy species, eventually becoming replaced by long-lived shrub species. Its abundance gradually decreases in 5 to 10 years after fire. The branched tap root is relatively shallow (< 1 m), and roots form symbiotic associations with nitrogen fixing bacteria and arbuscular mycorrhizal fungi (author's observation). Plants are facultatively drought-deciduous, a trait commonly associated with shallow-rooted shrubs of coastal sage scrub vegetation in California. Seasonality of leaf production, nutrient accumulation, and leaf drop in response to summer drought has been studied extensively in *L. scoparius* var. *scoparius* (Nilsen and Muller 1980, 1981a,b, 1982, Nilsen and Schlesinger 1981, Nilsen 1982). Other researchers have examined response to photoperiod (Comstock and Ehleringer 1986).

Reproduction.—Seeds of California broom germinate in mid to late winter during the rainy season. Plants establish quickly with normal rainfall and typically reach flowering size the second year. Flowering occurs primarily from March to June but may start as early as January in warm, wet winters, and last much longer in more moist, coastal areas and in years with long-lasting soil moisture. Flowers are self-compatible and insect-pollinated (Moldenke 1976, Hickman 1993, Jones and Cruzan 1999) primarily by native bees in the genera *Bombus, Hoplitus, Anthophora, Habropoda*, *Osmia*, and *Anthidium*, but flowers are also visited by butterflies and non-native honeybees (author's observation, Jones and Cruzan 1999). The indehiscent pods ripen in about 4 to 6 weeks and are primarily passively dispersed short distances. The hard seeds require heat or mechanical scarification to break dormancy. Of several treatments including control, soil heated to 100 ^{o}C for 1 hr, ash /chemical fertilizer, and heat plus fertilizer, Christensen and Muller (1975) found that heat treatment yielded the highest germination. In addition, Keeley (1987) found that heating seeds in their pods to 120 ^{o}C for 5 minutes increased germination over that of unheated controls.

Genetics.—There are significant genetic differences among populations of the two varieties of California broom (Montalvo and Ellstrand 2000, 2001). An analysis of genetic marker data (13 allozyme loci) from three populations of var. *brevialatus* and nine populations of var. *scoparius* showed significant population substructure due primarily to differences among populations of the two varieties. In an analysis of all populations, 18 percent of the variation was due to differences among populations, while analysis of just var. *brevialatus* or var. *scoparius* populations showed only 1 and 8 percent of the variation due to differences among populations. Thus, populations within a variety are substantially more genetically similar to each other than to populations of the other variety. Inbreeding coefficients were low for all populations, a pattern consistent with substantial cross pollination, severe loss of inbred progeny, or both (mean f = 0.09, range = 0.00 – 0.18) (Montalvo, Clegg, and Ellstrand, manuscript in preparation).

There is also genetically based geographic variation in floral form in this species. In San Diego Co., Steppan (1991) detected distinct discontinuities in floral morphology between varieties and moderate correlations among environmental variables and floral traits of wild populations. Montalvo and Weaver (unpublished data) measured floral traits on 12 populations of plants raised in a common environment and made pairwise comparisons of genetic, floral, geographic, and environmental distances of source populations. Floral morphological distance correlated with environmental distance, genetic distance correlated with floral distance, but genetic distance did not correlate with geographic distance until var. *brevialatus* was removed from the analysis. Results were consistent with floral form having a genetic basis and with environmental factors playing a role in the evolution of floral divergence.

The substantial genetic differentiation of populations has implications for translocation of California broom for restoration. Common garden experiments testing plants originating from seed collected from 12 source populations (both varieties represented) demonstrated a significant home site advantage (Montalvo and Ellstrand 2000). Furthermore, Montalvo and Ellstrand (2001) directly tested the potential for "outbreeding depression," a loss of fitness upon crossing genetically differentiated populations, by crossing individuals from six populations of the two varieties in every combination and testing the progeny in two common gardens at wild sites. Seeds per flower and seedling emergence decreased significantly with an increase in genetic distance of the crossed parental populations. Among variety crosses were only 70 percent as fit as within variety crosses by the time seedlings emerged, and further fitness differences accumulated after seedlings were outplanted into field plots. In these common gardens, success of progeny decreased with increasing differences between parental environments and the transplant location. Results indicate that careful attention should be given to the similarity of taxonomic position and environment of source populations relative to planting location, especially when choosing source populations for restoration, mitigation, and roadside landscaping.

Interspecific Hybridization.—Putative hybrids have been reported between California broom and *L. junceus* (Benth.) Greene and *L. benthamii* Green in central and northern California, as well as between other members of the species complex (Isely 1981), but there have not been any genetic studies confirming introgression. Liston and others (1990), however, did genetic studies on San Clemente Is. and documented hybridization between the rare *L. dendroideus* (Greene) Greene var. *traskiae* (Nodden) Isely, formally *L. scoparius* ssp. *traskiae* (Noddin) Raven, and the more widespread *L. argophyllus* (A. Gray) E. Greene var. *ornithopus* (E. Greene) Ottley. They concluded that genetic assimilation of the rare species by the widespread species is possible.

Growth and Management.—The small pods of California broom can be collected from May to July depending on location. Pods or cleaned seeds can be covered with boiling water and left to soak to break dormancy (Atwater 1980, Young and Young 1986, Emery 1988, Montalvo and Ellstrand 2000, 2001), or exposed to dry heat (Keeley 1987). Whole pods can be dry or wet broadcast in the fall for revegetation and restoration. Seedlings plugs can also be used for small projects. In greenhouse plantings, seeds germinate best when planted less than 2 mm deep (author's observation). Despite the strong geographic and morphological differences, the two varieties have been used indiscriminately in many seeding projects. Due to the adaptive differences and the observed outbreeding depression following hybridization, land managers should use the variety native to the planting location.

Benefits.—California broom is an important, fast growing, early successional species used extensively in erosion control, post-fire mitigation, and habitat restoration in California, especially in the rapidly disappearing coastal sage scrub. The flowers and seeds are an important food resource for a variety of insects and seed foraging rodents and birds (Duncan 1968). The plants provide valuable forage for deer, especially in drought years when growth of herbaceous vegetation is sparse (Dale 2000).

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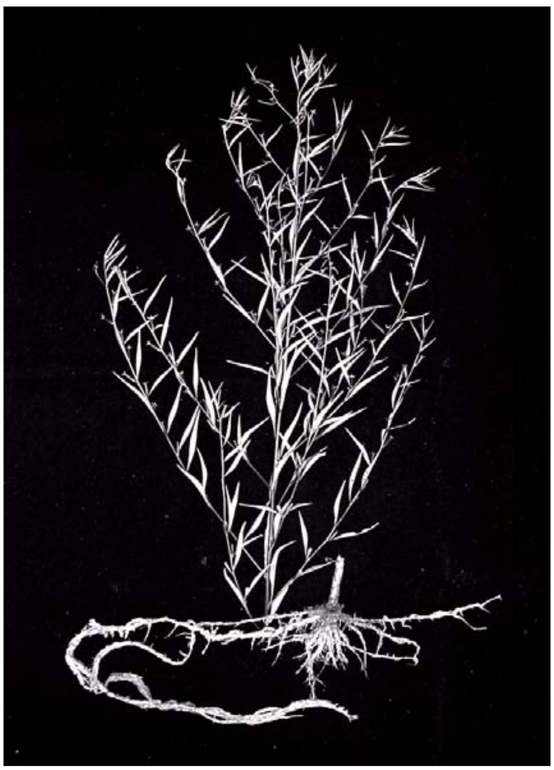
***Ludwigia octovalvis* (Jacq.) Raven** primrose willow
ONAGRACEAE

Synonyms: *Oenothea octovalvis* Jacq.
Jussiaea suffruticosa L.
Jussiaea pubescens L.
Jussiaea octovalvis (Jacq.) Sw.
Jussiaea angustifolia Lam.
(many others Howard 1989, Liogier 1995)

John K. Francis



General Description.—Primrose willow, also known as Jamaica loostrife, wild clove, many-seed, kamole, cangá, yerba de clavo, girofle-ma, grand giroflé, and manger mouton, is a suffruticose shrub or perennial woody herb to 2 m in height and 1 cm in stem diameter. The stems of older plants are woody through most of their height; branches become increasingly succulent toward the tips. Only the lower parts of young plants are woody. Primrose willow plants are supported by "sinker" roots, one of which may be the taproot, and long white, lateral roots that grow just under the soil surface. These roots have a hard central core and are surrounded by a cottony mass of root hairs. In the first year, the stem produces a number of fine lateral branches. In the next one or more years, thelateral branches each produce similar secondary or tertiary branches. The alternate leaves are linear to narrowly ovate with blades 1.3 to 16.2 cm long. The species is highly variable in leaf size, shape, and pubescence. Primrose willow flowers are solitary in the upper leaf axils. Four sepals form a peg-like hypanthium, 5 to 12 mm long, from which emerge four yellow petals. The twigs, leaf veins, and hypanthium are often tinged in red. The capsules, which have a clove-like shape, are 2.5 to 5 cm long and contain many rounded, black seeds. Chromosome number for the species is 2n = 32, 48 (Howard 1989, Jones 1975, Liogier 1995, Long and Lakela 1976).

Range.—The original range of primrose willow is unknown. It grows today from Southern United States through the West Indies, and from Mexico through Central and South America to at least Bolivia (Hodgdon Herberium 2002, Natural Resources Conservation Service 2002). It has naturalized in Hawaii (Fish and Wildlife Information Exchange 2002) and grows in tropical and subtropical regions almost worldwide (Burkill 1997, Howard 1989, Liogier 1995).

Ecology.—Primrose willow grows in wet soils and shallow water, such as drainage ditches, borrow pits, sloughs, marshes, ponds, seasonally flooded bottoms, river banks, and rice paddies. Soil type within those sites is apparently not very important. Primrose willow grows from near sea level to at least 800 m in elevation (Missouri Botanical Garden 2002). It prefers full sun and tolerates no more than side shade. The species grows singly or in clumps.

Reproduction.—After primrose willow plants in the tropics reach about 0.4 m, blooming and fruiting is continuous (author's observation, Long and Lakela 1976). In Texas, it is reported to bloom from July through October (Correll and Johnston 1970). Seeds collected in Puerto Rico averaged 54 million per kg. Placed on moist filter paper, 28 percent of them germinated within 14 days, most on the seventh day (author's observation). Local dispersal is by wind and water. Long-distance dispersal is probably accidental on birds, machinery, or materials being shipped.

Growth and Management.—Primrose willow grows up to 1 m/year. Under favorable conditions, plants live at least 3 years and possibly more. There seems to be little reason to plant the species. Control may be necessary in drainage ditches to maintain flow and in rice paddies. Control can be achieved by cultivation, hand pulling, and by applying commercial weed killers.

Benefits and Detrements.—Primrose willow grows in wet areas where few other plants will grow and as such it aids in the successional process. It furnishes cover for wildlife. Its yellow flowers add a splash of color to areas often devoid of colorfully flowering plants. In herbal medicines, preparations of the leaves are used to treat diarrhea, dysentery, as a laxative and a vermifuge, and to relieve headache, chest pains, and rheumatoid pain (Burkill 1997, Liogier 1990, Parrotta 2001). A test of a local crude drug from Taiwan made from primrose willow effectively inhibited the cariogenic bacteria *Streptococcua mutans* (Chen and others 1989). The plant is a major weed in rice in the tropics and sometimes chokes drainage ditches and irrigation canals (Burkill 1997).

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***Lupinus arboreus* Sims** yellow bush lupine
FABACEAE

Synonyms: None

Christopher Ross

General Description.—Yellow bush lupine is a small erect shrub, less than 20 dm tall, with cauline leaves on 2- to 3- cm petioles, and composed of five to 12 leaflets, on 8 to 12 mm stipules. Leaf colors range from green and smooth to silver and hairy. In northern California it grades into and coexists with *L. rivularis* Doug. ex Lindl., distinguished by blue flowers (Sholars 1993).

Range.—Yellow bush lupine is native on coastal bluffs and dunes, or less than 5 km inland (Davidson and Barbour 1977), in central California from Ventura to Sonoma Counties, and is widely naturalized on the northern California coast (Sholars 1993) and as far north as Vancouver, Canada (Hitchcock and Cronquist 1973). There has been considerable debate over the native range, although it probably encompasses only the southern part of the current range.

Ecology.—Yellow bush lupine is an aggressive colonizer of dunes, where it outcompetes native dune mat species. It encourages other non native invaders by fixing nitrogen (Pickart and others 1998) and creating shade. Outside its former range, it also hybridizes with native lupines, especially *L. rivularis* (National Park Service 2001). The California Native Plant Society places it on the "A" List of invasive weeds in Humboldt County; however, it is apparently only a serious invader of dune communities (Anderson et al. 1999). Most lupines are poisonous to large herbivores, but I found no data on this species. Yellow bush lupine is a strong nitrogen fixer, and is used in New Zealand as a planted precursor to tree planting in unstable, nitrogen-deficient dune environments, where it has been estimated to contribute 220 kg of nitrogen/ha in 4 ½ years of growth (Gadgil 1971). In California coastal prairies it is a facilitator of exotic weed and annual grass invasions, which establish after the dense canopies of the short-lived lupines are opened by fire or insects (Maron and Connors 1996). A variety of insects prey upon it, sometimes killing extensive stands. Among the predators are the subterranean ghost moth *Hephialus californicus* and the tussock moth *Orgyia vetusta.* The nitrogen rich litter that results from such mortality makes establishment of native vegetation uncertain and a long-term process (Maron and Jefferies 1999).

Reproduction.—Inflorescences are 10 to 30 cm, with flowers sometimes arranged in whorls. Flowers are 14 to 18 mm with upper lip 5 to 9 mm and lower lips 5 to 7 mm. Petals are yellow, or north of central California lilac to purple. Pods are hairy, brown or black, 4 to 7 cm long. Eight to 12 seeds per pod are black, tan, or striped, and are 4 to 5 mm long (Sholars 1993). Flowers are both self-compatible and outcrossing and have generated considerable interest from genetic investigators. Self-pollination requires facilitation, usually from insects, but is responsible for only about 25 percent of seed production (Kittelson and Maron 2000).

Fire Effects.—Although fire may cause widespread mortality in dense lupine stands, and may be followed by invasion of annual weeds and grasses (author's observation), the long-lived lupine seed banks may result in reestablishment of lupine (Maron and Connors 1996). The annual weeds and grasses that follow the nitrogen enrichment by lupine potentially alter fire regimes, increasing frequency and intensity of burns.

Growth and Management.—Yellow bush lupine is fast growing and short lived (maximum 7 years) (Davidson and Barbour 1977). Stands may grow rapidly and die off in as little as 3 years (Strong et al. 1995). Restoration of lupine-invaded sites should include litter and duff removal in addition to direct removal of lupine, because it enriches soil to the detriment of native competitors (Pickart and others 1998). In New Zealand, where it is used as a soil developer, it is controlled prior to tree planting by crushing and herbicides (Gadgil 1971). Coastal dune restoration in northern California has focused heavily on removal of yellow bush lupine. Manual removal is accomplished by pulling up small plants and chopping larger ones, which rarely crown sprout. Heavy equipment has also been used successfully, but all mechanical methods are labor intensive and expensive (Pickart and Sawyer 1998). Although others have noted a long-lived seed bank (see Maron and Connors 1996 and above), Pickart and Sawyer (1998) found no recruitment by 3 years after removal of established stands.

Benefits.—Yellow bush lupine has been widely cultivated as a sand stabilizer and ornamental in coastal California. It is a strikingly beautiful plant, both in and out of bloom, although its short life and messy litter probably limit its value as an ornamental. Elsewhere it has been used to prepare coastal and dune soils for planting of commercially useful trees (Gadgil 1971). It provides habitat for birds, reptiles, and rodents.

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***Lycium pallidum* Miers** pale wolfberry
SOLANACEAE

Synonyms: None

Juanita A.R. Ladyman

Illustration credit: Tonia Masaood

General Description.—*Lycium pallidum* is commonly known as pale wolfberry, pale lycium, rabbit thorn (Epple 1995), box thorn (Derig and Fuller 2001), chico, cambronera, and tomatillo (Elmore 1976). The latter name can be confusing because "tomatillo" also commonly refers to species of *Physalis* (Tull 1987). The epithet "pallidum" refers to the pale colored leaves. Pale wolfberry are thorny, intricately-branched shrubs that form loose thickets. Unlike other *Lycium* species it is seldom drought deciduous (Bowers 1993, Kearney and others 1960). The pale green, elongated-oblong leaves are adjacent to short, sharp thorns or spines. The flowers are greenish cream, sometimes tinged with purple, and funnelform in shape. The corolla tube is longer than 12 mm. The stamens are usually exerted (Vines 1986, Welsh and others 1993). The oval fruits are red colored and approximately 1 cm or less in diameter (Vines 1986). Typically the plants are 1 m high shrubs but may grow to 2 m (Elmore 1976, Carter 1997). Two varieties of *Lycium* pallidum are recognized: var. *oligospermum* C.L. Hitchc., and var. *pallidum* (Kartesz 1994). Variety *oligospermum* differs from var. *pallidum* in having smaller flowers (corolla tube less than 12mm), smaller anthers (1 to 1.5mm versus 1.8 to 3 mm) and fewer, only approximately seven seeds, per berry (Cronquist and others 1984, Baldwin and others 2002).

Range.—Pale wolfberry is a common shrub in Arizona, southern Colorado, southern California, Nevada, New Mexico, western Oklahoma, western Texas, and Utah in the U.S.A., and in Sonora, Chihuahua, Zacatecas, and San Luis Potosí in Mexico (McGregor and others 1986, Vines 1986, Carter 1988, Welsh and others 1993). Variety *oligosperma* occurs only in Nevada and California (Integrated Taxonomic Information System 2002).

Ecology.—Pale wolfberry grows at elevations of 910 m to 2,134 m in a variety of habitats and soils, including those derived from limestone and igneous formations. It often grows in sandy soils and is tolerant of saline soils (Kearney and others 1960). It is frequently a member, and may be a co-dominant, in blackbrush, sagebrush, four-wing saltbush, mesquite, greasewood, mountain brush, and pinyon-juniper communities (Dick-Peddie 1993, MacMahon 1988, Welsh and others 1993). However, it has never been reported as a dominant species. Pale wolfberry grows throughout the Sonoran, Chihuahuan, and Mohave Deserts. At higher elevations it grows on dry slopes and plains, but in the deserts it tends to grow in washes or other areas where run-off supplements rainfall (Bowers and McLaughlin 1987, Bowers 1993). Wolfberry species have tough and fibrous roots and the root systems are relatively extensive extending 25 to 30 feet (7.5 to 9.0 m) from the plant (Matthews 1994) that suggests they may be important in retarding soil erosion.

Reproduction.—Pale wolfberry generally flowers in April to June but in some regions may flower as early as February (Powell 1998, Epple 1995). The fruits mature in the late spring and summer (Bowers 1993, Vines 1986). The fragrant, creamy-yellow to yellowish-green flowers are insect-pollinated. The bright, shiny red berries contain 20 to 50 seeds.

Growth and Management.—Pale wolfberry sprouts readily when cut or broken (Van Dersal 1938). Once established, shrub longevity may be substantial. In one Arizona study 69 percent of individual shrubs of a related species, *Lycium berlandii*, survived for at least 50 years (Goldberg and Turner 1986). Seeds are likely dispersed by birds and other animals that feed on the berries (Bowers 1993). It can be propagated from hardwood cuttings, suckers, layers, and seeds.

Benefits.— Pale wolfberry is an important source of food for wildlife, especially birds and rodents (Elmore 1987, Bowers 1993, Powell 1998). In many areas of degraded habitat in the Southwestern United States it frequently provides a source of berries and browse, in an otherwise depauperate landscape (authors personal observation). It has been reported to be locally important and valuable as browse for livestock especially on winter range (Van Dersal 1938). The berries also are eaten by humans, especially Native Americans, who have also used other parts of the plant as medicine and in ceremonials (Moerman 1998, Stevenson 1915). In times of famine the Native Americans of northern Arizona ate the dried berries mixed with saline clay (Kearney and others 1960). In this form they were called "food clay" by the Navajo or "potato clay" by the Hopi (Dunmire and Tierney 1997). As well as being an extender, the clay may have been used to reduce bitterness. With the recent interest in using native plants, more palatable recipes for sauces and jams using pale wolfberry berries are available (Derig and Fuller 2001). Medicinal uses include applying the soaked leaves to cuts and using the ground-up roots for toothaches. These hardy shrubs have been used as ornamentals since 1878 but on a limited scale (Vines 1986, Powell 1998). Stands of pale wolfberry are frequently associated with ancient Anasazi ruins in the Four Corners area of the Southwestern United States (Dunmire and Tierney 1995). Some stands have been speculated to be deliberate plantings and others the result of inadvertent seed dispersal. After a pueblo is abandoned, moisture tends to collect over decomposing subsurface floors and plazas and these conditions may make suitable habitat for seeds that were unintentionally dropped by the inhabitants of the ancient Pueblos (Dunmire and Tierney 1997).

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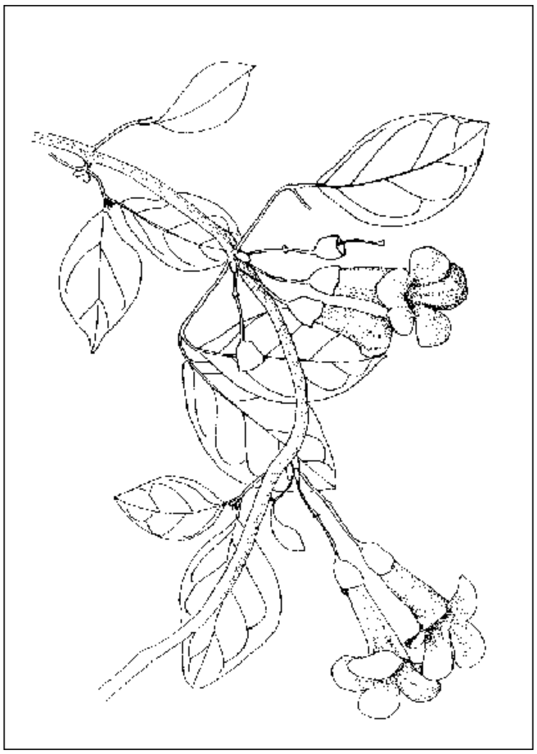
***Macfadyena unguis-cati* (L.) A.H. Gentry** cat's claw
BIGNONIACEAE

Synonyms: *Bignonia unguis* L. emend. DC.
Bignonia unguis-cati L.
Batocydia unguis (L. emend. DC.) Mart. ex DC.
Doxantha unguis (L. emend. DC.) Miers
Doxantha praesignis Miers
Doxantha serrulata Miers

John K. Francis



General Description.—Cat's claw is a woody vine or occasionally a scrambling shrub. The name, and its equivalent in Spanish, uña de gato, comes from the tripartite, hooked tendrils resembling an animal's claws that enable the vine to adhere to tree bark and other surfaces (Acevedo-Rodríguez 1985). Old plants are more or less free hanging. It is also known by the common names bejuco de gato, paz y justicia, and griffe à chatte (Howard 1989, Liogier 1995). Cat's claw has a strong and flexible, cylindrical stem that is brown in color with many lenticels. The stems produce adventitious roots to anchor them tightly to vertical surfaces. Cat's claw may exceed 8 cm in stem diameter and extend more than 20 m into the crowns of trees. A long main root extends laterally near the soil surface with finer roots scattered over its length. Tubers are produced by both young and old plants (Stockard 2001). The plant grows and maintains few branches until the growing tip reaches increased light. The compound leaves have two leaflets with the clawed tendril between them. The leaves are generally ovate to lanceolate in shape but quite variable in size. Depending on both age and environment, petioles may vary from 0.25 to 2.5 cm in length, and blades may vary from 1 to 16 cm in length. They are dark green above and lighter below. Inflorescences are axillary with one to three flowers. The 4.5 to 10 cm-long tubular flowers have five lobes and are bright yellow with red-orange lines in the throat. From them develops a long (up to 75 cm), narrow (1.0 to 1.5 cm), flattened capsule that produces brown, flattened, winged seeds. The species has both diploid (2n = 40) and tetraploid (2n = 80) populations (Acevedo-Rodríguez 1985, Gentry 1983, Howard 1989, Liogier 1995).

Range.—Cat's claw is native to the Greater and Lesser Antilles, Mexico, Central America, and South America to Argentina (Howard 1989). The species is reported to have naturalized and escaped in Florida, Texas, Hawaii (Aquatic Plant Control Operations Support Center 2001), New Caledonia (Pacific Island Ecosystems at Risk 2001), Australia (Stockard 2001), South Africa (Pest Cabweb 2001).

Ecology.—In Puerto Rico, cat's claw grows from near sea level to over 600 m in elevation and in sites that receive mean annual rainfalls from about 750 to about 2400 mm. It will tolerate most soils, except very poorly drained and salty soils. The species can tolerate a few degrees of frost, being killed to the ground but resprouting afterward (Watkins and Sheehan 1975). Cat's claw is moderately shade tolerant as a young plant and grows in both full sun and under forest canopies. It may be less shade tolerant as an adult. The species is common in savannas, secondary forest, and remnant high forest. It can survive grazing and fire but is eliminated by deep grass swards.

Reproduction.—In Hawaii, flowering takes place during the spring (Rauch and Weissich 2000) whereas there are actually two periods of flowering in Puerto Rico, both during dry seasons (Acevedo-Rodríguez 1985). In Costa Rica, nearly all the plants flower at once and flowering lasts just a short time (Gentry 1983). The capsules mature about 6 months after flowering. The winged seeds are dispersed by the wind. Seedlings are common and widespread in suitable habitat. Eleven capsules collected in Puerto Rico had a maximum of 212 seeds and a minimum of 106 seeds. These seeds (air dry) averaged 0.0224 ± 0.0005 g/seed or 45,000 seeds/kg. One hundred percent of the seeds tested germinated between 49 and 95 days after sowing in commercial potting mix. Young plants sprout when damaged and layer (root) whenever stems touch the ground. Cat's claw, for ornamental uses, have been propagated by seed, cuttings, and layering (Turner and Wasson 1999).

Growth and Management.—Stem extension is moderately rapid, especially in sprouts. Diameter growth of cat's claw stems is slow. The vines are long-lived, nearly as long as the trees that they claim for support. There are relatively few problems in establishing cat's claw. Insect and disease problems are rare. The biggest problem is controlling ornamental plants. Yearly pruning after the flowering season is essential to maintaining them within the bounds desired. In its native range cat's claw vines have only a minor effect on the trees they parasitize. However, the species is beginning to seriously suppress native vegetation in parts of Florida (Florida Exotic Plant Council 2001) and Australia (Stockard 2001). The only means of control recommended at present is to cut the vines and paint the cut ends with glyphosate herbicide (Stockard 2001). However, Vélez and van Overbeek (1950) report that older plants are killed by simply cutting the stems. A more practical long-term solution is hoped for in the ongoing biological control introductions in several countries (Pest Cabweb 2001).

Benefits.—Despite the propensity to naturalize and compete with native vegetation, cat's claw is still a handsome ornamental. It is often used to cover fences or screen unsightly buildings. Cat's claw is recommended for areas where there is little chance of invasion and especially in desert areas because it requires relatively little water for maintenance (Desert-Tropicals 2001). It was reported that a preparation made from cat's claw was used to treat dermatitis from *Hippomane mancinella* L. (Michell and Rook 2001). A number of other uses in herbal medicine from diverse locations are cited by Liogier (1990).

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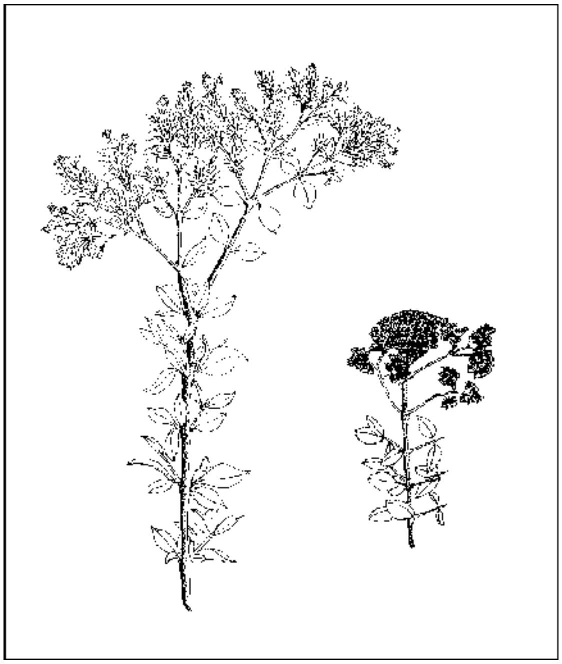
Machaonia portoricensis **Baill.** alfilerillo
RUBIACEAE

Synonyms: none

John K. Francis



General Description.—Alfilerillo, also known as roseta, is a spiny shrub or small tree that occasionally reaches 6 m in height and 7.5 cm in stem diameter. It is supported by an extensive lateral root system. Alfilerillo may have single or multiple stems arising just above the ground level, but it is always branchy and thorny. The stem bark is gray and smooth becoming fissured in old plants. The branches and twigs are brown, slender and stiff and support paired spines 1 to 2.5 cm long at the nodes and ends of twigs. The plant tends to have a slender, vertical profile. Opposite or whorled, almost sessile leaves are orbicular to elliptic with entire edges and blades 7 to 16 mm long and 5 to 10 cm broad. Tiny, white flowers are grouped in many-flowered terminal panicles. The capsules are turbinate (inverse conical), brown, quadrangular, 4 to 5 mm long, crowned with four calyx lobes and contain two seeds (Liogier 1997, Little and others 1974).

Range.—Alfilerillo is native to Puerto Rico (Liogier 1997) from Salinas to Cabo Rojo. A closely-related, recently-separated species, *Machaonia woodburyana* Acev.-Rodr., occurs on St. John in the U.S. Virgin Islands (New York Botanical Garden 2002) where it is endangered (University of the Virgin Islands 2002). Alfilerillo is not known to have been planted or naturalized elsewhere.

Ecology.—Alfilerillo grows on a wide variety of well-drained soils derived from a variety of rock types including limestone and ultramafics (serpentine). These are usually rocky, sandy, or moderately salty so that competition is somewhat reduced. It is moderately intolerant of shade and can inhabit forests with low basal areas. The species grows in dry habitat that receives from about 750 to about 950 mm of mean annual precipitation at elevations ranging from near sea level to about 400 m. Alfilerillo is relatively tolerant of fire, being killed to the ground, but readily sprouting. It seems to be resistant to grazing by cattle probably owing to the spines. The species may be found in remnant forests on ridges and bluffs, in overgrazed brush lands and savannas, near mangroves and salt ponds, and in beach strand vegetation (author's observation, New York Botanical Garden 2002, Vázquez and Kolterman 1998).

Reproduction.—Alfilerillo flowers and fruits irregularly through the year (Little and others 1974). Seeds collected from trees in western Puerto Rico weighed an average of 0.00182 g/seed or 548,000 seeds/kg. Sown on moist filter paper, 24 percent germinated within 54 days. Germination is epigeal. No specialized means of seed dispersal is apparent aside from a weak tendency to cling to clothing. Seedlings are uncommon in spite of relatively good seed production. Plants sprout when disturbed.

Growth and Management.—Growth of alfilerillo is relatively slow. A 3-cm thick stem cut by the author had 11 growth rings. No planting or management experience has been published.

Benefits.—Afilerillo helps protect the soil in the fragile environments where it grows and furnishes cover for wildlife. The wood, which is light-brown, hard, and brittle, is good for fuel.

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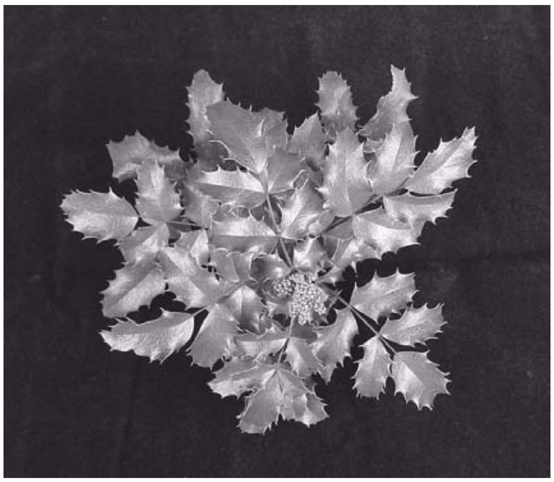
***Mahonia aquifolium* (Pursh) Nutt.** Oregon grape
BERBERIDACEAE

Synonyms: *Berberis aquifolium* Pursh
Berberis piperiana (Abrams) McMinn
Mahonia piperiana Abrams
Odostemon aquifolium (Pursh) Rydb.

John K. Francis



General Description.—Oregon grape, also called tall mahonia, hollyleaved barberry, mountain grape, Oregon grape-holly, and Oregon holly-grape, is an upright evergreen shrub from 0.6 to 3 m in height. The stems are slender, stiff, usually upright, and usually without branches. The wood is whitish and brittle and has a significant pith. Bark of young stems is green; older bark is rough and gray-brown with yellow inner bark. The root systems produce horizontal rhizomes up to 1.8 m long from which suckers arise. The foliage attaches directly to the stems. Alternate, stiff and leathery, pinnately compound leaves have five to 13 leaflets with a form like holly (coarse dentate with prickles). Leaves are dark green above, except in winter, when exposed leaves take on a purplish color. The species is monoecious with perfect, bright-yellow flowers in terminal (sometimes lateral) racemes. Flowers have a honey-like fragrance. Fruits (berries), 6 to 10 mm long, ripen from green to blue or blue-black in late summer (Abrams 1950, Center for Applied Nursery Research. 2003, Dirr 1983). Oregon grape is the state flower of Oregon (Paghat.com 2003).

Range.—Oregon grape is native to British Colombia, Washington, Oregon, northern California, and northern Idaho (Abrams 1950, Natural Resources Conservation Service 2003). The species has been planted widely as an ornamental and medicinal plant and has naturalized in Michigan, Ohio, Kentucky, New York, New Jersey, United Kingdom, Germany and probably other areas (Auge and Brandl 1997, Natural Resources Conservation Service 2003, Plants for a Future 2003). Oregon grape hybridizes naturally with *Mahonia repens* (Lindl.) G. Don (many ornamentals are actually this hybrid) and *Mahonia pinnata* (Lag.) Fedde (Plants For a Future 2003). At least three artificial intergeneric crosses between Oregon grape and *Berberis* species have been made (Dirr 1983).

Ecology.—Oregon grape is tolerant of shade and normally grows in the forest understory. Natural stands contain scattered individual plants arising from seeds and clumps of the species arising both from seed and suckers. The species grows well in soils with a wide variety of properties. However, ornamentals do not do well in dry, wind-swept sites, or soils with high pH’s (above 8.0). The tops are severely injured at –29 °C (Dirr 1983). It grows in areas with natural precipitation ranging from 950 to 5450 mm annually (Las Pilitas Nursery 2003). A number of diseases and insects attack the leaves and fruits but usually do not cause serious damage.

Reproduction.—Oregon grape blooms from April to June (Clark and Trelawny 1976). Flowers are self-fertile and pollinated by insects (Plants for a Future 2003). The fruits mature in late July through September and remain on the plants into December (Center for Applied Nursery Research 2003). Fruits collected by the author from ornamental plants in Utah averaged 0.312 ± 0.013 g/fruit. Air-dried seeds separated from them averaged 0.0067 $\pm$ 0.0002 g/seed or 149,000 seeds/kg. The number of seeds/fruit varied from zero to nine. Fruits can be harvested in quantity by hand and can be cleaned by gentile maceration, wet sieving, and screening. Seeds should not be allowed to dry out completely and should be stratified at 5 °C before sowing. Taken in November and treated with 0.8 to 1.0 percent of IBA (Indolbuteric acid), cuttings root well. Division of established plants is an alternate method of vegetative propagation (Dirr 1983). In nature, mostly birds disperse the seeds (Paghat.com 2003) and both sexual and asexual reproduction are effective (Auge and Brandl 1997).

Growth and Management.—Oregon grape is moderately slow growing. Individual stems reach a 60- to 90-cm height in 3 to 4 years (Dirr 1983). While individual stems probably have a life of not more than 10 years, clones can last much longer. Plants are grown for the nursery trade in containers and are usually 1 year old when sold. The species is planted both in sunny and shady locations. Ornamental plants tolerate pruning well (Plants for a Future 2003). Data on management of the species in natural stands are lacking.

Benefits.—Oregon grape shrubs contribute to the diversity and beauty of understory vegetation in native habitats, help protect the soil, and furnish food and cover for wildlife. The species is planted in temperate areas throughout the world as an ornamental, for hedges, and foliage, and leafy branches with their fall colors are sometimes used for Christmas decorations. The fruits, edible but sour, are made into jellies and juice drinks (Clark and Trelawny 1976). Flowers are eaten in salads, cooked in tempuras, and used to make a lemonade-like drink (Paghat.com 2003). Yellow, green, violet, and purplish-blue dyes are made from various tissues for arts and crafts (Plants For a Future 2003).

Herbal Medicine.—Infusions of Oregon grape root and doses of isolated alkaloid have been used effectively in the past to relieve many of the symptoms of syphilis (Felter 1922). Ointments made from the plant and isolated alkaloids are currently enjoying tremendous popularity in treating psoriasis and similar skin conditions. In clinical trials, symptoms improved or disappeared in 81 percent of 443 patients suffering from subacute and chronic psoriasis (Gieler and others 1995). Of the constituent compounds tested, the benzylisoquinoline alkaloids berbamine and oxyacanthine were principally responsible for inhibition of abnormal cell growth, with berberine showing lesser activity (Muller and others 1995). The fruit serves as a safe and gentle laxative (Plants for a Future 2003).

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***Mahonia repens* (Lindl.) G. Don** creeping barberry
BARBERIDACEAE

Synonyms: *Berberis amplectens* (Eastw.) L.C. Wheeler
Berberis aquifolium Pursh var. *repens* (Lindl.) Scoggan
Berberis pumila Greene
Berberis sonnei (Abrams) McMinn
Mahonia amplectens Eastw. (additional synonyms: Natural Resources Conservation Service 2003)

John K. Francis

General Description.—Creeping barberry, also known as Oregon grape, creeping Oregon grape, creeping mahonia, creeping hollygrape, ash barberry, and dwarf Oregon grape, is an upright to recumbent, evergreen shrub 12 to 40 cm in height and 3 to 9 mm in basal diameter. The stems are solitary, usually unbranched but occur in clonal groups arising from rhizomes. The main root is stiff and deep, and the lateral roots are short and fine. Stem bark is slightly rough and gray brown, and the inner bark is bright yellow, especially the inner root bark. The wood and pith are yellow. The alternate leaves, which have petioles 2 to 3 cm long, are pinnately compound with three to seven leathery, sessile, ovate leaflets that are dull on both surfaces, and have spiny-toothed margins. There are usually two to eight leaves per plant. Several flowers with six petals and six sepals, both yellow, are clustered in terminal racemes 3 to 7 cm long. Fruits are glaucous, blue berries containing one to four seeds. The seeds are 6 to 10 mm long. There are 2n = 28 chromosomes (Auger and other 2002, Harrison 2003, Lesica 2002, Rehder 1951, Welsh and others 1987). Creeping barberry readily hybridizes with *M. aquifolium* (Pursh) Nutt. and *M. pinnata* (Lag.) Fedde when growing near them (Pagahat.com 2003).

Range.—Creeping barberry is native to the Western United States as far east as Texas and Minnesota, and to British Colombia and Alberta in Canada. It is present (probably naturalized) in Indiana and Pennsylvania (Natural Resources Conservation Service 2003, Walkup 1991). The species has been planted widely as an ornamental and has probably naturalized in many areas outside its native range.

Ecology.—Low in stature and moderately tolerant of shade, creeping barberry is not highly competitive. In Utah, it will not grow in heavy grass and forb stands. It is most frequently seen in rocky or gravely areas with low vegetative cover or under open conifer or hardwood stands with sparse understory vegetation. However, the species is reported to be the dominant understory shrub in closed-canopy Douglas fir in central Idaho (Walkup 1991). Creeping barberry apparently grows well under conifers that produce a thick layer of decomposing needles. However, it does not flower when growing in shade (Pahgat.com 2003). Natural populations are affected little by treatments such as prescribed fire, clearcutting, and scarification. It usually survives (by sprouting) even moderate and high-intensity fires (Walkup 1991). Creeping barberry is an invader of disturbed sites (Harrison 2003). It will grow in most well-drained soils and is especially common in rocky or gravelly soils. The species is much more common over limestone or other alkaline parent materials than granite or quartzite (Walkup

1991). It tolerates acidic soils but grows poorly when concentrations (less than 2.5 mg/L) of boron are low (Harrison 2003). Creeping barberry grows at elevations of 1,125 to 3,300 m in the inland West (Harrison 2003, Walkup 1991). Although it is most common on north-facing slopes, it grows on south-facing slopes and ridge tops at higher elevations.

Reproduction.—Creeping barberry flowers in May through June and matures fruit in June through July (Rudolf 1974). The flowers are pollinated by bees and butterflies (Paghat.com 2003). Flowers not cross pollinated with other plants will self pollinate, but produce much fewer seeds (Walkup 1991). Ratio weight of fresh fruits to air-dried seeds is 12.5:1 (Auger and others 2002). There are 119,000 to 157,000 seeds/kg (Rudolf 1974). Cleaned seed can be sealed and stored for 5 years (Harrison 2003). Rudolf (1974) recommends stratification of 30 days at 1 °C followed by 60 days at 21 °C, and then 196 days at 1 °C. Treated thus, 74 percent of test seeds germinated. Alternately, a hot water treatment followed by cold stratification for 60 days is recommended (Kjelgren 2003). Seeds can be sown in fall without pretreatment. In nature, seeds are dispersed by birds and to a lesser extent by mammals including black bears and rodents (Auger and others 2002). Once established, plants spread through sprouts from rhizomes (Walkup 1991).

Growth and Management.—Growth is slow. Individual stems may live 10 years or more. It is difficult to imagine the need to control this unobtrusive species in its native habitat. On the other hand, it should frequently be planted as part of environmental restoration projects. The species can be artificially propagated by seed, divisions, cuttings, and layers (Walkup 1991). Direct seeding in the fall is the most practical method to introduce it to disturbed sites. Repellants or poisons may be necessary because the seeds are readily consumed by mice (Kjelgren 2003).

Benefits.—Creeping barberry adds beauty to the forest, helps protect the soil, provides food for wildlife, and makes a useful ornamental. It is planted as ground cover, especially under light tree canopy cover or on poor, gravelly ground. In the summer, the leaves are dark green; in winter they are green, mottled with bright red, or a bonze-purple. The species is particularly recommended because it requires little or no irrigation (Kansas State University Research and Extension 1996). It is included in reclamation plantings (Welsh and others 1987) and has been used especially for revegetation of mine spoils (Harrison 2003). Mule, white-tailed deer, and sometimes elk browse creeping barberry during fall and winter. The protein content ranges from 4.7 to 5.5 percent, and the species contains high contents of carotene in July. Creeping barberry foliage is mildly toxic and domestic animals normally make little use of it for forage except when other food is scarce (Walkup 1991). In one case, browsing of creeping barberry killed cattle in Arizona (Harrison 2003). Many mammals (including black bears) and birds eat the fruits (Walkup 1991). The fruits become edible to humans after they have passed through at least one frost. They are used to make jelly, wine, and a juice drink (Harrison 2003). Native Americans used the berries and the roots for lavender and yellow dyes, respectively, and made teas from the roots to treat a range of afflictions (Lesica 2002, Paghat.com 2003). Creeping barberry contains the alkaloids berberine and oxyacanthin (Harrison 2003). The species is an alternate host for black stem rust of cereal grains (Walkup 1991).

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***Malvastrum americanum* (L.) Torr.** Indian Valley false mallow
MALVACEAE

Synonyms: *Malva americana* L.
Malva spicata auct. non L.
Malvastrum spicatum auct. non (L.) Gray
Malva blumeana Steud.
Malva gangetica L.
Malva borbonica Willd. (and others, Institute of Systematic Botany 2003)

John K. Francis

General Description.—Indian Valley false mallow, also known as spiked malvastrum, false mallow, malva loca, malva silvestre, and mauve d'Amérique, is a shrub, subshrub, or woody herb that often reaches 1.5 m in height and 1 cm in basal diameter. The semideciduous plant generally has a single stem that is upright and sparsely branched. The wood is light colored, moderately hard, and moderately strong. Plants are supported by a tap and lateral root system of ivory colored roots. The twigs and leaves are stellate-pubescent. Gray-green leaves have a 1- to 6-cm petiole, usually ovate blades 2 to 8 cm long with serrate margins. Inflorescences are dense spikes, terminal on stems and branches. The flowers are sessile, subtended by an involucel of three linear bracts. The petals are pale yellow to yellow-orange and 8 to 9 mm long. The fruits are 5 to 6 mm in diameter and contain 10 to 15 mericarps without spines with seeds 1.5 mm long (Howard 1989, Liogier 1994, Stevens and others 2001). There are 2n = 24 chromosomes (Lavia and others 2000).

Range.—Indian Valley false mallow occurs in Florida and throughout the Caribbean including Puerto Rico and the U.S. Virgin Islands and from Texas through Central and South America to Argentina (Howard 1989, Stevens and others 2001). The species occurs as a naturalized exotic in Hawaii (Natural Resources Conservation Service 2003), Australia, India, and other locations in the Old World tropics and subtropics (Howard 1989).

Ecology.—Plants observed by the author appear to be short-lived shrubs that grow yearly without dieback. The species is reported also growing as an herb (annual) and subshrub (dieing back to permanent woody parts each year) (Howard 1989, Stevens and others 2001). Indian Valley false mallow is usually not eaten by cattle or other herbivores. Moderate grazing coupled with fire tends to make the species more abundant. It also grows in areas disturbed by river overflows, farming, road building, and land clearing. The species is intolerant of shade and severe competition. It disappears under closed tree canopies or in dense tall grass swards. However, Indian Valley false mallow does grow under a broken tree canopy. It grows on most types of well-drained soil. Mean annual rainfall in Puerto Rican habitat ranges from about 750 to 1000 mm (author's observation). It is known from near sea level to 1000 m in elevation in Nicaragua (Stevens and others 2001).

Reproduction.—Indian Valley false mallow is reported to flower and fruit throughout the year in Nicaragua (Stevens and others 2001). In Puerto Rico, plants begin flowering at about 15 cm in height and continue through life except for pauses during dry seasons. Air-dried seeds collected in Puerto Rico averaged 1.19 million seeds/kg. Placed on moist filter paper without pretreatment, 15 percent germinated over a period of 6 months. No specialized means of dispersal is apparent; the seeds are small and undoubtedly are moved to some extent by wind, water, and animals. Seedlings are relatively common in favorable sites. The dry fruits can easily be collected in quantity by hand but cleaning the tiny seeds is difficult.

Growth and Management.—Growth rates are moderate (0.3 to 0.5 m/year) and plants live 1 to 5 years, depending on competition and growing conditions. Although control is occasionally needed in rangelands and disturbed areas, no specific recommended treatments are known to the author.

Benefits and Detriments.—Indian Valley false mallow helps protect the soil, furnishes cover for wildlife, and because of its blooms contributes moderately to the aesthetics of wildlands where it grows. It is a host for the cotton bollworm, *Helicoverpa armigera* (Hubner) (Mensah and others 2003). The species also is the larval food-plant for the Laviana white-skipper butterfly, *Heliopetes laviana* (Hewitson) of Texas (Quinn 2003) and a Cuban butterfly, *Strymon columella cybira* (Hewitson) (Fernández 2001).

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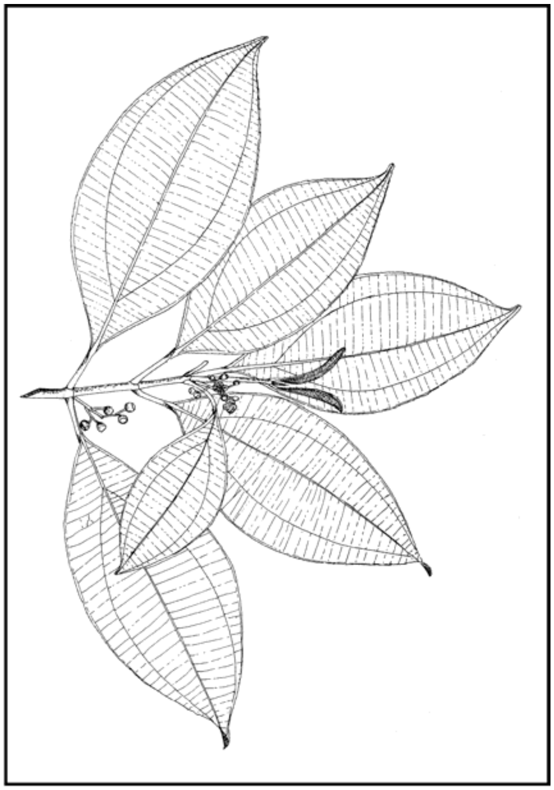
Mecranium latifolium (Cogn.) Skean camasey almendro
MELASTOMATACEAE

Synonyms: *Mecranium amygdalinum* (Desr.) C. Wright ex Sauvalle
Melastoma amygdalinum Desr.

John K. Francis



General Description.—Camasey almendro is a shrub or small tree sometimes reaching 7.5 m in height and 13 cm in stem diameter. The plant frequently has multiple stems arising near the base. Horizontal stems and branches produce vertical sprouts. Stems, which are covered with gray-brown, thin, slightly furrowed bark, tend to be straight with relatively few branches. Twigs are light green turning brown, slightly four-angled, and marked with half-round leaf scars. The wood is light tan, weak and brittle, and has a 2-mm pith. Plants are supported by a shallow system of dark tan, somewhat brittle roots. Opposite, light green leaves are elliptic to ovate, pointed at both ends, with the margin mostly finely serrate, and 5.4 to 15.4 cm long. There are three main veins, the two lateral ones arising 0.3 to 1.3 cm above the base of the blade. Small inflorescences (panicles) are axillary and bear several-to-many small, white, four-petaled flowers. The juicy fruits (berries) are globose, 5.5 mm in diameter, purplish black when mature, and have a slightly sweet and slightly bitter flavor. Within are many seeds that are light brown, tear-drop shaped, and about 0.5 mm long by 0.25 mm thick (author's observation, Liogier 1995, Little and others 1974).

Range.—Camasey almendro is native to the Luquillo Mountains and the Cordillera Central of Puerto Rico and to St. Thomas in the U.S. Virgin Islands (Liogier 1995). DNA evidence indicates a likelihood that this species arose from *M. multiflorum* (Desr.) Triana or *M. septentrionala* Skean now found in the adjacent island of Hispaniola (McKenny 2002). The species is not known to have been planted or naturalized outside the native range.

Ecology.—Camasey almendro is widely distributed throughout the mountain forests in Puerto Rico from 300 m elevation upward (Little and others 1974) in areas that receive more than about 1800 mm of precipitation. Soils are usually clayey or loamy, developed from igneous and sedimentary rocks with pH's from about 5.0 to 6.0. Camasey almendro flowers and fruits in full sun and partial shade. It grows well in moderate shade but eventually succumbs to the heavy shade of a fully closed forest canopy. Apparently, at least mild disturbance is necessary for establishment. Such disturbance results naturally from hurricanes and other winds that cause tree-fall gaps, rarely from landslides, and more recently from road cuts and other construction. However, invasion is slow and never with large populations. Thirty years after a plane crash removed the elfin forest vegetation at 1,000 m elevation in the Luquillo Mountains of Puerto Rico, 0.1 percent of the stems of the resurgent vegetation was camasey almendro (Weaver 2000).

Reproduction.—Camasey almendro flowers and fruits throughout the year (Little and others 1974). The small fruits are produced in relatively large numbers, and each fruit contains a large number of seeds. A collection of fruits from Puerto Rico averaged 0.138 ± 0.005 g/fruit. The seeds are tiny; an air-dried sample averaged 25.4 million/kg. The seeds can be cleaned by crushing, wet sieving with a fine mesh screen, filtering and drying on the paper filter, and rubbing the seed off the paper. Without pretreatment seeds took 4 months to begin germinating and completed 11 percent germination in 11 months. Germination is epigeal, and seedlings are about 1 mm across the two cotyledon leaves. It is assumed that birds eat the fruits and disperse the seeds. Seedlings are scattered to relatively common in suitable, disturbed habitat. Layering (rooting) occurs whenever horizontal stems come in contact with the ground. Camasey almendro sprouts when stems are broken or cut.

Growth and Management.—Camasey almendro grows moderately slowly and probably lives at least 2 or 3 decades. No planting or management experience has been published. Removal of the forest canopy and soil disturbance near seed sources would likely result in reproduction.

Benefits.—Camasey almendro helps protect the soil and furnishes food and cover for wildlife. It is an attractive plant and adds to the aesthetics of the forest. The species might be suitable as an ornamental in natural landscaping if it proves adaptable at lower elevations where the island urban centers are located.

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***Melochia nodiflora* Sw.** malva colorada

STERCULIACEAE

Synonyms: *Mougeotia nodiflora* (Sw.) HBK.
Riedlea nodiflora (Sw.) DC.
Visenia nodiflora (Sw.) Spreng. in L.

John K. Francis

General Description.—Malva colorada, also known as britónica prieta and mauve, is a medium-sized shrub to 3 m in height and 5 cm in stem basal diameter. The species forms a fairly robust tap and lateral root system. The species is herbaceous when small, becoming woody before the end of the first year. Malva colorada may have single or multiple stems that arise from the root crown and lateral roots and large lateral branches may form low on the stem. Malva colorada often develops only primary and secondary branches. The bark of older stems and branches is reddish brown. The leaves are alternate with petioles 0.5 to 3 cm long and ovate or ovate-lanciolate blades are 2.5 to 10 cm long and 1.2 to 6 cm broad. The tip is pointed, the margin serrate, and the veins prominent. The inflorescences are axillary in dense globose clusters in which are situated tiny, dark pink, pink, or white flowers. The inflorescences mature into clusters of reddish-brown capsules each of which contain, when completely filled, five 2-mm brown seeds (Grisebach 1864, Howard 1989, Liogier 1994).

Range.—Malva colorada is native to the Bahamas, the West Indies, and from Mexico through Brazil (Grisebach 1864, Howard 1989, Liogier 1994). The species is not known to have been planted or naturalized outside its natural range.

Ecology.—Malva colorada grows on all types of well drained soils with medium or high fertility (Sánchez, and Uranga 1993) derived from sedimentary (including limestone), igneous, and metamorphic (including ultramafic) rocks. In Puerto Rico, it grows in areas that receive from 750 to about 2000 mm of mean annual precipitation. In dry areas, the species is confined to riparian zones. Malva colorada grows in Puerto Rico from near sea level to over 600 m in elevation. The species does not tolerate heavy shade and seems to require at least minor soil disturbance to become established. Malva colorada grows in old fields and neglected pastures, on roadsides and fencerows, along river flood planes and bars, and on neglected construction sites and vacant lots. It competes well with low grass and broadleaf weeds but does not grow under closed tree canopies.

Reproduction.—Malva colorada flowers over a 2 or 3 month period. After flowering, capsules take about 6 months to mature seeds. The species produces large quantities of seeds that are released during the dry season. They are small and are carried by wind, water, animals and agricultural equipment (Sánchez and Uranga 1993); no specialized means of dispersal is known. Seeds of malva colorada collected in Puerto Rico weighed an average of 0.00167 g/seed or 597,000 seeds/kg. Seeds with no pretreatment were placed to germinate on moist filter paper, and 36 percent germinated over an 11-month period. Germination is epigenous.

Growth and Management.—Individual stems live from 2 to about 4 years. Through suckers and coppices, plants can live several times longer. Malva colorada is sometimes a weed and is primarily a problem in perennial plantations such as citrus, pasture, coffee, and sugar cane (Sánchez and Uranga 1993). The species is controlled by mowing, cutting with machete, and by spraying with broadleaf weed killers.

Benefits.—Malva colorada is browsed by goats and to a limited extent by cattle. It protects against erosion in recently disturbed areas.

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***Melochia tomentosa* L.** pyramid bush

STERCULIACEAE

Synonyms: *Melochia frutescens* Jacq.
Moluchia frutescens (Jacq.) Medikus
Melochia turpiniana Kunth
Moluchia tomentosa (L.) Britton

John K. Francis

General Description.—Pyramid bush, also known as tea bush, raichie, broom wood, broom weed, black widow, balsam, bretónica afelpada, and bois-champignon, is an erect shrub 0.5 to 4 m in height and up to 10 cm in basal diameter. Pyramid bush is supported by a tap and lateral root system. Usually, a single stem emerges from the ground, but it may branch near the base. The branches farther up the stem are slender. The bark is slate-gray with many lenticels. Stemwood is tan colored, moderately hard, and tough. The leaves are covered with a short wooly hair giving the plant a gray flannel look. Ovate to lanciolate leaves are attached by short petioles and have blades 1.5 to 10.5 cm long and 0.9 to 8.5 cm broad with serrate margins. Its inflorescences are axillary umbelliform cymes of perfect flowers with five pink, purple, or blue petals that are 8 to 13.5 mm long. The fruits that develop are pyramidal capsules 6 to 9 mm across. The seeds are 2 mm long and reddish brown (Howard 1989, Liogier 1994).

Range.—The native range of pyramid bush extends from southern Florida and southern Texas through the West Indies and Central America into Brazil and Colombia (Howard 1989, Liogier 1994, Instituto Nacional de Biodiversidad 2002, Recursos Hidricos 2002). No planting or escapes have been reported outside its natural range.

Ecology.—Pyramid bush grows in dry areas (areas receiving from 750 to 1000 mm of annual precipitation in Puerto Rico), usually within a few km of the coast. It grows from near sea level to altitudes of about 400 m in Puerto Rico. The species tolerates a wide variety of well-drained soils derived from sedimentary and igneous rocks and grows on coastal sands. Because there is relatively little competition, pyramid bush is most common on sites that are rocky, eroded, or excessively drained. In Texas, the species is found on sandy or rocky soil in mesquite thickets, palm groves, and dry streambeds (San Antonio Botanical Gardens 2002). The species inhabits pinelands in southern Florida (Long and Lakela 1976). In Brazil, it is part of the pioneer community on the sandy soils of the coastal plain (Recursos Hidricos 2002). The species does not tolerate heavy shade, and overtopping by trees will eliminate it. It is not eaten by cattle and tends to be common on overgrazed rangeland--probably because competition from grasses and other plants is reduced.

Reproduction.—Pyramid bush flowers at the end of the wet season (November and December) and ripens fruits about 2 months later. It flowers during the summer and early fall in Texas (Everitt and Drawe 1993). Air-dried capsules of pyramid bush collected in Puerto Rico weighed an average of 0.0135 g. Seeds separated from them weighed an average of 0.00104 g/seed or 963,000 seeds/kg.

Sown without pretreatment on moist filter paper, 79 percent germinated within a short period 6 months later. The species can be propagated with cuttings (San Antonio Botanical Gardens 2002). There appear to be no specialized means of seed transport; the small seeds are probably disbursed incidentally by wind, water, machinery, and cattle.

Growth and Management.—Nursery-grown pyramid bush seedlings in Texas reached 60 cm in just 2 months after outplanting (San Antonio Botanical Gardens 2002). However, adult plants in Puerto Rico add only about 30 cm to their height each year. Based on ring counts in Puerto Rico, plants appear to live about 10 years. Overgrazing to reduce competition may be the best way of promoting this species. Pyramid bush is often considered a weed in rangeland (Liogier 1990). Mowing may be sufficient to control it.

Benefits.—Pyramid bush appears to have great potential as a flowering ornamental for xeric landscaping (San Antonio Botanical Gardens 2002). In natural habitat, it contributes to biodiversity, soil stability, and wildlife cover. Although cattle avoid it, sheep and goats in Brazil browse it in mixture with other native species (Charles and others 1983). A tea is made from the foliage to treat colds and as an eye wash (Liogier 1990).

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Miconia impetiolaris **(Sw.) D. Don ex DC.** camasey de costilla
MELASOMATACEAE

Synonyms: *Melastoma impetiolaris* (Sw.) D. Don
Miconia wydleriana DC.
Tamonea impetiolaris (Sw.) Cook & Collins

John K. Francis

General Description.—Camasey de costilla, also known as camasey colorado, cordobán, oreja de mula, dos caras, auguey, hoja de pasmo, punta de sarvia, maya, and trios côtes, is a shrub or small tree 2 to 8 m in height. The plant is supported by a deep taproot and strong, lateral roots. These roots are light gray and have fissured bark. Camasey de costilla forms multiple stems if cut or damaged. Stem bark is brown and finely fissured. Young branches are stout, quadrangular, and covered with brown hairs; lower leaf surfaces, petioles, and flower stalks of camasey de costilla are also covered with brown pubescence. Leaf petioles are 2 to 7 mm long and mostly obscured by the cordate leaf base. The leaves are opposite and usually have five main nerves. The blades are ovate, minutely serrate at the edges, long pointed, 12 to 40 cm long, and roughly half as wide. Large terminal panicles bear many tiny, stalkless white flowers. The fruits are berries 4 to 7 mm in diameter progressing from red to purple or blue-black as they ripen. Each fruit contains numerous tiny brown seeds (Croat 1978, Howard 1989, Liogier 1995, Little and others 1974, Stevens and others 2001).

Range.—Camasey de costilla is native to Mexico, Central America, South America as far south as Bolivia, and to the Greater and Lesser Antilles (Liogier 1995, Little and others 1974, Stevens and others 2001). Three varieties have been described (Stevens and others 2001). The species is not known to have been planted or naturalized outside its native range.

Ecology.—Camasey de costilla grows from a few meters above sea level to about 600 m in elevation (Little and others 1974, Stevens and others 2001). It requires moist to wet habitat where it rains from about 1500 to about 3000 mm/year. Although a wide variety of soils are tolerated, the species is most frequent on well drained to somewhat poorly drained, neutral to strongly acid clays and clay loams, often with the A horizons absent or partially gone because of erosion. Excessively drained soils are not colonized. Camasey de costilla is moderately intolerant of shade. It succumbs in dense shade, grows but does not fruit under a forest canopy, and fruits in broken or full sun. The species requires disturbance to become established (Stevens and others 2001). It may be found in early and middle secondary forests, plantations, fencerows, pastures, and roadsides. The species varies from an occasional plant to common as dispersed plants or in clumps.

Reproduction.—Camasey de costilla flowers from spring until fall in Puerto Rico (Little and others 1974). It reportedly flowers during the dry season (February and March) and fruits during the wet season (April and May) in Panama (Croat 1978), and flowers and fruits throughout the year in Nicaragua (Stevens and others 2001). The seeds are disbursed by birds and primates (Molano and others 2002). A collection of fruits from Puerto Rico averaged 0.242 $\pm$ 0.008 g/fruit. Air-dried seeds from these fruits averaged 0.00044 g/seed or

2.3 million seeds/kg. Sown on wet peat, 56 percent of the seeds germinated between 13 and 23 days after sowing. The new seedlings are tiny and develop slowly (author's observation).

Growth and Management.—Camasey de costilla is relatively slow growing. About 0.25 to 0.5 m of height is added annually. Plants live at least 10 years and probably much longer. No known attempts have been made to plant or manage camasey de costilla. Probably management practices that maintain forests interspersed with pastures, brushlands, and roadsides will ensure at least a presence of camasey de costilla.

Benefits.—Camasey de costilla is employed as a living fencepost in Colombia when it springs up naturally along fence rows (Molano and others 2002). The wood is light colored and hard (Little and others 1974) and used to a limited extent for stakes and fuel. Camasey de costilla benefits wildlife by furnishing food (fruits) and cover. It also contributes to biodiversity and protects the soil from erosion. In herbal medicine, leaf extracts are used for aromatic baths, to arrest bleeding, promote healing, and to treat mouth sores (Liogier 1990). The species is pretty enough to be employed as an ornamental, but perhaps because of the difficulty of propagation, it has not been used so far.

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***Miconia prasina* (Sw.) DC.** camasey blanco
MELASTOMATACEAE

Synonyms: *Melastoma prasina* Sw.
Miconia collina DC.
Acinodendrom prasinum (Sw.) Krasser in Engl. & Prantl.
Melastoma parviflora Aublet
Melastoma pendulifolia Rich.
Miconia parviflora (Aublet) Cogn. in A. DC.

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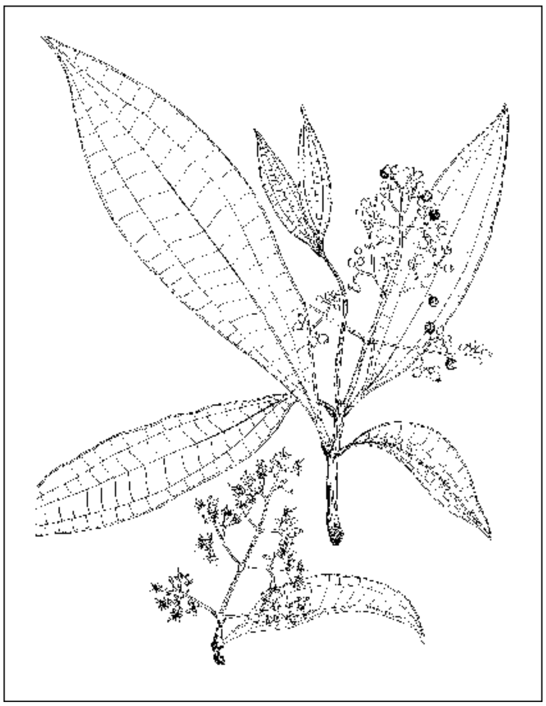

General Description.—Camasey blanco, also known as sardine, granadillo bobo, cenizoso, mullaca colorado, waraia, santo selele bélétére, jacatirão, and mondururu preto, is a shrub or small tree usually 2 to 6 m in height. It is an evergreen with single or multiple stems arising at or near the ground level. Camasey blanco tends to be branchy. The sapwood is light brown and the heartwood is grayish brown. It is a hard and heavy wood with a specific gravity of 0.7. The bark is smooth, gray, and thin. The plant is supported by a lateral root system with sinkers and a moderate amount of fine roots. The leaves frequently have winged petioles and leaf blades that are elliptic to lanciolate, 10 to 30 cm long, entire or with wavy-toothed edges, three- to five-nerved, and pointed at both ends. The terminal panicles contain many tiny whitish flowers that develop into berries 3 to 8 mm in diameter and blue to black at maturity. The fruits are juicy, slightly sour but mostly tasteless. Each fruit contains many minute brown seeds (Croat 1978, Howard 1989, Liogier 1995, Little and Wadsworth 1964, Stevens and others 2001).

Range.—Camasey blanco is native to the Greater and Lesser Antilles, Trinidad, Mexico, Central America, South America to Bolivia, Brazil, and Paraguay (Howard 1989, Killeen and others 1993, Liogier 1995, Little and Wadsworth 1964). The species is not known to have been planted or naturalized elsewhere.

Ecology.—Camasey blanco grows in secondary and remnant forests, brushy pastures, fencerows, creek-bottom galleries, coastal thickets, and disturbed areas. The sites where it grows are moist or wet and sometimes swampy, receiving from 1600 to 3500 mm of annual precipitation. The species occupies elevations from near sea level to 650 m in Costa Rica (Missouri Botanical Garden 2002) and up to 1,500 m in Bolivia (Killeen and others 1993). Camasey blanco grows in loamy and clayey soils derived from both sedimentary and igneous rocks. Most of these soils have anaerobic subsoils. Leaves collected under a *Pinus caribaea* Morelet plantation had 2.34 percent N, 0.13 percent P, 0.90 percent K, and 10.29 percent ash; were higher in N, P, and K, but lower in ash than these leaves of plants from nearby natural forest of similar age (Lugo 1992). Camasey blanco is a shade intolerant pioneer species. It was the second most abundant species 7 years following destruction of forests in Nicaragua by Hurricane Juana (Granzow-de la Cerdal and others 2002). In Puerto Rico, the species appears to invade active pastures, taking advantage of disturbance by cattle and persists as small individuals until the pastures are abandoned, after which they grow rapidly and dominate for 10 to 20 years (Pascarella 2002). It usually grows as dispersed individual shrubs or small clumps. Camasey blanco disappears in a few seasons after being overtopped by a forest canopy.

Reproduction.—Camasey blanco flowers from February to June and fruits from April to September in Nicaragua (Stevens and others 2001). The species is reported to flower and fruit twice each year in Panama (Croat 1978). In Puerto Rico, it is reported to flower and fruit almost throughout the year (Little and Wadsworth 1964). Fruits collected in Puerto Rico averaged 0.137 ± 0.003 g/fruit. Seeds separated from them averaged 10.6 million seeds/kg. Sown on wet peat, 57 percent of the seeds germinated between 20 and 63 days after sowing. The seedlings are tiny and difficult to manage. In nature, birds are the principal dispersers of seeds. Camasey blanco sprouts readily when disturbed.

Growth and Management.—The largest camasey blanco recorded in Puerto Rico had a diameter at breast height of 16.3 cm and a height of 11 m (Puerto Rico Champion Tree List on file at the International Institute of Tropical Forestry, Río Piedras, PR). The species has a moderate growth rate and is relatively short lived. None of a group of 24 camasey blanco stems in a survey in Puerto Rico were present 24 years later at a second visit (Weaver 1979). However, by suckering and ground layering, plants can perpetuate themselves somewhat longer than individual stems. Nursery propagation of the species has not been reported.

Benefits.—Camasey blanco wood is not durable in the ground and therefore not suitable as fence posts (Little and Wadsworth 1964), unless treated. Penetration of preservative was about average for 52 Puerto Rican species tested (Englerth and Goytía-Olmedo 1960). The wood is used for fuel and occasionally as tool handles. Wood specific gravity of 30 plants sampled in Puerto Rico was measured at 0.630 ± 0.021. A weighted average of carbon content for above-ground parts was 50.0 percent. Total above-ground biomass in grams may be predicted by multiplying the stem diameter in cm squared at 30 cm above the soil times stem length in meters by 38.344 (R^2 = 0.981) (Francis 2000). The fruits are edible but seldom eaten by people. Camasey blanco is browsed sparingly by cattle and more heavily by goats. The fruits are eaten by the Puerto Rican birds, *Mimocichla ardosiaceae portoricensis* Bryant, *Vircosylva calidris calidris* L., *Spindalis portoricensis* Bryant (Whetmore 1916) and certainly many other species across the range. Camasey blanco serves as a transitional (successional) species between pasture, farmland, or disturbed forest and secondary forest.

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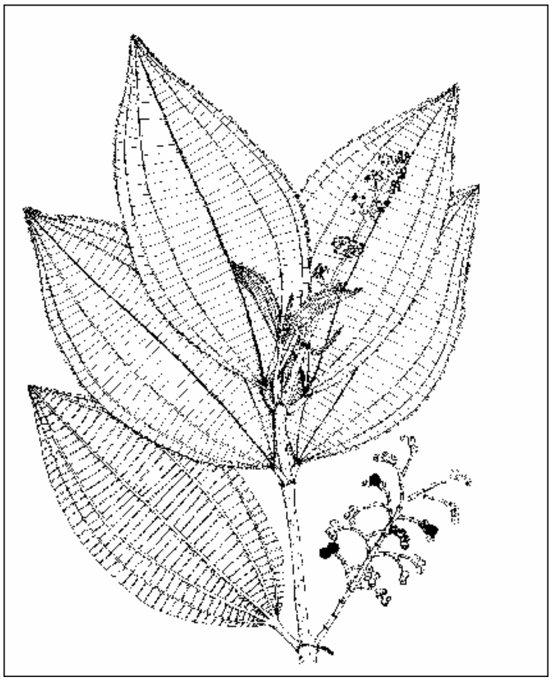
***Miconia racemosa* (Aubl.) DC.** camasey de felpa
MELASTOMATACEAE

Synonyms: *Melastoma racemosa* Aubl.
Melastoma decussata Vahl
Miconia brachypoda DC.
Tamonea racemosa (Aubl.) Cook & Collins

John K. Francis



General Description.—Camasey de felpa (meaning "felt" *Miconia* in Spanish), also known as terciopelo and camasey racimoso, is an evergreen shrub or small tree 2 or 3 m in height and 3 to 5 cm in stem diameter. The stems are smooth and gray with an inner bark of light gray. The plants are supported by an ample lateral root system. Multiple stems arising from the root crown and lower trunk are common. The wood is light brown and hard. Twigs are light green and somewhat four-angled and have a ring of hairs at the nodes. The opposite elliptic leaves have petioles 8 to 45 mm long, five main veins from the base, a saw-toothed, hairy edge, and are pointed at both ends. The inflorescences are panicles with many tiny white, pink, or purple flowers. The fruits are berries, 3 to 5 mm in diameter, whitish when immature, dark blue, purple, or black at maturity, and contain numerous tiny brown seeds (Howard 1989, Liogier 1995, Little and others 1974).

Range.—Camasey de felpa is native to Hispaniola, Puerto Rico, Dominica, St. Lucia, Granada, Trinidad and Tobago, Venezuela, the Guianas, and Brazil to the Atlantic forest in the South (Centro Nordestino de Informaçõas Sobre Plantas 2002, Fundaçao Andre Tosello 2002, Howard 1989, Liogier 1995, Little and others 1974).

Ecology.—Camasey de felpa inhabits areas that receive 1600 to 3000 mm of annual precipitation. Common habitat is on moderately well drained, somewhat poorly, and poorly drained, clayey, weathered soils, particularly ultisols. Areas of both sedimentary and igneous rocks are colonized at elevations from near sea level to 900 m in elevation. The species is shade intolerant, requiring partial sunlight to flower and fruit. Disturbance favors reproduction, but this requirement does not appear to be absolute. Seedlings are frequently found under plantations in mid-rotation or trees that have colonized old fields. Camasey de felpa may be found in old fields, tree plantations, secondary forests, roadsides, and landslides (author's observation, Little and others 1974).

Reproduction.—Camasey de felpa flowers and fruits throughout the year (Little and others 1974). A collection of fruits from Puerto Rico weighed 0.1315 ± 0.0041 g/fruit. The seeds are tiny amounting to several million per kg. Placed on moist filter paper at ambient temperature, 33 percent germinated within 18 days. The seeds are principally dispersed by birds (Devoe 1989). A study in Puerto Rico showed predispersal losses of seeds to vertebrates and insects accounted for 3 percent of the seeds, fungi destroyed 9 percent, and postdispersal loss to ants was 15 percent (Myster 1997). Although seedlings are rarely abundant, the species is common at least in Puerto Rico, growing in small clumps or as scattered individuals. Camasey de felpa coppices readily when cut.

Growth and Management.—Camasey de felpa has a moderate growth rate and probably lives 10 to 20 years. No management experience has been published. Natural reproduction could be encouraged by disturbance of moist and wet forest and unwanted plants eliminated by grubbing or spraying with broadleaf herbicides.

Benefits.—Camasey de felpa contributes to the aesthetics of forests where it grows, helps revegetate disturbed sites and protect the soil, and provides food and cover for birds and other wildlife. The fruits are juicy and edible but small and almost tasteless (Little and others 1974). The wood is useful for fuel, small fence posts, and stakes.

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***Mimosa aculeaticarpa* Ortega** wait-a-bit
FABACEAE

Synonyms: *Mimosa biuncifera* Benth.
Mimosa lindheimeri Gray
Mimosa warnockii B.L. Turner
Mimosopsis biuncifera (Benth.) Britt. & Rose

Juanita A. R. Ladyman

Illustration source: USDA-Forest Service collection, Hunt Institute

General Description.—*Mimosa aculeaticarpa* is a straggling, thicket-forming shrub typically armed with curved prickles that are responsible for the common names, wait-a-bit, Catclaw mimosa, Una de Gato and Gatura. The origin of the genus name is likely from the Spanish word Mimoso meaning "sensitive", which refers to the sensitive, thigmotactic leaf movement (Barneby 1991). An equally appropriate derivation may be from the Greek mimos that means "to mimic" and refers to the animal-like response of the leaf movements (Gledhill 1992, Vines 1986). Although plants may have straight prickles or be unarmed, they most commonly have two curved spines per node and spines on the leaves and pods (Barneby 1991, Bowers 1993, Carter 1997, Powell 1998). Shrubs are generally 1 to 3m tall with deciduous, divided leaves that may have as many as 300 tiny leaflets. The species has variable phenotypic and habitat characteristics and has been described as genetically and ecologically confusing (Carter 1997). Barneby (1991) recognized four variants of *Mimosa aculeaticarpa* of which var. *biuncifera* (Benth.) Barneby is a particularly common one. However, even within each variety he emphasizes that substantial variability exists. Varieties *glabrescens* and *lindheimeri* are synonymous with var. *biuncifera* (Kartesz 1994) and should not be confused with the variants described by Barneby (1991).

Range.—Catclaw mimosa occurs in central and southern Arizona, southern New Mexico, western and central Texas, and northern Mexico in Nuevo León, Tamaulipas, Durango, Coahuila, Puebla, San Luis Potosí, and Chihuahua (Carter 1997, Kearney and others 1960, Martin and Hutchins 1981, Vines 1986).

Ecology.—Catclaw mimosa grows at lower elevations, between 600 to 1,525 m (2,000 to 5,000 ft), frequently in limestone and igneous rock habitats (Powell 1998). It often becomes abundant on dry, rocky, open slopes (Pase and Brown 1982) although it can be equally profuse in washes where water availability is periodically copious. Catclaw mimosa is a member of various communities: Desert shrub, Texas savanna, Southwestern shrub steppe, Chaparral - mountain shrub, Pinyon – juniper woodlands, Plains, and Desert grasslands (Dick-Peddie 1993, Cable 1975, Uchytil 1990). Many authors have mentioned the importance and frequency of low shrubs, such as Catclaw mimosa, in a perennial-grass dominated matrix on rocky boulder-ridden terrain in Arizona (Shreve 1915, Whittaker and Niering 1965), Mexico (Muller 1939, 1947), New Mexico (Dick-Peddie and Moir 1970), and Texas (Gehlbach 1967).

Reproduction.—Flowering dates are variable (generally late April to September), and available moisture is the limiting factor for flowering (Carter 1997). The individual flowers are small (<4 mm) and they are massed in a pale-pink to whitish globose head. The flowers are fragrant and are pollinated by insects. Only a few flowers in each inflorescence produce pods (Bowers 1993). The fruit is an elongated flattened legume (pod), the margins separate from the valves at dehiscence. The valves often break transversely into one-seeded sections. The seeds exhibit high germination rates over a relatively wide range of temperatures (Jordan and Haferkamp 1989). Livestock and wildlife are likely to disperse the seeds (Uchytil 1990).

Growth and Management.—Catclaw mimosa forms true brier patches that may become almost impenetrable to humans (author's personal observation). Plants can profusely re-sprout from protected buds following fire-induced mortality of aboveground tissue (Cable 1975, Carmichael and others 1978, McPherson 1995). However, in general, plants must be several years old before they have the ability to re-sprout. Re-sprouting decreases as soil-moisture decreases and is less common after fires that occur during the growing season compared with dormant-season fires (McPherson 1995). Stands can recover from burning in 5 years (Ahlstrand 1982, Kittams 1972). However, at least in Arizona, wildfire does not appear to stimulate sprouting (Pase and Pond 1964). Catclaw mimosa is moderately resistant to phenoxy herbicides and after only one application tend to re-foliate or re-sprout from the crown (Hibbert and others 1974). Successive applications kill the plants.

Benefits.—Catclaw mimosa thickets provide cover and food for a variety of small wildlife species, especially quail (Graham 1941, Powell 1998). The flowers are a good source of nectar for honey bees (Powell 1998, Vines 1986). Deer and pronghorn browse Catclaw mimosa and its palatability is rated good (Nichol 1938, Buechner 1950). Its livestock palatability is low (Dayton 1931). However, livestock use it when other forage is scarce, and by virtue of its abundance in New Mexico and Arizona it has been described as important cattle browse (Dayton 1931, Vines 1986). Both livestock and wildlife eat the pods (Dayton 1931, Cable 1975, Uchytil 1990). Because plants have a tendency to form thickets that effectively bind soil, Catclaw mimosa shows potential for erosion control (Kearney and others 1960, Vines 1986). In a comparison with 100 other plant species studied for the production of fuels and chemicals, it yielded substantial amounts of oils, polyphenols, and hydrocarbons (Carr and others 1986).

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***Mimosa arenosa* (Willd.) Poir.** tepehuiste
FABACEAE

Synonyms: *Acacia arenosa* Willd.
Acacia malacocentra Mart.
Mimosa caudero L.
Mimosa leiocarpa DC.
Mimosa malacocentra (Mart.) Benth.
Mimosa xantholasia Benth.

John K. Francis

General Description.—Tepehuiste is a thorny shrub or tree usually 3 to 5 m (up to 12 m) in height and stem diameters to 15 cm or more. Young and undisturbed plants have a single stem that may branch several times near the ground. As trees become older and heavier, they tend to lie down and produce new, vertical sprouts. Sometimes, the mid section of the trunk is thicker than the base. The hard, somewhat flexible wood has light tan sapwood and light brown or brown heartwood. The plant is supported by a tap and lateral root system of brown, strong, and flexible roots. Stems are covered by dark brown, shallowly furrowed bark. The inner bark is green. Twigs are greenish brown with 3 to 4 mm, curved spines. The alternate, compound leaves commonly have four to 22 pinnae each with 15 to 35 pairs of leaflets. Inflorescences are 6-cm spikes with paniculiform branching bearing many tiny, white flowers. The fruits, which are borne in clusters, are linear-oblong, flat, brown legumes, 4 to 5 cm long by 5 to 6 mm broad. The seeds are yellow, flattened, and about 4.5 by 5 mm wide and long (author's observations, Liogier 1988, Stevens and others 2001).

Range.—Tepehuiste is native to South America from Colombia and Venezuela through Brazil and lowland Bolivia. It is possibly native to Mexico (recorded in Jalisco State) and Nicaragua. Populations in Puerto Rico and the Dominican Republic were introduced and have become naturalized (Liogier 1988, Missouri Botanical Garden 2002, New York Botanical Garden 2002, Stevens and others 2001).

Ecology.—Tepehuiste is intolerant of shade. It competes rigorously with grass, herbs, and low shrubs but cannot survive overtopping by tall trees. The Puerto Rican populations occur in areas that receive from 1200 to 1600 mm of mean annual precipitation on well-drained to somewhat poorly-drained sites. Tepehuiste does not appear to compete or survive on rocky, excessively well-drained sites. The species grows at elevations from near sea level to 500 m in Nicaragua. Tapehuiste grows in catinga (scrub) forest in Brazil, savannas in Nicaragua, and vacant lots, roadsides, fencerows, and neglected pastures in Puerto Rico (author's observations, Nunez de Medeiros 2002, Stevens and others 2001).

Reproduction.—Tepehuiste blooms June through September and fruits September and October in Nicaragua (Stevens and others 2001). The author observed stands in Puerto Rico in bloom in March and other stands with heavy seed crops during that same period. Insects pollinate the flowers. Fruits collected in Puerto Rico averaged 7.0 ± 0.2 seeds/pod. Seeds separated from them weighed an average of 0.0054 ± 0.0006 g/seed or 186,000 seeds/kg. One percent of unscarified seed germinated in 6 months. but a lot of mechanically scarified seed germinated at 99 percent between 3 and 5 days after sowing on moist filter paper (author's observation). Germination is epigeal (Parra 1984). Plants sprout when cut or burned.

Growth and Management.—Tepehuiste grows rapidly. Because the species is thorny, forms almost impenetrable thickets, and aggressively invades pastures and rangeland, it is a highly undesirable species in exotic habitats. Every effort should be made to prevent it from invading new areas. Control techniques have not been published. However, the same measures used against *Mimosa pigra* L. probably would be effective.

Benefits.—Tepehuiste helps sites move through the grass stage to secondary forest, protects the soil, and provides cover for wildlife. It is an important forage plant for goats in northeastern Brazil (Nunez de Medeiros 2002). The wood is useful for fuel.

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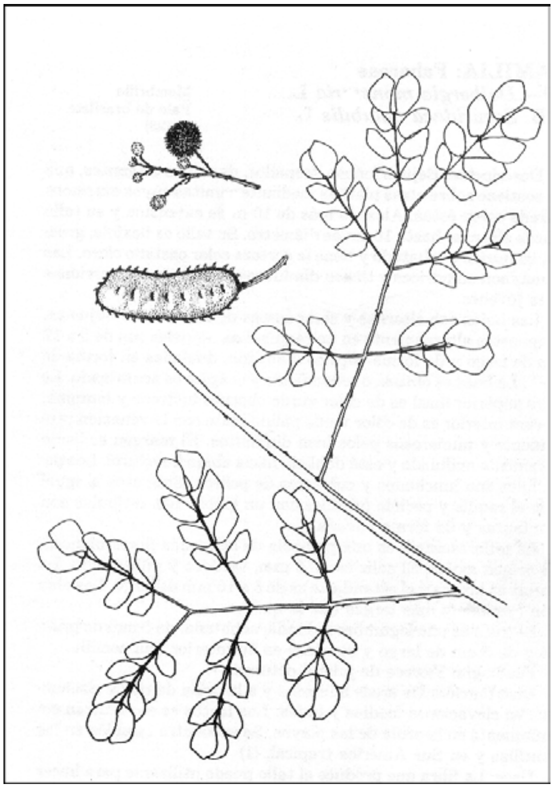
***Mimosa ceratonia* L.** zarsa

FABACEAE

Synonyms: *Lomoplis ceratonia* (L.) Raf.

John K. Francis



General Description.—Zarza, also known as climbing mimosa, black ambret, amourette-grand-bois, grate-jambe, and croc-chien, is a multi-stemmed scrambling shrub. It supports itself on other vegetation by means of curved spines and may reach 4 to 6 m into the crowns of trees and as far laterally. The plant has a weak taproot, a moderate amount of lateral roots, and abundant fine roots. Lower stems are gray, scaly, and cylindrical. The branches tend to be long, almost straight or evenly curved, with few divisions. The twigs are green, sometimes reddish with many curved 2-mm spines. Lateral twigs usually die back after 1 year. The leaves are bipinnately compound with three to five pairs of pinnae, each with three to five pairs of leaflets. The leaflet blades are obliquely obovate, three-nerved, 1.0 to 2.5 cm long and 6 to 10 mm broad, rounded at the apex and asymmetrically acute at the base. The inflorescences are terminal racemes of globose heads of flowers that are white or cream-colored. The pods, which are borne in clusters, are straight or slightly curved, oblong, 4 to 6 cm long and armed at the edges. The flattened seeds are brown or black (Acevedo-Rodríguez 1985, Howard 1988, Liogier 1988).

Range.—The range of zarza includes Hispaniola, Puerto Rico, the Virgin Islands, Antigua, Guadeloupe, Martinique, St. Lucia, and Barbados (Howard 1988, Liogier 1988). Also, populations of zarza have been identified in Brazil including the varieties *M. ceratonia* L. var. *pseudo-obovata* (Taubert) Barneby and *M. ceratonia* L. var. *interior* Barneby (Barneby 1985, Paganucci de Queiroz 2001).

Ecology.—Zarza is moderately intolerant of shade. It grows in fencerows, roadsides, wooded drains, brushy pastures, forest edges and openings, and in low-density secondary forest. The species often forms compact, nearly impenetrable clumps. Diffuse stands mixed with tall grass, weeds, and shrubs form in areas that are mowed or burned on one- to several-year cycles. Zarza is most common on soils derived from limestone and serpentine (Vélez and van Overbeek 1950), but also grows on soils overlying other sedimentary and igneous rocks. It tolerates all textures of well-drained soils and a wide range of fertility levels. In Puerto Rico, the species may be found in areas receiving rainfalls from 750 mm per year to over 2000 mm per year. Zarza grows from near sea level to at least 600 m in elevation. Frosts do not occur within its natural range.

Reproduction.—Zarsa flowers between June and December and fruits December through January in Puerto Rico (Acevedo-Rodríguez 1985). A collection of zarza pods from Puerto Rico weighed an average of 0.1371 ± 0.0005 g (air dry). They averaged 4.18 ± 0.12 seeds/pod and ranged from three to six seeds per pod. The seeds weighed an average of 0.0201 ± 0.004 g/seed or 50,000 seeds/kg. Sown on commercial potting mix, 71 percent germinated between 7 and 165 days after sowing. Germination is epigeal. Stems layer (root) if covered by soil or organic debris. Stems sprout when cut and lateral roots sometimes sucker when damaged. The seeds are disbursed by lateral extension of the vines and by the pods clinging to clothing or to the fur of animals. Seedlings are common, but only a few survive for more than a few weeks.

Growth and Management.—Both seedlings and sprouts grow rapidly, up to 2 or 3 m per year. Zarza plants may endure for many years. Because of the thorny nature of this species, property owners often choose to eliminate it from pastures and plantations. Historically, farmers controlled it by repeated cutting. This method could probably be improved by treating the resulting sprouts with broadleaf weed killers.

Detriments and Benefits.—Thickets and tangles of zarza are almost impenetrable to humans. Paths may be cut to allow passage, but they soon grow over. Because of the thorns, cattle will not eat zarza (Vélez and van Overbeek 1950), but it is browsed by goats. The species is a host for the diaprepes root weevil (*Diaprepes abbreviatus*), which is of grave concern for growers of citrus and other agricultural crops (Simpson and others 2001). Zarza is a valuable honey plant (Marcano 1973), protects the soil, and serves as wildlife cover.

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***Mimosa pigra* L.** black mimosa

FABACEAE

Synonyms: *Mimosa asperata* L

John K. Francis

General Description.—Black mimosa is also known as catclaw mimosa, thorny sensitive plant, giant sensitive plant, bashful plant, giant mimosa, dormilona, pigra, agüiste, amouretto, amourette-rivière, and banglin. It is a thorny upright to scrambling shrub 2 to 4 m in height and up to 12 cm in basal diameter. The plant usually has a single stem from the ground but may branch near the ground and form an inverse cone-shaped crown. There are relatively few branches. The shrub is supported by extensive lateral roots with numerous fine roots that have occasional nodules. Stems, limbs, twigs, and leaves bear curved thorns up to 7 mm long. Black mimosa produces a thin crown of touch-sensitive bipinnately compound leaves. Each leaf has four to 14 pairs of pinnae and 20 to 40 pairs of linear-oblong leaflets per pinna. The inflorescences are tight, subglobose mauve or pink heads with about 100 flowers, grouped one to three in the upper axils. The clustered brown legumes are densely bristled, 4 to 12 cm long, and breaking transversally into 14 to 26 segments, each containing one seed. The seeds are flattened, about 6 by 2.5 mm, and brown to olive green (Howard 1988, Pacific Island Ecosystems at Risk 2002, Stevens and others 2001).

Range.—The original range of black mimosa is uncertain. The contention that the native range extends from Mexico to northern Argentina (Stevens and others 2001) is supported by the fact that 440 species of insects and several fungi species keep it under control there (CSIRO 2002). On the other hand, a rich native tradition supports Equatorial Africa as being native range (Burkhill 1995). Perhaps it crossed the South Atlantic in prehistoric times or early in the colonization of the New World. More recently, the species has invaded most humid tropical and subtropical areas including Florida, Texas, and Puerto Rico (Natural Resources Conservation Service 2002). There are two varieties: var. *berlandieri* (Gray ex Torr.) B.L. Turner that occurs from the Texas to Costa Rica, and var. *pigra* that grows from Mexico to Argentina, Africa, and in the invaded ranges in the New and Old Worlds (Stevens and others 2001).

Ecology.—Presettlement populations of black mimosa in Costa Rica were found mainly on the edges of marshes and on large river floodplains. Today, they are found along roads and in marshy spots in pastures (Janzen 1983). The species is highly intolerant of shade. It requires full sunlight to flower and fruit and nearly full sunlight to survive. The two principal ingredients for successful establishment are moist or wet soils and disturbance that allows full sunlight. It is a fierce competitor with low vegetation and one of the few shrubs capable of succeeding in dense, tall grass swards. Black mimosa tolerates a wide variety of soil conditions, short-term flooding, seasonal drought, and grows at elevations from near sea level to 700 m (Janzen 1983). Although it grows mixed with other vegetation in its native habitat, the species forms pure stands with little understory in many of its exotic habitats (Pacific Island Ecosystems at Risk 2002).

Reproduction.—Black mimosa blooms

continuously in moist habitat, intermittently in seasonally dry habitat. Bees pollinate the flowers and pods mature about 1 month after pollination (Binggeli 1997). Black mimosa grows rapidly and can begin producing seed in as little as 3 months after emergence (Department of Natural Resources and Mines 2002). One average plant can produce more than 9,000 seeds annually (Marko 2002). The pod segments disperse by floating on water and clinging to clothing and possibly animal fur and feathers. A sample of black mimosa pods in Puerto Rico contained an average of 15.0 seeds/pod. The seeds weighed an average of 0.0166 g/seed. Sown on commercial potting mix between 6 and 20 days, 81 percent of the seed germinated. Germination is epigeal (author's observation). Scarification is required for quick and uniform germination. In an experiment with several treatments of temperature and storage, germination percentages of 75 to 94 percent were observed (Creager 1992). Seeds can remain viable in dry soil for more than 2 years. Plants sprout freely following fires (Binggeli 1997). Layering occurs when stems become prostrate and covered with litter.

Growth and Management.—Black mimosa grows rapidly. Seedlings grown in a greenhouse reached 25.8 ± 0.5 cm in 30 days, 97.1 ± 16.2 cm in 90 days, and 335.1 ± 15.9 cm in 360 days (Swarbrick and Mercado 1987). Plants in Puerto Rico in tall, dense grass swards and disturbed upland sites grow about 1.0 to 1.5 m the first year, 1 m in the second year, and usually live 2 to 3 years. Larger plants tend to lie down due to weight and often do not become taller than 3 m (author's observation). Maximum age is about 5 years (Binggeli 1997). In an effort to control the aggressively spreading infestation, nine insect enemies and two pathogenic fungi have been released in Australia. Most have become established but so far have had little effect on black mimosa populations (Marko 2002). However, a recent release of *Malacorhinus irregularis*, a defoliater beetle from Mexico shows early promise (CSIRO 2002). Mowing is ineffective (Creager 1992). Grubbing of adult plants achieved only about 82 percent mortality (Cross and Wiedemann 1997). Until effective biological control can be achieved, chemical control is probably the best approach for spot infestations (Marko 2002).

Benefits and Detriments.—Black mimosa invades dense grass swards and in some environments helps them move on to the brush and secondary forest stages. It also protects the soil in disturbed sites. Although the cover and diversity it furnishes is probably beneficial for wildlife in artificially maintained exotic grass swards, the species can reduce wildlife populations in natural swards such as river floodplains in Australia (Marko 2001). The plant has been used as a green manure, a cover crop, for fuel wood, and as beanpoles. Although cattle and horses generally do not eat black mimosa because of the thorns (Binggeli 1997), with 22 percent foliar protein, it was found to be perfectly acceptable to rabbits (Lebas and others 1986). Black mimosa can be weedy in row crops and plantations, and a serious problem in pastures and hay fields. The thorny branches make it difficult for people to walk through fields and along trails where it grows. In Africa, it is planted as a barrier around fields and cattle enclosures to discourage human intruders and animal predators. The species is used in a number of herbal remedies and magic rites in Africa (Burkill 1995).

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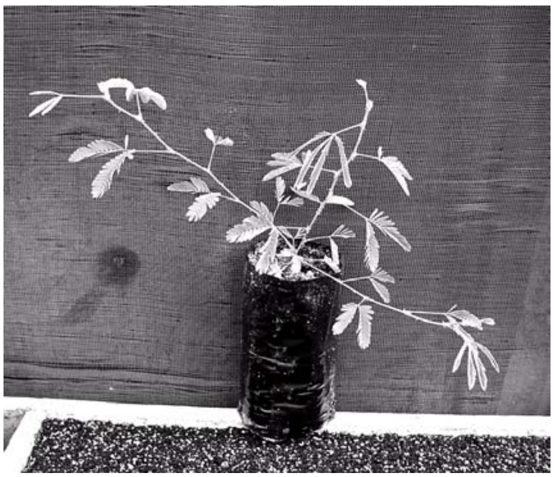
***Mimosa pudica* L.** sensitive plant
FABACEAE

Synonyms: *Mimosa tetrandra* Humb. & Bonpl. ex Willd.
Mimosa pudica L. var. *tetrandra* (Willd.) DC.
Mimosa unijuga Duch. & Walp.
Mimosa pudica L. var. *unijuga* (Duch. & Walp.) Griseb.

John K. Francis



General Description.—Sensitive plant is a small, prostrate or ascending, short-lived shrub. Some authors consider it a woody herb. It may reach 1 m in height when supported on other vegetation and more than 2 m in horizontal extension. The reddish-brown, woody stems are sparsely or densely armed with curved prickles. The root system consists of a taproot and extensive fibrous roots with nodules. The twigs are fine and flexible and support leaves with one or two pairs of pinnae and 15 to 25 pairs of oblong leaflets 3 to 12 mm long. The flowers are pink and clustered in globose heads. The legume (pod) is linear-oblong, 1.0 to 1.5 cm long and 3 mm broad, with bristles on the margins. The pods are born in groups and contain two to four brown seeds (Howard 1988, Liogier 1988, Pacific Island Ecosystems at Risk 2001). Sensitive plant is also known as dorme dorme, dormidera, humble plant, marie-honte, mayhont, morivivi, honteuse, sleeping grass, ti mawi, touch-me-not, and many other names (Holm and others 1977, Howard 1988, Liogier 1988). The great curiosity of sensitive plant and the source of most of its names is that when touched, it quickly folds its leaflets and pinnae and droops downward at the petiole attachment. The leaves also droop at night, and when exposed to rain or excessive heat. This response may be defenses against herbivorous insects, leaching loss of nutrients, or desiccation.

Range.—Sensitive plant was first described from Brazil (Pacific Island Ecosystems at Risk 2001) and is perhaps native to much or all of the New World Tropics (Liogier 1988). Today, it is pantropical in its distribution (Howard 1988).

Ecology.—Sensitive plant grows on most well-drained soils, even scalped or eroded subsoils and soils with low nutrient concentrations. It requires disturbed soils to establish itself. Repeated burning may encourage its spread in pastures (Siregar and others 1990). Sensitive plant is shade intolerant and does not compete with tall vegetation or grow under forest canopies. The species' roots produce carbon disulfide, which selectively inhibits colonization of the rhizosphere by mycorrhizal and pathogenic fungi (Feng and others 1998). This plant occurs in croplands, orchards, pastures, mowed areas, roadsides, and areas disturbed by construction. It may grow as a single plant or in tangled thickets. Sensitive plant grows from near sea level up to 1,300 m in elevation (Holm and others 1977) and in areas with annual precipitations from about 1000 to over 2000 mm. The species is frost-sensitive.

Reproduction.—In the Philippines, sensitive plant flowers all year and may produce as many as 675 seeds per plant per year (Holm and others 1977). The species is both wind (Chieng and Huang 1998) and bee-pollinated (Payawal and others 1991). Air-dry seeds from Puerto Rico weighed an average of 0.0065 ± 0.0002 g/seed. With no pretreatment, seeds from this collection began germinating 7 days after sowing and reached a maximum germination of 17 percent by 94 days (author's observation). In another test, 80 percent germination was obtained in 4 weeks with alternating temperatures of 20 and 40 °C (Holm and others 1977). Bui (2001) recommends a pretreatment with hot water followed by overnight soaking. Germination is epigeal. Seeds are transported by means of the bristles on the edges of their pods that cling to clothing or to the fur of mammals. Most nursery and home propagation is done using seeds, but summer cuttings may also be used (Bui 2001).

Growth and Management.—In Puerto Rico, sensitive plants live 1 to 2 years. Seedlings grow slowly for 2 or 3 months and then accelerate, reaching 0.5 to 2 m of extension at the end of the first year. Growth of plants that survive into the second year is much slower. Potted and field-grown individuals are sensitive to overwatering (Bui 2001). This species has been successfully tested and recommended for erosion control plantings using potted material at a spacing of 60 x 60 cm (Coimbra and Magnanini 1953).

Benefits and Detriments.—Sensitive plant has become a serious weed in fields of corn, soybeans, tomatoes, upland rice, cotton, bananas, sugarcane, coffee, oil palms, papayas, coconuts, and rubber in many tropical areas. It is particularly troublesome where hand pulling of weeds is practiced. The species may be controlled by a number of commercial broad-leaf herbicides (Bui 2001). On the other hand, it is tolerated or valued as a forage plant in pastures (Holm and others 1977, Turbet and Thuraisingham 1948). In fact, sheep grazing is reported to control sensitive plant in pastures and plantations (Simonnet 1990). The root nodules have been shown to fix nitrogen (Pokhriyal and others 1990). Thickets of sensitive plant may be a fire hazard when dry (Pacific Island Ecosystems at Risk 2001). The seeds and other plant parts of sensitive plant contain mimonsine, an amino acid that is known to cause hair loss and depressed growth in mammals (Arora 1983). An unlikely large dose is necessary to cause problems, however. The pollen is important to honeybees in the Philippines (Payawal and others 1991). Extracts of the plant have been shown in scientific trials to be a moderate diuretic, depress duodenal contractions similar to atropine sulphone, promote regeneration of nerves, and reduce menorrhagia (Modern-natural 2001). Anitdepressant activity has been demonstrated in humans (Martínez and others 1996). Root extracts are reported to be a strong emetic (Guzmán 1975).

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Mimulus aurantiacus W. Curtis bush monkeyflower
PHRYMACEAE (formally in SCROPHULARIACEAE)

Synonyms: *Diplacus aurantiacus* Jeps.
Mimulus glutinosus Wendl.
Diplacus latifolius
Diplacus leptanthus Nutt.

Arlee M. Montalvo and Paul A. McMillan

General Description.—Bush monkeyflower, or sticky monkeyflower, is a beautiful, erect to sprawling subshrub, that is named for its woody habit and typical "monkey-faced" flowers. Bush monkeyflower represents a complex assemblage of hybridizing forms with intergrading floral colors and morphologies. For this reason, the most recent taxonomic treatment lumps together all the species of woody monkeyflowers from California, excepting *M. clevelandii* Brandegee, under *M. aurantiacus* (Thompson 1993). The various taxa, sensu Munz and Keck (1968), are distinguished by stature, flower size and color, and range, but share similar leaf morphology. Given the taxonomic uncertainty, we describe *M. aurantiacus* sensu Munz and Keck. Then under "Range and Taxonomy," we provide a brief description of diagnostic differences and distributions of their other taxa that were treated as a single species complex by Thompson (1993).

Shrubs are erect, 6 to 12 dm tall, and the specific epithet "*aurantiacus*" refers to the often deep orange corollas (sometimes yellowish) that are 3.5 to 4.5 cm long. The simple, opposite, leaves are elliptic to narrowly-elliptic, with entire to serrulate margins that are often rolled under. Leaves are 2 to 8 cm long and dark green, and resinous above. Smaller leaves are clustered on shortened shoots in the axils of larger leaves. The lighter underside of leaves and the 2 to 2.5 cm long green, pleated calyx are covered with sticky glandular and nonglandular hairs. Flowers have a long floral tube, spreading limbs, and a large, two-lobed stigma. Plants are often sticky with glandular secretions.

Range and Taxonomy.—Recent phylogenetic work favors placement of woody monkeyflowers (section *Diplacus*) in *Mimulus* and transfers the genus from family Scropulariaceae to the Phrymaceae (Beardsley and Olmstead 2002). Bush monkeyflower (broad sense) ranges from the coast to coastal ranges to interior foothills from northwestern Baja California, northward to Mendocino County, California below 1,600 m and along the western foothills of the Sierra Nevada range. The underlying topography of coastal hills, interior valleys, and foothills is complex, as are the west to east and north to south gradients in temperature and rainfall. The correspondingly complex pattern of variation in bush monkeyflower may reflect once isolated and differentiated populations that have come into secondary contact and hybridized. The resulting patterns of genetic diversity do not match the patterns of morphological diversity (Beardsley and others 2003). The taxonomy is necessarily complex and may be resolved with detailed phylogeographic analysis. See Munz and Keck (1968) and Tulig (2000) for details of the geographic distribution of the following color forms (narrow sense).

The small, orange-flowered *M. aurantiacus* occurs in the foothills and coastal ranges north of Santa Barbara County. *M. a.* ssp. *australis* (McMinn) Munz has orange-yellow to buff or white corollas and occurs in interior San Diego County to Baja California. *M. aridus* (Abrams) A.L. Grant, the lowbush monkeyflower, has a yellow corolla, low, spreading habit to 4 dm tall, and occurs farther east in San Diego County to Baja California. *M. bifidus* Pennel has a larger orange corolla with larger, deeply-notched lobes, a somewhat spreading habit to 1 m tall, and occurs from coastal San Luis Obispo to Monterey County and along the western base of the Sierra Nevada from Placer into Butte and Plumas Counties. *M. flemingii* Munz has red corollas with limbs about half as long as other forms, is low growing from 1 to 6 dm tall, and is restricted to the Channel Islands. *M. longiflorus* (Nutt.) A. L. Grant, the southern bush monkeyflower (see figure), has an orange-yellow to salmon corolla, a long and pubescent calyx (to 3.5 cm), is 3 to 12 dm tall, and occurs from central San Diego County through Riverside to San Bernardino County. A shorter, pale-yellow form [*M. l.* ssp. *calycinus* (Eastw.) Munz] occurs primarily farther inland in Riverside and western San Bernardino Counties. A red-corolla form (*M. l.* var. *rutilus* Grant) occurs mostly in interior Los Angeles County. Finally, *M. puniceus* (Nutt.) Steudel, the red bush monkeyflower, has a red corolla, short calyx (to 2.5 cm), and erect habit from 5 to 15 dm tall. It occurs on Catalina Island, coastal Orange County, and inland through the Santa Ana Mountains to southwestern Riverside County south into Baja California.

Hybridization.—All bush monkeyflowers have n = 10 chromosomes and crosses among them produce viable progeny. Natural, putative hybrids between forms have been hypothesized based on morphology (Munz and Keck 1968, Wells 1980, Grant 1993, Tulig 2000). Preliminary phylogenetic work suggests widespread introgression among forms (personal communication with Paul Beardsley, Colorado College, CO). Grant (1993) examined pollinators in relation to several floral forms (equals species of *Diplacus* in his paper) and postulated that the populations with different floral forms would be partially reproductively isolated. He hypothesized that the red-colored *D. puniceus* Nutt. and salmon *D. longiflorus* Nutt. were primarily hummingbird-pollinated, and that *D. calycinus* Eastw. (*M. l.* var. *calycinus*) with pale yellow flowers and long tube) were hawkmoth-pollinated. He found that habitats interdigitated and resulted in *D. puniceus* and *D. calycinus* populations overlapping in distribution, with *D. longiflorus* habitat forming a connecting link between the different forms. He hypothesized that the intermediate nature of *D. longiflorus* suggested past hybridization of *D. puniceus* and *D. calycinus*.

Tulig (2000) analyzed floral and vegetative variation throughout the geographic range of bush monkeyflowers and found statistical evidence for hybrid populations that were intermediate between parental forms. For example, in San Diego County, putative hybrid populations were intermediate between *M. puniceus* (coastal form) and *M. aurantiacus* ssp. *australis* (inland form), consistent with analysis of Waayers (1996). In the region between the San Gabriel and San Bernardino Mountains, putative hybrids were intermediate between *M. longiflorus* ssp. *calycinus* (lemon yellow corolla) and *M. longiflorus* (salmon corolla).

Ecology.—Bush monkeyflowers occur in areas with cool moist winters and warm to hot, dry summers. They grow on rocky hillsides and cliffs, usually on the border of chaparral or sage scrub, or in open foothill-woodland forest. The roots are fibrous, less than 2 m deep, with feeder roots concentrated within the first 8 cm of soil (Hellmers and others 1955). There is evidence for differentiation and local adaptation in morphological and physiological characters relating to water use. For example, differences in wood anatomy among forms and among populations are correlated with habitat (Michener 1983). Plants from mesic habitats have relatively few, large vessel-elements, while plants from xeric habitats have many, small vessel-elements. Under humid, low-stress conditions, both mesic-adapted and xeric-adapted populations had high water-use efficiency and maintained a high rate of photosynthesis relative to transpiration (Mooney and Chu 1983). Plants from xeric populations had high water-use efficiency under low relative humidity, while the efficiency of coastal plants diminished rapidly with decreasing relative humidity.

The primary herbivore of bush monkeyflower is a specialist butterfly *Euphydryas chalcedona* Doubleday and Hewitson. The timing of growth of both plants and the butterfly is linked to water availability. Emergence of larvae from diapause is synchronized with the initiation of leaf growth. The leaves produce a resin that inhibits the growth of the larvae. During the growing season the youngest leaves have the highest nitrogen (N) content, the highest carbon gain, and the highest resin content. Growth rate of the larvae increases with increasing N but decreases with increasing resin content (Lincoln and others 1982). Larvae feed initially on young leaves with high nutritional value, then switch to older leaves with lower resin content. During flowering, N is translocated from the leaves, and larvae stop feeding (Mooney and others 1981).

Such studies demonstrate physiological trade-offs in resource allocation to growth, reproduction, or defense. Han and Lincoln (1994) found significant heritability and maternal effects for resin content within one population, and they found negative genetic and phenotypic correlations between resin production and growth rate. This indicates potential trade-offs between traits during selection. Leaf resin content varies among populations, but little is known about geographic differentiation in such trade-offs.

Hare (2002) found that nearly 30 percent of the dry weight of leaves is resin. In a common garden experiment, he examined the chemistry and relative quantities of important resin components for six populations of bush monkeyflower from a range of environments and that differed in attack by *E. chalcedona*. The populations differed in chemical components of the resins but not in the pattern of insect attack. This study followed Thompson's (1993) classification and did not mention if there were differences in floral morphology among the populations. The collection locations could have represented at least three species or subspecific taxa following Munz and Keck (1969) or Tulig (2000).

Emergence and Growth.—Seedlings emerge in the cool rainy season, and most growth is in winter and spring. Plants can reach reproductive maturity in a single growing season, with flowering primarily from mid spring to early summer. The capsules mature in summer, and the many, tiny seeds (about 1 mm long, half as wide and nearly flat) disperse by gravity and wind. Plants become dormant in the summer dry season and shed many leaves by fall. Leaf production begins after the first fall rain and ends near the beginning of July (Mooney and others 1981). A large and relatively constant proportion of carbon and nitrogen are allocated to reproduction, and reproductive structures supply some of their own carbon (Alpert and others 1985). Both growth and reproduction are primarily water limited.

Reproduction.—Bush monkeyflowers are pollinated by diverse flower visitors, and the dominant pollinators vary with color form and location. This may reflect local differentiation, or the relative abundances of pollinators. Fetscher and Kohn (1999) reported Anna's hummingbird as the primary pollinator of a red flower form in San Diego County, California, with black-chinned, Costa's, and rufous hummingbirds as occasional visitors. Bromer and others (1990) reported that *M. longiflorus* was "generally but not exclusively" pollinated by Black-chinned and Anna's hummingbirds. Six populations from the Santa Monica Mountains varied in floral form, sucrose content of nectar, and anther-stigma separation. Populations with high pollinator diversity but low visitation rates had shorter corolla tubes and lower sucrose:hexose ratios in nectar than populations with less diverse pollinators. In a different population of *M. longiflorus*, Eckert (1970) found that almost all pollination was done by solitary bees and that Anna's hummingbirds were only occasional visitors. Most pollination was effected by bees in the genus *Osmia* and carpenter bees in *Ceratina*. Both visited multiple flowers per plant, and self-pollination appeared common. Eckert also found that selfed flowers produced fewer capsules per plant and had more aborted ovules than outcrossed flowers.

Horticulture.—The bush monkeyflowers and their horticultural hybrids have striking flower colors, produce masses of flowers, and are popular ornamental plants (Schmidt 1980, Perry 1992, Keator 1994). Plants can be grown from seeds or cuttings, but plants grown from seed tend to live longer (personal communication with Steve Morgan, University of California Riverside Botanic Garden, CA). The shrubs grow best in full sun to light shade. Flowering and leaf production may be extended by summer watering in more arid regions. However, Atkinson and others (1988) found that watering may increase susceptibility to atmospheric pollution in the dry season. In summer, unwatered plants drop most leaves, are not photosynthetically active, and take up little SO_2, while watered plants retain their leaves, are photosynthetically active, and take up SO_2.

Growth and Management.—Bush monkeyflowers have been planted along highways corridors and are used in habitat restoration. There are about 145 million seeds/kg (Mirov and Kraebel 1939). Seeds will germinate without pretreatment (Mirov and Kraebel 1939, Schmidt 1980), but seeds need to be exposed to light and leachate from charred wood may improve germination slightly (Keeley 1987). For pot culture, the tiny seeds should be sown on the surface of the soil and kept moist until seedlings emerge. Outdoors, they should be planted with shallow broadcasting methods. The phylogenetic relationships among populations and the fitness effects of translocations and hybridization are not yet known, and there are no published studies on population genetic patterns. However, there is a complex pattern of geographic variation, genetic differentiation of floral form and resin chemistry, local adaptation to moisture environments, and extensive ability to hybridize. Consequently, attention should be made of flower color and habitat matching when obtaining seeds for large planting projects. Use of regionally local seed sources for planting projects can mitigate unknown fitness consequences of out of range plantings. A careful analysis of hybrid zones and the fitness of hybrids is needed to understand if hybridization following translocations will cause decreases in fitness of adjacent wild populations.

Benefits.—Bush monkeyflowers are important plants for water-wise landscaping and revegetation projects. They provide nectar to hummingbirds and large bees and are an important larval host of the checkerspot butterfly.

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***Mitracarpus portoricensis* (Urban) Urban** Puerto Rico girdlepod
RUBIACEAE

Synonyms: *Mitracarpus frigidus portoricensis* Urban

John K. Francis

General Description.—Puerto Rico girdlepod (a name assigned by the Natural Resources Conservation Service) is a low, 20- to 60-cm tall evergreen shrub with basal diameters of 0.5 to 1.0 cm. It may have one or more gray stems from the root crown and a compact, rounded crown with bifurcate or trifurcate branching. The stems, branches, and roots are woody but flexible. Plants are supported by a tap and lateral root system of yellow or tan roots. The glabrous branches and twigs are four-striate and four-angled. The leaves, which are crowded on recent twig growth, are sessile, nearly linear, 30 to 60 mm long and 1 to 3 mm broad. The 2-cm broad, many-flowered heads are lateral or terminal on long peduncles. Tubular flowers are bright white, about 5 mm long. Capsules disperse their seeds when the tops come off releasing 1-mm long, ovate, brown seeds (Liogier 1997).

Range.—Puerto Rico girdlepod is endemic to Puerto Rico, particularly to the northern, western, and southwestern portions of the Island (Liogier and Martorell 1982). The species is not known to have been planted or naturalized anywhere else.

Ecology.—Puero Rico girdlepod is a low-statured, slow-growing plant that requires full or nearly full sunlight. It can compete with low herbs and grasses but cannot grow under a forest or shrub canopy. Consequently it must grow in areas with low competition, usually disturbed areas and areas of low fertility. It finds these conditions in eroded areas, dirt roads and road cuts, old fields, rocky hillsides, and coastal sands. Puerto Rico girdlepod may be found in areas of sedimentary (including limestone), igneous, and metamorphic (including ultramaphic) rocks. It tolerates salt spray, low soil fertility, compacted soils, and moderate physical abuse. Elevations range from a little above sea level to about 400 m in areas with rainfall from about 900 to about 1800 mm of mean annual precipitation.

Reproduction.—Puerto Rico girdlepod blooms and produces seed throughout the year. A collection of seeds from the Susúa State Forest contained an average of 2,400 seeds/g. Placed on moist blotter paper, 29 percent of the seeds germinated between 4 and 90 days after sowing (author's observation). Seeds are dispersed by wind and water. Opening of the forest canopy and probably bare soil are necessary for establishment. Seedlings are not common.

Growth and Management.—Growth of Puerto Rico girdlepod is slow. Plants observed by the author appeared to have grown about 10 to 25 cm/year. Life span of the shrubs appears to range from about 2 to 6 years. No planting or management experience has been reported. The species is not common enough or aggressive enough to warrant control.

Benefits.—Puerto Rico girdlepod helps protect the soil, revegetates disturbed sites, adds to the aesthetics of wildland areas (because of its white flowers), and furnishes cover for wildlife.

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***Morella caroliniensis* (P. Mill.) Small** bayberry
MYRICACEAE

Synonyms: *Myrica caroliniensis* P. Mill.
Myrica curtissii A. Chev.
Myrica heterophylla Raf.
Myrica pensylvanica Mirb.

Gerry Moore

Illustration credit: Britton and Brown 1913

General Description.—Bayberry is the name used most often to refer to this common eastern shrub. Other common names include candleberry, tallowshrub, and waxberry. Bayberry is a deciduous (northern part of range) to evergreen (southern portion of range) aromatic shrub or small tree to 4 m. The plant is single or multistemmed. The branchlets and twigs are terete and vary in color from brown-gray-blackish; they are dotted with yellow aromatic glands and vary from being glabrous to pubescent. The leaves are resinous, glandular, aromatic, with short pubescent petioles (to 7 mm) and elliptic to oblanceolate, membranaceous-leathery 3.0 to 7.0 cm by 1.5 to 2.5 cm blades with margins (sometimes slightly revolute) entire or more usually toothed from the middle to the apex. The flowers are in unisexual catkins (aments), with the staminate (male) and pistillate (female) catkins appearing on different plants. The staminate catkins range from 0.4 to 1.8 cm; the pitsillate catkins range from 0.3 to 1.4 cm. The fruit of the bayberry is technically not a berry but a globose 3.0- to 6.0-mm drupe (one-seeded stone fruit) that at maturity is covered by a thick coat of gray-white wax. The fruits persist throughout the winter. The globose seed in each fruit measures slightly less in diameter than the fruit (author, personal observation).

Range.—Bayberry occurs in eastern Canada (New Brunswick, Newfoundland, Nova Scotia, Ontario, Prince Edward Island, and Quebec) and the United States, from Maine south to Florida and west to Texas and Arkansas. Inland populations are known from western New York, Ohio and southern Ontario (Gleason and Cronquist 1991).

Systematic Botany.—There are taxonomic and nomenclatural difficulties associated with the bayberry. Taxonomists disagree regarding bayberry's generic placement, with some (Bornstein 1997, Fernald 1950, Gleason and Cronquist 1991) placing the bayberry and sweet gale (*Myrica gale* L.) in the same genus, *Myrica,* and others choosing to place the bayberry in its own genus, *Morella* (Wilbur 1994, 2002). Some taxonomists also choose to recognize two species of bayberry, a northern bayberry *Morella pensylvanica* and a southern bayberry, *Morella caroliniensis* (synonym: *Myrica heterophylla* Raf.). The two supposedly can be distinguished based on whether the leaves are evergreen (southern) or deciduous (northern), the fruit wall is hairy (northern) or not (southern), and the twigs possess black hairs (southern) or not (northern). Further complicating matters, bayberry and the wax myrtle [*Morella cerifera* (L.) Small] can hybridize when growing together (Bornstein 1997). Some authors also treat the name *Morella caroliniensis* (Miller) Small as a synonym of the wax myrtle *(M. cerifera).* This is due to different interpretations as to which plant–bayberry or wax myrtle–Miller (1768) was actually referring to in his original description. The recent work of Wilbur (1994, 2002) is followed here; therefore only one species is recognized under the name *M. carolininesis.*

Ecology.—Bayberry can tolerate full sun to dense shade and can grow in dry to wet conditions. Habitats where it can be found include bogs, swamps, dunes, fields, heathlands, oak forests, pine forests, and the margins of streams and lakes. The roots of bayberry contain nitrogen fixing nodules, and this allows it to be particularly tolerant of nitrogen-poor, acidic soils (Morris and others 1974). Results are mixed as to whether bayberry's nitrogen-fixing properties may assist the growth of other plant species growing nearby (Tiffney and Barrera 1979, Dudley and others 1996). Leachate from the leaf litter of bayberry may have alleopathic properties and affect some other plants (Collins and Quinn 1982).

Reproduction.—Bayberry is wind pollinated and blooms in the spring. The pollen is allergenic (Lewis 1977). The seeds of bayberry are dispersed by birds that eat the fruits (McClanahan and Wolfe 1993, Place and Stiles, 1992, Ridley 1930).

Growth and Management.—Bayberry is often cultivated on dry, sandy, sterile soils where few other species can grow (Bailey 1922, Rehder 1940). It thrives best in acid peaty soils; it can not tolerate liming. Propagation can be by seed or layering (Chittenden and Synge 1956). Propagation can also be done with cuttings taken in late summer or fall. The cuttings should be placed in a bed of peat moss and sand (Everett 1960).

Benefits.—Settlers used the bark of bayberry in dentifrice mixtures (Lewis 1977) and the fruits in candle making (Bornstein 1997). Bayberry candles remain popular today; it can take up to 8 kg of bayberry fruit to yield 1 kg of wax. The fruits are also often used in decorative arrangements. Native Americans used the plant for various medicinal purposes (Moerman 1986).

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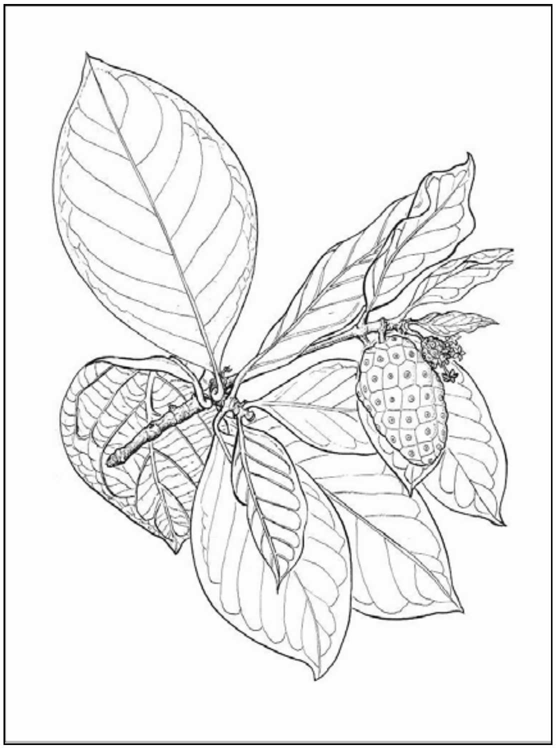
***Morinda citrifolia* L.** noni

RUBIACEAE

Synonyms: none

John K. Francis



General Description.—Noni, is also known as Indian mulberry, great morinda, cheezefruit, morinda, mouse’s pineapple, yellow root, jumbie breadfruit, hog apple, pain killer, mengkudu, nono, feyukke friudem rhubarbe caraïbe, bilimbi, pomme-macaque, and pomme de singe. It is a large evergreen shrub or small tree to 6 m or more in height and 13 cm or more in stem diameter. Sapwood is yellow-brown and soft. The bark is gray or brown, smoothish to slightly rough. Twigs are light green and four-angled. The opposite leaves are attached by stout petioles 1 to 2 cm long. The blades are dark green and shiny, ovate or elliptic, 14 to 30 cm long by 8 to 18 cm broad, and have prominent veins. The white tubular flowers are grouped in globose heads at the leaf axils. The five-lobbed flower tubes are about 6 mm long. The greenish-white to pale-yellow, fleshy fruits are ovoid or globose syncarps 5 to 7 cm long. They have an unpleasant odor resembling cheese. They contain a number of seeds about 4 mm long (Howard 1989, Liogier 1997, Little and Wadsworth 1964, Nelson 1996).

Range.—Noni is probably native to maritime forests of Northern Australia, the Western Pacific, and Indian Oceans (Stevens and others 2001). It was widely spread by native peoples beginning 2000 years ago (Smith 2002) and more recently by Europeans so that it is naturalized in most of the tropical and tropical coastal forests of the World (Howard 1989) including Florida, Puerto Rico, and the U.S. Virgin Islands (Little and Wadsworth 1964).

Ecology.—Noni is most competitive on sands and loamy sands but will grow on soils of all other textures if planted and protected from competition. It also grows well on very rocky soils. Although it grows naturally only a few meters above sea level, noni can be cultivated on sites up to 800 m or more above sea level (Stevens and others 2001). The species tolerates salty soils and salt spray. It is intermediate in shade tolerance, growing under the canopy of forests as well as in the open. Noni grows naturally on the edges of mangroves, in coastal forests, and on the landward side of beach strand vegetation. The species is grown in plantations, as an ornamental, and as a garden medicinal tree. A symbiotic association in the native range with weaver ants (*Oecophylla smaragdina*) provides the ants with food and leaves for nesting in exchange for protection from insect predators (Tan 2001).

Reproduction.—Noni flowers and fruits nearly throughout the year (Little and Wadsworth 1964). Seeds (air dried) in Puerto Rico weighed an average of 0.0259 g/seed or 38,600 seeds/kg. Without any pretreatment, 24 percent germinated in commercial potting mix beginning 70 days after sowing (Francis and Rodríguez 1993). In its native habitat, the seeds of noni are probably dispersed by fruit bats and other mammals. The plant may be propagated from both seeds and cuttings (Association of Societies for Growing Australian Plants 2000).

Growth and Management.—Published

information is lacking on growth and management.

Benefits.—Although the fruits of noni are somewhat tasteless and have an unpleasant smell, they are eaten as famine food in Indonesia, Australia, and the Pacific Islands. The young leaves are also eaten as a vegetable and contain 4 to 6 percent protein. Noni is planted as a windbreak, for support of pepper vines, and shade for coffee bushes (Tan 2001). The species is useful for coastal erosion control (Association of Societies for Growing Australian Plants 2000), and it is planted as an ornamental in some areas. The bark has been the source of a red dye (Little and Wadsworth 1964). Roots are used to produce an orange dye (Nelson 1996). Harvested from both plantations and from the wild, noni is one of the most important botanical remedies and food supplements traded on the international market. It is usually the fruit juice that is sold, fresh or dried. Leaves, bark, and roots are also used for a great many maladies. Pain, arthritis, diabetes, high blood pressure, skin and stomach ulcers, depression, senility, diarrhea, arteriosclerosis, cancer, AIDS, skin parasites, and bad breath are all treated (Association of Societies for Growing Australian Plants 2000, Cambie and Ash 1994, Tan 2001). A number of physiologically active chemicals, anthraquinones, alkaloids, asperuloside, caproic, caprylic, and ursolic acids, β-sitosterol, and asperuloside may account for some of the effects (Cambie and Ash 1994). Antitumor activity expressed in enhanced survival of tumor-bearing mice has been demonstrated after treating with juice extracts (Hirazumi and Furusawa 1999). Aqueous extracts of roots were shown to have an analgesic effect on mice without any sign of toxicity, and a sedative effect at high doses (Younos and others 1990). Octanoic acid, which is present in the ripe fruits, effectively poisons a fruit fly (*Drosophila melanogaster*), honey bee (*Apis mellifera*), an ant (*Lasius sp.*), and cockroaches (*Periplaneta americana* and *Blattella germanica*) (Legal and Plawecki 1995). Noni is the principal larval host of the hawk moth, *Macroglossum hirundo vitiensis* in Fiji (Stampsfiji.com 2002).

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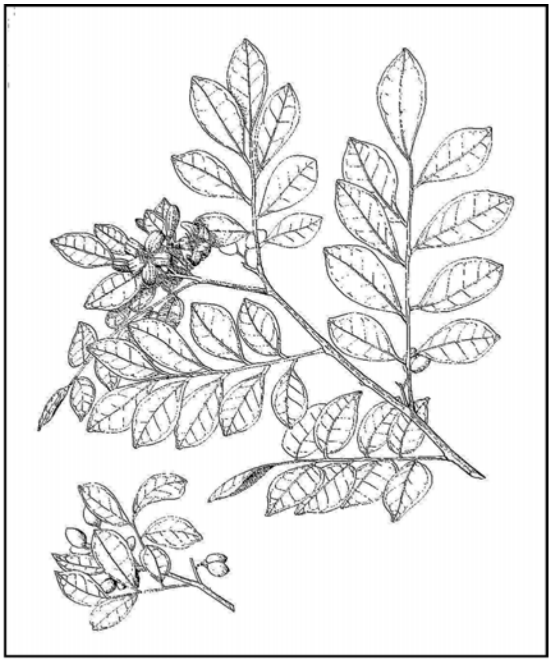
Murraya exotica L. orange jasmine
RUTACEAE

Synonyms: _Murraya paniculata_ (L.) Jack
Chalcas paniculata L.
Chalcas exotica (L.) Millsp.

John K. Francis



General Description.—Orange jasmine is also known as mock orange, satin wood, honey bush, China-box, café de la India, mirto, azahar, naranjo jazmín, limonaria, and bun (Little and others 1974). It is an evergreen shrub or occasionally a small tree, usually 2 to 3 m in height but reaching 7.5 m and 13 cm in stem diameter. Older orange jasmine normally have multiple stems from the ground level. The stems are supported by taproots with lateral roots and abundant fine roots. Stem bark is gray, becoming fissured and rough. Orange jasmine branches and twigs are slender and abundant at all heights. The alternate leaves are pinnately compound with three to nine leaflets alternating on the rachis. The 1- to 5-cm, leaflets are dark-green, stiff, ovate, and smell of citrus when crushed. The shrub produces fragrant, five-petaled, white flowers borne in small clusters near the branch ends. Later, shiny, red elliptic fruits about 1 cm long develop. One or two light green seeds are embedded in the bitter, watery pulp (Liogier 1988, Little and others 1974). The seeds are tear-drop shaped, rounded or flattened on one side depending on whether there are one or two seeds per fruit.

Range.—The native range of orange jasmine includes China, India, Sri Lanka, the Andaman Islands, Myanmar, Thailand, Kampuchea, Viet Nam, Malaysia, northeastern Australia, New Caledonia, and Taiwan (Parrotta 2001). In addition, the shrub has been planted throughout the Tropics and has naturalized in many locations including Puerto Rico (author's observation). Some authors consider _M. exotica_ and _M. paniculata_ to be separate species (Howard 1988, Pacific Island Ecosystems at Risk 2002).

Ecology.—Orange jasmine is adapted to a wide range of conditions. Naturalized plants in Puerto Rico grow in areas receiving from about 750 mm to 1900 mm of annual precipitation. The species grows from nearly sea level to elevations of 1,300 m (Neal 1965). It grows on most well-drained soils derived from both sedimentary and igneous rocks, although it is said to favor limestone areas (Pacific Island Ecosystems at Risk 2002). Plants survive temperatures to about –4 °C (Desert-Tropicals 2002). Ornamental plants are attacked at times by white flies, scale insects, nematodes, and sooty mold (Sheehan 1975). It was noted that powdery mildew attacked the species in pruned hedges but not in free-growing unpruned plants (Pathak and others 1992). Orange jasmine is moderately intolerant of shade. Although growing well under partial shade, it produces few flowers or fruits. Escaped plants in Puerto Rico are most often seen at the edges and in the understory of dry and moist secondary forests. Seedlings do not compete well with grass or herbaceous vegetation.

Reproduction.—Orange jasmine flowers irregularly throughout the year (Little and others 1974). In Hawaii, it flowers from June to September (Neal 1965). Fruits collected from plants in Puerto Rico averaged 0.370 $\pm$ 0.012 g/fruit. Air-dried seeds from these fruits averaged 0.0568 $\pm$ 0.0012 g/seed or 17,600 seeds/kg. Sown on commercial potting mix, 65 percent germinated between 25 and 60 days of sowing. Germination is hypogenous. Seedlings quickly develop deep root systems and grow at a moderate rate. Plants coppice vigorously after disturbance. Nursery production is by seed, cuttings (Little and others 1974), and air-layers (Woman's Club of Havana 1952).

Growth and Management.—Orange jasmine plants can live at least 15 years (author's observation). Once established as an ornamental, they need little care. The species has not yet been reported to be a weed in any area. Orange jasmine can be killed (with moderate success) with herbicides recommended for broad-leaf weeds, by girdling (Negreros-Castillo and Hall 1994), or by grubbing out the plants. The species is the preferred host of the citrus psyllid, *Diaphorina citri*, the vector for "citrus greening" disease (Pacific Island Ecosystems at Risk 2002), and is a host of Mediterranean fruit flies (Diptera: Tephritidae) (Harris and Lee 1986).

Benefits.—Orange jasmine is a popular hedge plant in the tropics. It can be used as a background plant or an accent plant. It can be pruned into animal and other shapes (topiary), pruned into tree form, grown as a potted plant (Whistler 2000), or cultivated as a bonsai (Gonzalez 2002). The sapwood is light yellow, and the heartwood is light brown and heavy, hard, fine-textured and good for small turned articles (Little and others 1974). Branches or stems 2 to 5 cm in diameter in the Indian Himalayan region were evaluated for fuelwood suitability. Results were as follows: oven-dry density 0.72, dry-weight caloric value 20.2 kj/g, ash 0.6 percent, moisture 54.7 percent, and nitrogen 0.42 percent (Negi and Todaria 1993). In the wild, orange jasmine contributes to the biodiversity, protects the soil, and furnishes food and cover for wildlife. The leaves and other tissues have both stimulant and astringent properties and are used to treat diarrhea, dysentery, cuts, joint pain, body aches (Parrotta 2001), venereal disease (Kinoshita and Firman 1996), and as an abortive (Xiao and Wang 1991). In addition to essential oils, tissues of orange jasmine contain the indole alkaloid yuehchukene (Xiao and Wang 1991) and at least eight highly oxygenated flavones (Kinoshita and Firman 1996).

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***Myrica gale* L.** sweet gale
MYRICACEAE

Synonyms: *Gale palustris* A. Chev.
Myrica gale var. *subglabra* (A. Chev.) Fernald
Myrica gale var. *subarctica* J. Rousseau.
Myrica gale ssp. *tomentosa* (C. DC) E. Murray
Myrica gale var. *tomentosa* C. DC

Gerry Moore

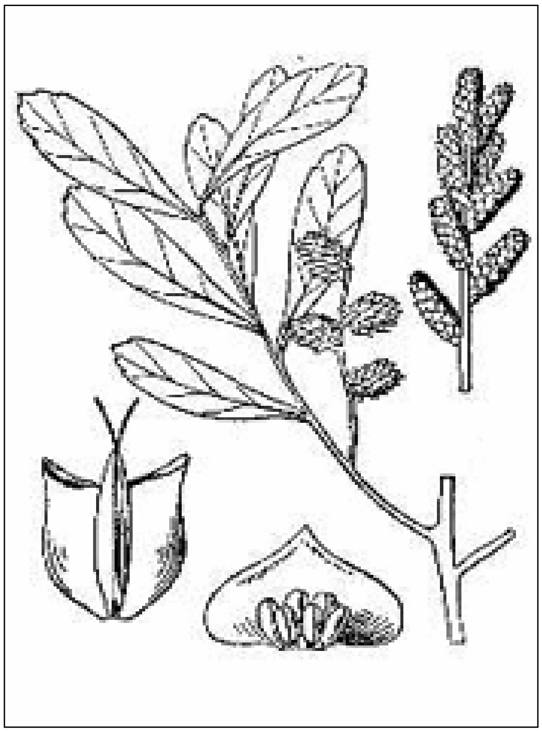
Illustration source: Britton and Brown 1913

General Description.—Sweet gale is the name used most often to refer to this shrub species. It is also known as bog myrtle, Dutch myrtle English myrtle, and meadow fern, although this species is neither a true fern nor myrtle. Sweet gale is an aromatic, deciduous, shrub up to 2.5 m tall. The plant is single or multistemmed, with strongly ascending branches. The twigs are terete, brown with scattered yellow glands. The leaves are 2 to 6 cm long (including the short petiole), oblanceolate (i.e., widest toward apex) with cuneate bases, toothed only toward the apex, glabrous and shining above but usually pubescent on the blade's underside. Like the twigs, the blades on both sides are often beset with yellow glands. The flowers are in unisexual, unbranched catkins (aments), with the staminate (male) and pistillate (female) catkins appearing on different plants. Individual plants have been known to change sex from year to year (Burges 1993). The catkins are stalkless and borne on the upper portions of the preceding year's branchlets. These branchlets die after flowering. The staminate catkins range from 6 to 10 mm long, are crowded on the branchlet, with the individual flowers overtopped by the broad, shining, subtending, brown bracts. The pistillate catkins range from 7 to 10 mm long, each flower subtended by two wing-like bracts that remain fused to the fruit. The fruit of the sweet gale is a three-pointed, compressed, ovoid nutlet that at maturity is dotted with shining red to yellow resin glands.

Range.—Sweet gale is found in the New and Old World temperate regions. It occurs in the Northeastern (Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, Michigan, Minnesota, New York, North Carolina, Pennsylvania, Rhode Island, Vermont, and Wisconsin) and the Northwestern (Oregon and Washington) United States (USDA 2003). The species is also known throughout much of Canada (Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland, Northwest Territory, Nova Scotia, Ontario, Prince Edward Island, Quebec, Saskatchewan, and Yukon) and Alaska (Bornstein 1997). In Eurasia it is known from northwest Europe to Portugal, Poland and northwestern Russia (Belgium, Britain, Denmark, Finland, France, Germany, Ireland, Netherlands, Portugal, Norway, Poland, Russia, Spain, and Sweden).

Systematic Botany.—Taxonomists disagree as to whether the sweet gale and the waxy-fruited bayberry [*Morella caroliniensis* (Mill.) Small] and wax myrtle [*Morella cerifera* (L.) Small] should be placed in the same genus (Bornstein 1997, Fernald 1950, Gleason and Cronquist 1991) or in separate genera (Wilbur 1994, 2002). Sweet gale can be readily distinguished from the waxy fruited species (bayberry, wax myrtle) on the bases of flowers and fruits. If sweet gale is to be recognized as generically distinct from bayberry and wax myrtle, as is done here, the generic name *Myrica* is to be retained for sweet gale, with the bayberry and wax myrtle being placed in the genus *Morella* (Wilbur 1994, 2002). Various varieties and subspecies [e.g., *M. gale* var. *subglabra* Fernald, *M. gale* var. *tomentosa* C. DC., *M. gale* ssp. *tomentosa* (C. DC) E. Murray] have been recognized within sweet gale based on the degree of pubescence present on the leaves.

Ecology.—Sweet gale can tolerate full sun to dense shade and is usually found in moist to wet areas. Habitats where it can be found include bogs, fens, swamps, and the margins of streams and lakes. The roots of sweet gale contain nitrogen-fixing nodules, which allow it to be particularly tolerant of nitrogen-poor, acidic soils (Baker and Parsons 1997). Nitrogen fixation is accomplished by the actinomycetous fungal genus, *Frankia.*

Reproduction.—Sweet gale is wind pollinated and blooms in the spring. The pollen is allergenic (Lewis 1977). The fruits of sweet gale mature in the fall and are dispersed by water (Ridley 1930, Wilbur 1994).

Growth and Management.—Sweet gale is often cultivated on moist acidic soils where few other species can be grown (Bailey 1922, Rehder 1940). It thrives best in peaty soils and cannot tolerate liming. Propagation can be by seed, layering, or root suckers (Chittenden and Synge 1956). Propagation can also be effected through cuttings taken in late summer or fall. The cuttings should be placed in a bed of peat moss and sand (Everett 1960).

Benefits.—The branches and bark have been used in making a gale beer and in tanning; a decoction has been used for an insecticide and to kill vermin (Rook 1998). The branches of sweet gale were used by the Native Americans, Bella Coola, to prepare decoctions to be used as a diuretic or as a treatment for gonorrhea (Moerman 1986).

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***Neea buxifolia* (Hook. f.) Heimerl** nia

NYCTAGINACEAE

Synonyms: *Eggersia buxifolia* Hook. f.

John K. Francis

General Description.—Nia, also known as saltwood, is a fine-leafed, upright, evergreen shrub from 2 to 7 m in height and 2 to 8 cm in basal stem diameter. There is usually a single stem emerging from the ground with multiple branches low on the stem. Nia plants have a weak taproot with lateral and fine roots, all brownish orange in color. The few slender branches form a diffuse crown. Bark is smooth and gray. The inner bark is bitter. The wood is whitish, soft, and does not have discernable annual rings. Oblong to oblanceolate, entire leaves are opposite or in whorl-like groups along the twigs. The 9- to 24-mm long and 3- to 9-mm broad blades are supported by 1- or 2-mm petioles. Small light yellow flowers are borne on separate plants (dioecious). The elliptic, red, slightly fleshy fruits are 4 to 5 mm long and contain one seed each (Liogier 1985, Little and others 1974).

Range.—Nia is native to Puerto Rico, its offshore island of Culebra, St. Thomas and St. John of the U.S. Virgin Islands, and Virgin Gorda of the British Virgin Islands (Clubbe 2000, Liogier 1985, Little and others 1974). It has been widely used as a bonsai plant and planted somewhat as an ornamental but is not known to have naturalized anywhere.

Ecology.—Nia has an intermediate tolerance for shade. It usually grows in the understory of low to medium-density remnant and late secondary forests. The species sometimes grows in semi-exposed positions with other shrubs and low trees on the tops of ridges. These are moist and dry forests over sedimentary (especially limestone), igneous, and metamorphic rocks. It is rare to infrequent in most habitats except the moist limestone hills in northern Puerto Rico where it is locally common. Nia is sometimes found in coastal thickets. A wide variety of well-drained soils are colonized. Mean annual precipitation ranges from 750 to about 2200 mm at elevations from a little above sea level to 500 m. The minimum temperature for potted plants is reported to be 4.5 °C (Zane 2002).

Reproduction.—Nia flowers in the spring and early summer and matures fruits in mid- to late summer. The fruits, which are produced in sparing quantities, ripen a few at a time over a period of a few weeks. A group of fruits collected in Puerto Rico averaged 0.0291 ± 0.0011 g/fruit. However, the seeds from this collection that averaged 0.0021 ± 0.0001 g/seed (air dried) failed to germinate. Seeds of this species are probably dispersed by birds. Natural seedlings are rare to scattered. According to Zane (2002), nia can be propagated by seed, branch cuttings taken in March through June, and by air layering.

Growth and Management.—Nia is relatively slow growing. Open-grown ornamentals reached 2 m in height in about 8 years. Understory saplings add just a few centimeters of height per year. Life span in forests may reach several decades. Although methods of propagation and culture in pots as bonsais is well understood, no wildland plantings have been documented. Probably the best management is protection of the stands where the species occurs.

Benefits.—Nia contributes to the diversity and aesthetics of the forests where it occurs, helps protect the soil, and furnishes food and cover for wildlife. It is one of the best broadleaf tropical (room temperature) bonsai species available and offers promise as an ornamental, especially for hedges and other shaped ornamentals.

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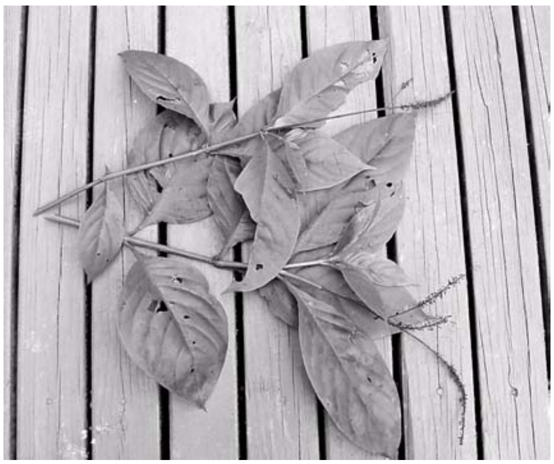
Odontonema cuspidatum (Nees) Kuntze cardinal's guard

ACANTHACEAE

Synonyms: *Odontonema tubiforme* (Bertol.) Kuntze
Odontonema strictum (Nees) Kuntze
Thrysacenthus cuspidatus Nees in DC.
Thyrsacanthus strictus Nees in DC.

John K. Francis



General Description.—Cardinal's guard, also known as firespike, is an evergreen shrub 1 to 2 m in height and 1 to 2.5 cm in basal stem diameter. It grows in patches and clumps that generate from root suckers. The smooth, green stems, which are woody below and semiwoody above, are supported by stiff lateral roots. The stems develop few branches. The opposite leaves are dark green, glabrous, elliptic, 10 to 30 cm long, and acuminate at the tip. The inflorescences are terminal racemes, sometimes branched, composed of tubular flowers of scarlet or other colors including pink, white, and lavender. Fruits are clavate (club-shaped) capsules 1 to 2 cm long that contain flattened semiorbicular seeds (Liogier 1997).

Range.—Cardinal's guard is native from Mexico to Panama (Stevens and others 2001). The species has naturalized and escaped in at least Puerto Rico, Hispaniola, and Cuba (Liogier 1997), and is widely grown as an ornamental in Florida (Watkins 1975). Some authors propose separating *O. cuspidatum* and *O. tubiforme* into individual species (Whistler 2000) or using only the name *O. tubiforme* (Stevens and others 2001).

Ecology.—Cardinal's guard prospers on fertile and moderately fertile soils that are continually moist. It is moderately tolerant of shade and will bloom in full sun, broken sun, and moderate shade (author's observation, Blomber 2000). In Central America, it grows from near sea level to 1,400 m in elevation (Stevens and others 2001). Cardinal's guard is not salt tolerant (Watkins 1975) and dies to the ground if subjected to frost. In areas subject to frost, it is grown as an annual or herbaceous perennial (Blomber 2000, Watkins 1975). The plants are mostly free of pests and disease but may occasionally be attacked by mealy bugs (Pseudococcidae) (Woman's Club of Havana 1952).

Reproduction.—In tropical countries, cardinal's guard blooms throughout the year (Whistler 2002), but in warm temperate areas, it blooms in the fall (Watkins 1975). Although the species is common in Puerto Rico, the plants produce few viable seeds. Capsules fall off before drying and liberating seeds. Fresh capsules collected in Puerto Rico weighed an average of 0.0095 ± 0.0002 g/capsule. One hundred of these capsules were sown on moist potting mix and only a single seedling emerged. Cardinal's guard is most common in disturbed areas (Stevens and others 2001), along streams and drains, and in extra-moist places in secondary forests. Most of the stands of cardinal's guard in Puerto Rico have originated from abandoned gardens or errant pieces of stem or root that have been transported by streams or dumped in the woods with garden prunings. Once established, plants spread by root suckers. The stems also layer (root) readily when they become prostrate.

Growth and Management.—Cardinal's guard grows rapidly from suckers and must be pruned frequently when used as hedges (Woman's Club of Havana 1952). Normally, little care is needed once the plant is established (Whistler 2000).

Benefits.—In natural stands, cardinal's guard adds to biodiversity and protects against soil erosion.

The species is widely cultivated as an ornamental in tropical and subtropical areas for its striking red flowers. It is used as an accent and background plant and sometimes employed to form hedges (Watkins 1975, Whistler 2000, Woman's Club of Havana 1952). It is also popular in gardens because it attracts butterflies and hummingbirds that feed on the nectar (Blomber 2000, Watkins 1975).

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***Olyra latifolia* L.** carricillo

POACEAE

Synonym: *Olyra paniculata* Sw.
Olyra cordifolia Kunth.

John K. Francis

General Description.—Carricillo (or carrucillo), also known as lintentwa, cortadora, lambedora, and sonadora, is a slender, arching bamboo-like grass. Unsupported culms reach about 1.5 m before sagging to horizontal. Climbing into the crowns of shrubs and low trees, plants may reach 3 to 7 m in height and sometimes as much laterally. The culms (stems) are thin-walled, brittle but tough, and can reach 1.5 cm in diameter. Each plant usually has several culms arising from a tight root crown composed of brief rhizomes that support abundant fine roots. The culms are green, sometimes mottled with purple, throughout their length and are enveloped with up to 8-cm sheaths arising from the nodes. The culms are lineal except for vertical sprouts on reclining stems and "brooms" or diffuse multiple branches that form near the ends of older culms. The leaves are ribbon-like, 15 to 25 cm long and 3 to 6 cm broad with long pointed tips and one edge of the leaf base rounded and the other straight, forming a 50 ° angle with respect to the leaf axis for about 2 cm. Inflorescences are panicles 10 to 15 cm long, terminal or upper axillary, and contain few to many flowers. The 5-mm fruits are smooth, shiny, ivory-colored, and hard (author's observation, Croat 1978, Howard 1979, Stevens and others 2001).

Range.—Carricillo is native to southern Mexico, Central America, South America to northern Argentina, the Antilles, moist Tropical Africa, and Sri Lanka (Burkill 1994, Howard 1979, Judziewicz and others 1999). There is speculation that the species may be exotic in the Old World (Judziewicz and others 1999).

Ecology.—Carricillo is moderately intolerant to intermediate in tolerance to shade. It is widespread and relatively common in the understory of thin canopy forests, brushy forests, small openings, and edges of high forest. These are most often medium to late-secondary forests but can be primary forests and remnants. Carricillo grows on a wide variety of well-drained to somewhat poorly drained soils with pH's from near neutral to about 5.5 over sedimentary (including limestone), igneous, and metamorphic (including ultramafic) rocks. Elevation may vary from near sea level to 1,100 m in areas that receive from about 1000 to more than 3000 mm of mean annual precipitation (author's observation, Croat 1978, Shaka and others 1997, Stevens and others 2001).

Reproduction.—Carricillo flowers and fruits primarily during the rainy season in Panama (Croat 1978) and throughout the year in Nicaragua (Stevens and others 2001). Seed production is not abundant in Puerto Rico, but may be in Costa Rica (Missouri Botanical Garden 2002). Seeds in two collections made in Puerto Rico on the same site on different years averaged 0.0210 $\pm$ 0.0003 and 0.0225 $\pm$ 0.0003 g/seed or about 46,000 seeds/kg. Placed in moist potting mix, only 1 percent had germinated after 18 months. Scarification, alternate wetting and drying, and heat treatment all failed to stimulate germination (author's observation). Birds disperse the seeds (Burkill 1994, Judziewicz and others 1999). New plants are uncommon. Attempts to cultivate the species in temperate greenhouses have failed (Judziewicz and others 1999).

Growth and Management.—Carricillo is a relatively fast growing plant. Individual culms grow 2 m or more during their first year and 1 m or so thereafter and live 2 to 4 years. By continual sprouting, plants may live for many years. Artificial vegetative propagation has not been explored. Until vegetative methods are developed or the extended dormancy problem of seeds is solved, planting is not advised. Eradication can be done by grubbing out individual plants or probably by cutting and spraying the sprouts with glyphosate or other grass herbicides.

Benefits.—Carricillo contributes to the diversity of the forest, helps protect the soil, and furnishes food and cover for wildlife. Cattle eat the leaves and fine twigs. Birds eat the fertile florets and fruits, although there is speculation that they may not be able to digest the hardened seeds (Burkill 1994). The species is the food plant for larva of the moth *Eryphanis reevesii* (Doubleday) (North Carolina Botanical Garden 2002). The hollow culms are used for flutes (Judziewicz and others 1999) and drinking straws. Leaves, culms, roots, and seeds are used in a number of applications in herbal medicine (Burkill 1994). Blades made from the culms are used by the Cuiba tribe in Colombia to cut the umbilical cords of newborns (Judziewicz and others 1999).

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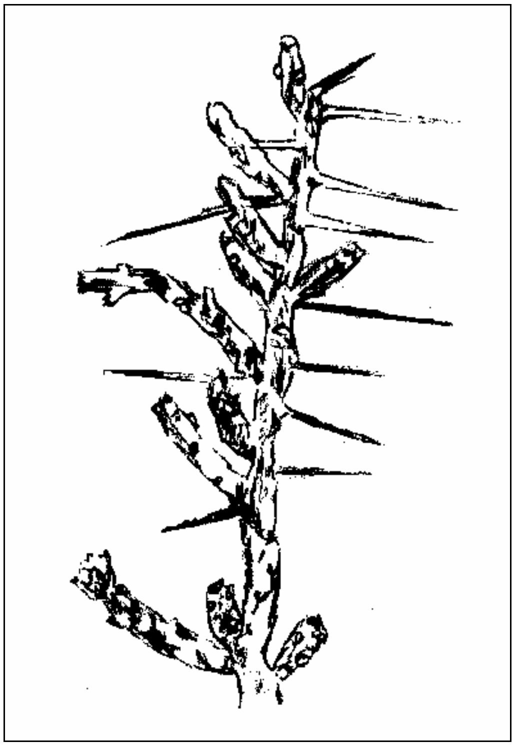
***Opuntia leptocaulis* DC.** desert Christmas cactus
CACTACEAE

Synonyms: *Cylindropuntia leptocaulis* (DC.) D.M. Knuth
Opuntia ramulifera Salm Dyck
Cylindropuntia leptocaulis var. *stipata* Coulter
Cylindropuntia leptocaulis var. *longispina* Berger

Juanita A. R. Ladyman



General Description.—The common name for *Opuntia leptocaulis* is desert Christmas cactus. This name is likely to have originated because the green -colored fruits turn a very festive red color in December just in time for Christmas. Other common names include slender-stem cactus, turkey pear, tasajillo, aguijilla and garrambulla (Taylor and others 1997, Weniger 1991). In the indigenous language of Nahuatl it is called tzazahuistli (Crook and Mottram 1999). A widely applied name that includes all the long jointed cylindropuntia cacti, of which desert Christmas cactus is one, is cholla. The genus name, *Opuntia*, is taken from the name given to succulent plants that were originally from the old Greek town of Opus. The species name, *leptocaulis* means slender stemmed in Greek (Crook and Mottram 1999). Desert Christmas cactus is an erect shrub that is usually less than 1.5 m tall but can grow up to 2.8 m in shady, protected environments such as under trees (Earle 1990). Although relatively compact, it is extensively branched from a main trunk that is covered by scaly bark in old age. It has pencil-like woody joints that are 12 to 40 cm long and 5 mm in diameter and can be easily detached from the plant. The tubercules, usually less than 1 cm long, may be indistinct and the joints smooth. The areoles, which are the small, clearly defined raised areas on the surface, are oval or almost diamond-shaped with short white wool. The areoles may be spineless or have from one to three spines that are from 19 to 51 mm long. There are few, usually short, yellowish-brown glochids, or minute bristles, in one to three small clusters in the upper part of the areole. The leaves are green, less than 1.3 cm long, and are early deciduous. The greenish-yellow flowers are approximately 1.3 to 1.9 cm in diameter and up to 2.5 cm tall. The fruits are up to 2.5 cm long, and smooth with brown glochids in the areoles. There are usually less than 12 seeds per fruit (Earle 1990, Weniger 1991, Vines 1986). Desert Christmas cactus is a diploid species where n = 11 (McGregor and others 1986).

Range.—Desert Christmas cactus occurs in Arizona, New Mexico, Oklahoma, and Texas in the U.S.A. and in Sonora and Chihuahua in northern Mexico (Bowers 1993, McGregor and others 1986, Powell 1998).

Ecology.—Desert Christmas cactus is a water storer and employs a type of photosynthesis called crassulacean acid metabolism that allows them to make efficient use of available water (Burgess 1995, Nobel 1988). The species is found at elevations below 1,524 m. It grows in most soil types but appears to be most successful in gravelly, sandy, and heavier bottomland soils (Taylor and others 1997, Epple 1995, Rondeau and others 1996, Bowers and McLaughlin 1987, Kearney and others 1960). It is commonly in the same habitat with creosotebush, *Larrea tridentata*

(DC) Colville, with which it has a cyclical relationship in the Chihuahuan desert (Yeaton 1978). Creosotebush colonizes sites and modifies microhabitat and edaphic conditions for desert Christmas cactus establishment and is eventually replaced by it. However, a combination of burrowing rodents and soil erosion increases the mortality rate of desert Christmas cactus while having little effect on creosotebush. The openings left by the dead cactus are then re-colonized by creosotebush.

Reproduction.—Desert Christmas cactus reproduces both sexually by seed and vegetatively. Flowers generally appear in May to July depending upon regional and environmental conditions. In response to wet weather, they can flower as early as April and again in August. The flowers open wide in late evening (Taylor and others 1997). The fruit ripens in December and persists on the plant until approximately February. Seeds may sprout while in the fruit and have a shoot of up to 7 cm long while still on the plant (Weniger 1991). Detached joints root and grow into plants. The terminal stem segments detach particularly easily and readily take root near the parent plant so that natural populations that appear to be dense monocultures of clonal individuals develop (Rebman and Pinkava 2001). Cuttings taken from woody stems do not root easily (Earle 1990). Hybrids between cholla species are common in nature (Rondeau and other 1996). An example herbarium specimen of such a hybrid, *O. leptocaulis* x *O. spinosior* (cane cholla), can be seen on the Internet (Pinkava 2001).

Growth and Management.—Desert Christmas cactus is frequently abundant on overgrazed range (Powell 1998). It tends to form thickets that can become almost impenetrable to humans and livestock. Individual plants can be long-lived and may be more than 53 years old (Goldberg and Turner 1986). In a study over a 72-year period, 40 percent of plants were determined to survive at least 7 years (Goldberg and Turner 1986). Survival after fire is dependent upon the intensity and frequency of the fire (Thomas 1991, Cave and Patten 1994). Plants can re-sprout after the fire kills the above ground parts (Bunting and others 1980). However, desert Christmas cactus appears more susceptible to direct damage from fire than some other *Opuntia* species (Bunting and others 1980). After a fire in a mixed-grass prairie in Texas, mortality was 65 percent in the first year and reached a cumulative value of 80 percent by the fourth year (Bunting and others 1980). Desert Christmas cactus recovery appeared particularly sensitive to the amount of precipitation. Precipitation was required before plants would re-sprout. Plants tolerate minimum temperatures of 7.3 ^{o}C in cultivation (Innes and Glass 1991). In cultivation, desert Christmas cactus is susceptible to the cochineal bug and periodic oil spray is recommended (Earle 1990).

Benefits.—Weniger (1991) describes it as a major pest and "probably one of the most hated cacti in our area [Texas]." This is an unfortunate sentiment because, although the spines can impale people and livestock that venture too close, it provides significant food, protected nesting sites, and cover for a variety of wildlife (Earle 1990, Dayton 1931). Most birds, including the bobwhite quail and wild turkey, as well as small mammals, favor the fruit (Powell 1998, Taylor and others 1997). Some animals, such as white-tailed dear, consume the joints as well as the fruit (Everitt and Drawe 1993). There is apparently no seasonal variation in the crude protein content of the stems, which is similar to the fruits; both are 8 percent (Taylor and others 1997). The larger shrubs provide cover and nesting sites, especially for the cactus wren. In addition, there is now a commercial value to maintaining these shrubs. Land management for wildlife has become increasingly important to livestock producers in the Western U.S.A. because of fluctuations in livestock prices. In some parts of Texas, income generated from consumptive (e.g., hunting) and non-consumptive (e.g., bird watching) wildlife activities already exceed revenue obtained through livestock operations (Hernandez and others 1999). Under these circumstances upland gamebirds, such as northern bobwhites and Rio Grande wild turkeys, have become particularly important. Recommendations have been made that low, thorny brush composed of species such as lotebush [*Ziziphus obtusifolia* (Hook. ex Torr. & Gray) Gray] and desert Christmas cactus should be protected in order to enhance nesting cover (Hernandez and others 1999) and provide a food source. Desert Christmas cactus also provides refugia to native plant species. A clear example of this on a landscape scale is in Arizona where clumps of tobosa grass are almost completely restricted to refugia that are most commonly under the desert Christmas cactus canopy where it is inaccessible to livestock (McAuliffe 1995). Native Americans gathered the fruits and ate them raw or cooked them into a jam (Earle 1990). The Apache tribes mixed the crushed fruits with a beverage to produce narcotic effects (Moerman 1998).

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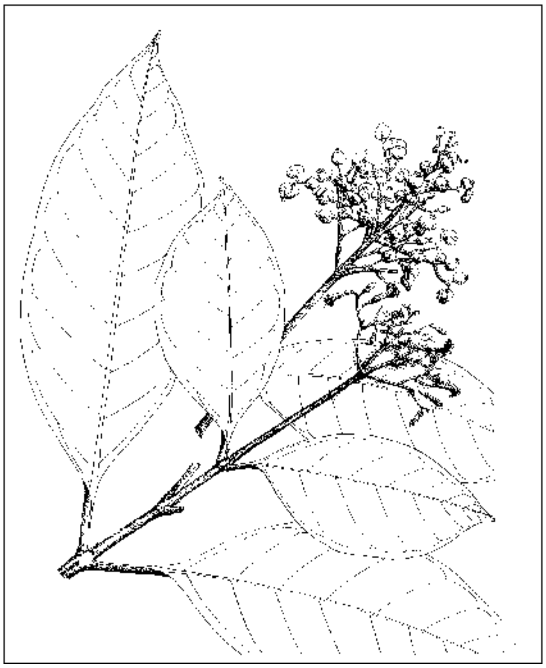
***Palicourea crocea* (Sw.) J.A. Schultes** cachimbo

RUBIACEAE

Synonyms: *Palicourea coccinea* Poiteau ex DC.
Psychotria crocea Sw.
Palicourea reparia Benth.
Palicourea croceoides Ham.
Palicourea crocea DC. var. *riparia* (Benth.) Griseb.
Palicourea brevithyrsa Britt. & Standl.

John K. Francis



General Description.—Cachimbo is a medium to large shrub also known as red palicourea, yellow palicourea, yellow-cedar, tapa camino, ponasí, bois de l'encore, bois cabrit, and bois fou-fou (Little and others 1974). There is some ambiguity in the classification of this species. Liogier (1997) separates *P. crocea* and *P. croceoides* on the basis of flower color; Howard (1989) treats them as a single species under *P. crocea*. We will follow Howard for the purposes of this description. The stems of cachimbo are green when young, changing to gray. The inner bark remains green. The wood is moderately hard and brittle. There are usually several sprouts from the base and long straight branches arising from major stems. Cachimbo develops a robust, shallow lateral root system with abundant fine roots. Foliage is relatively sparse and concentrated near the growing tips. The plant is glabrous or nearly so. The leaves are elliptic, 7.0 to 14.5 cm long and 3.5 to 5.5 cm broad, and pointed at both ends with a petiole 0.5 to 1.0 cm long. The tubular flowers are grouped in cymes. Flower color ranges from yellow to red. The fruits are ovoid to globose, 4 to 6 mm in diameter and dark red, purple, or black. They are faintly sweet with a grassy flavor. There are two seeds per fruit when perfectly developed. The seeds are black or grayish with a hard, bony shell, and hemispherical, with a groove on the flat side and three ridges on the rounded side.

Range.—The natural range of cachimbo extends from southern Mexico through Central America and South America to southern Brazil and Paraguay on the mainland and includes the Greater and Lesser Antilles in the Caribbean (Howard 1989, Liogier 1997)

Ecology.—Cachimbo grows in areas receiving precipitations ranging from 1500 to over 4000 mm/yr. Soils where it grows are usually loams to clays derived from volcanic or sedimentary parent material. Elevations may be a few meters above sea level up to 1,000 m (Little and others 1974). Cachimbo requires disturbance to establish itself. It grows well in tree-fall gaps, landslides, artificial openings, and under thin forest canopies. It competes aggressively with forbs, other shrubs, and young trees. When the canopies close and shade becomes dense, existing plants decline and eventually disappear. Labrón (1977) calls the species a "gap opportunist." Cachimbo was a principal species in abandoned pastures in the Luquillo Mountains, Puerto Rico, 60 years ago, but not in abandoned shade coffee plantations (Zimmerman and others 1995). The species grows slowly on nutrient-poor substrate (as in landslide areas), but responds to N and P fertilization under those conditions (Fetcher and others 1996).

Reproduction.—Cachimbo flowers and fruits irregularly throughout the year (Little and others 1974). The fruits in one Puerto Rican sample weighed an average of 0.1488 $\pm$ 0.0055 g/fruit. Seeds cleaned from the sample averaged 0.0314 $\pm$ 0.0048 g/seed or 32,000 seeds/kg. Thirty-five percent of these seeds germinated between 39 and 84 days after sowing in commercial potting mix. Palicourea flowers are pollinated by humming birds and the fruits are dispersed by frugiverous birds (Taylor 1996). Bees were also observed to visit the flowers (Labrón 1977). Cachimbo suffers relatively little seed loss to pathogens and predators and germinates at a higher percent after natural dispersal than without it (Myster 1997). Seedlings are common and widespread in suitable habitat. There is no significant difference between seasons in seedling appearance, but regardless of season, seed germination is always higher in the open than in closed canopy areas (Labrón 1977). Transplanted wildlings survive and grow poorly (personal communication with F.N. Scatena, IITF, Río Piedras, PR)

Growth and Management.—Cachimbo grows slowly (a few cm) the first year and rapidly (1 m or more per year) for about 2 years in openings (Labrón 1977). After about 3 years, seedlings sown under an open canopy had accumulated about 20 times more biomass than seedlings sown under closed canopy conditions. The above-ground to below-ground ratio of the open-canopy plants was 4.8 (Labrón 1977). Cachimbo may reach 6 m in height and 7.5 cm in stem diameter (Howard 1989, Little and others 1974). No annual rings are visible. However, single stems last about 10 years, and plants can continue to regenerate with new sprouts. Plants cut during plantation cleaning and trail clearing quickly regain their former height (author's observation). Scatena and others (1993) present an equation to predict oven-dry above-ground biomass (To) from diameter at breast height (D) and height (H): $To = \exp(0.752 \ln (D^2H) - 2.362)$ where $R^2 = 0.861$.

Benefits.—Cachimbo is a food source for several species of song birds (Devoe 1989). It is higher in the major nutrients in its tissues than most of the trees and shrubs with which it is associated (Scatena and others 1993) and is probably a good recycler of nutrients and a good forage plant. People in some areas of Puerto Rico use crushed cachimbo leaves to stop bleeding (Labrón 1977).

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***Parathesis crenulata* (Vent.) Hook. f.** rascagarganta
MYRSINACEAE

Synonyms: *Ardisia crenulata* Vent.

John K. Francis

General Description.—Rascagarganta, also known as secagarganta, jalapón, and raisin marron, is a shrub or small tree 1 to 3 m (occasionally reaching 6 m) in height and 1 to 4 cm (occasionally to 7.5 cm) in trunk diameter. The common names in Spanish imply that it will make one's throat raspy or dry. The species, unless disturbed, has a single stem and is supported by a taproot and lateral roots that are orange-brown in color. Most of the branches arise from the main stem, often in whorls of three's or four's. The alternate, dark-green, 7- to 23-cm leaves are narrowly elliptic, pointed at both ends, and often have wavy-toothed edges. The small pink flowers are borne in large numbers in terminal panicles. The 6- to 8-mm fleshy fruits progress from green to pink to red to black as they ripen. Each fruit contains one seed (Howard 1989, Liogier 1995, Little and others 1974).

Range.—Rascagarganta is native to Hispaniola, Puerto Rico, and Martinique (Howard 1989, Liogier 1995, Little and others 1974). Some taxonomists suggest that *P. serrulata* (Sw.) Mez, of Cuba and Hispaniola is synonymous with *P. crenulata* (Howard 1989).

Ecology.—Rascagarganta grows in moist forests that receive from about 1500 mm to 2800 mm of annual precipitation. In the dry end of the precipitation range, it only occurs near streams and extra moist hollows. The species is found mainly on slightly- to moderately-acid soils with loamy to clayey texture. Although areas with both igneous and sedimentary rocks are colonized, it is most abundant in valleys in limestone formations. Rascagarganta grows from a little above sea level to 760 m in elevation (Little and others 1974). The species is shade tolerant and prefers to grow under closed forests with moderate to light understory vegetation. It sometimes forms its own understory canopy under which little vegetation grows. There appear to be few insect or disease problems in natural stands.

Reproduction.—Rascagarganta is reported to flower from May to July and fruits from July to December (Little and others 1974). Fruits are often present in quantity and are easy to pick. They may be cleaned by maceration and wet sieving. A collection of fruits from Puerto Rico weighed an average of 0.407 g/fruit. Air-dried seeds cleaned from that collection weighed an average of 0.054 g/seed or 18,000 seeds/kg. Sown in peat, 45 percent germinated between 48 and 104 days after sowing. Many seedlings died from damping-off; therefore, a looser germination medium than peat is recommended. Seedlings grew slowly in the nursery, reaching less than 10 cm in 6 months (author's observation). Birds disperse the seeds. Seedlings are relatively common and widespread near fruit-bearing stands.

Growth and Management.—Rascagarganta grows slowly and appears to live several decades. No management experience has been published. However, the best strategy for establishment of natural stands may be to maintain plantations or natural forest stands in moist areas for long periods with closed canopies and relatively clear understories to allow rascagarganta to build up.

Benefits.—Rascagarganta contributes to biodiversity, cover for wildlife, and protects the soil from erosion in the forests where it grows. Although not usually heavily used by wildlife, the fruits are produced in large quantity and are available after hurricanes when overstory fruits are scarce. The wood is hard, but due to its small size is useful mainly for stakes and fuel.

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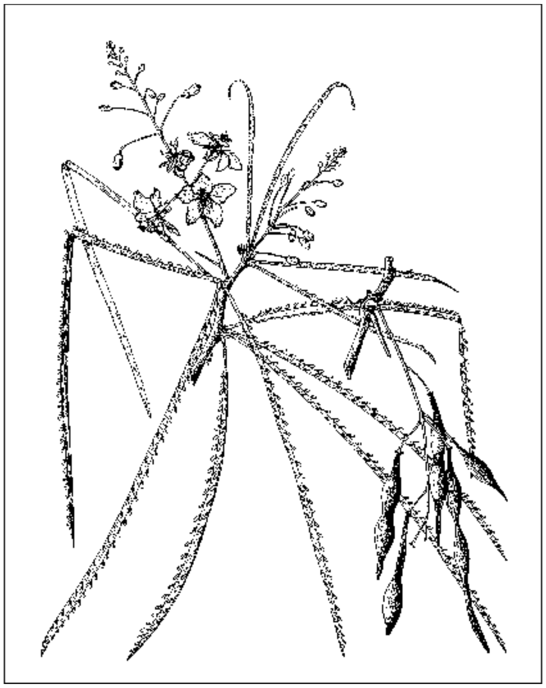
***Parkinsonia aculeata* L.** Jerusalem-thorn
FABACEAE

Synonyms: none

John K. Francis



General Description.—Jerusalem-thorn occupies the transition zone between shrub and tree life-forms. In difficult sites and portions of its range, it is very shrubby, but in moist and fertile areas, it becomes a small tree up to 10 m in height. Jerusalem-thorn often has multiple stems, especially if burnt or cut, and usually has a branchy, low, and diffuse crown. The branches and foliage are often somewhat pendulous. It has a taproot, carrot-like in young plants, and slender laterals radiating out from it at all depths. Old trunks are brown and fissured or scaly. The bark of smaller stems and twigs is thin, smooth, and yellow-green or blue-green. There are paired spines at the nodes and a larger spine (1 to 2 cm long) at the end of the leaf axis. The leaves are alternate, bipinnately compound (20 to 40 cm long) with a flattened rachis and many tiny (2 to 4 mm long) leaflets that are shed during the winter or the dry season. The yellow or yellow and orange fragrant flowers are grouped in racemes and have five sepals and five petals. The fruits are legumes 3 to 10 cm long, slightly flattened with constrictions between each seed. The seeds are one to several in number, ellipsoid, gray, and about 4 by 8 mm. The species has a haploid chromosome number of 14 (Pantulu 1942). Jerusalem-thorn is also known as horse bean, palo verde, retama, palo de rayo, espinillo, sulfato, cina-cina, mataburro, madam naiz, and arrête-boeuf (Correll and Johnston 1970, Howard 1988, Liogier 1988, Little and Wadsworth 1964).

Range.—Jerusalem-thorn is native to Texas, Arizona, Mexico, Central America, and South America as far south as the north of Uruguay (Holdridge and Poveda 1975, Little and Wadsworth 1964, Piaggio 2001). It has been planted and has naturalized in many of the islands of the Caribbean, including Puerto Rico and the U.S. Virgin Islands (Liogier 1988). The species has been introduced into the Old World and has become widespread in Australia. Jerusalem-thorn is planted as an ornamental in Florida, and the Southern and Western United States.

Ecology.—Jerusalem-thorn will grow on most types of soils, including sand dunes, clay soils, strongly alkaline, chalky, and mildly salty soils. It withstands a great deal of heat and can survive in areas that receive less than 30 cm of annual rainfall. Jerusalem-thorn is damaged by temperatures below –8 °C (Floridata 2001). Individual plants are attacked and damaged by termites, scales, and a number of other insect species, but populations are generally relatively free of pests. It requires full or nearly full sunlight to survive and reproduce. In most environments, Jerusalem-thorn needs some kind of disturbance to become established.

Reproduction.—Jerusalem-thorn flowers and fruits throughout the year in Puerto Rico (Little and Wadsworth 1964). It often flowers and fruits at 2 m in height or less. The flowers are pollinated by bees that are attracted to and orient themselves to the banner petal, which absorbs UV radiation (Jones and Buchmann 1974). Seeds collected in Puerto Rico by the author numbered 13,300 seeds/kg. Little and Wadsworth (1964) report 12,300 seeds/kg. Seeds from the former collection were scarified and germinated at 59 percent, beginning 2 days after sowing (Francis and Rodríguez 1993). Jerusalem-thorn produces two kinds of seeds. About 25 percent of them have thin testae and will germinate readily without pretreatment; the rest have hard seed coats and must be scarified before they will germinate (Floridata 2001). Mechanical scarification was used by the author; soaking for 45 minutes in concentrated sulfuric acid worked equally well in another test (Everitt 1983). In nature, seeds are transported by water, birds, and animals (Pacific Island Ecosystems at Risk 2001). Artificial propagation is routinely done with seeds followed by ordinary nursery culture in containers. *In vitro* propagation using nodal explants has been demonstrated (Jaideep and others 1992). Jerusalem-thorn will continue to resprout after many cycles of annual disturbance.

Growth and Management.—The growth rate is moderate, from 0.5 to 1 m per year in early years. Jerusalem-thorn plants live about 30 years (Pima Community College 2001). As an exotic, Jerusalem-thorn can be problematic in rangeland, as it has become in Australia. Biological control attempts are ongoing, but have not yet been successful. Jerusalem-thorn can be controlled with tractors by pulling or dozing the large plants out, if the seedlings are also controlled. Good control has been achieved with several herbicides as well (Pacific Island Ecosystems at Risk 2001).

Benefits.—The principal use of Jerusalem-thorn today is for landscaping. Its abundant yellow floral display alone justifies its use. Perhaps its best use is in xeric gardens, where it contrasts well with succulents and other desert plants (Floridata 2001). It is also useful in hedges and for living fenceposts (Hoekstra and others 2001). Jerusalem-thorn is also planted for environmental restoration in desert areas. Besides being hardy, it has the added benefit of fixing nitrogen (Harris 1982). The wood is moderately hard, heavy (specific gravity 0.6), and brittle. It is used principally for fuel. Native Americans harvested the seeds, which they parched before eating (Floridata 2001). Various extracts of leaves, flowers, fruits, and bark are used in herbal medicine to treat arthritis and fever, and as a nerve stimulant and abortive (Liogier 1990). Livestock eat the foliage and fruits (Little and Wadsworth 1964). Jerusalem-thorn is occasionally browsed by white-tailed deer and the seeds are eaten by bobwhite quail (Everitt and Drawe 1993).

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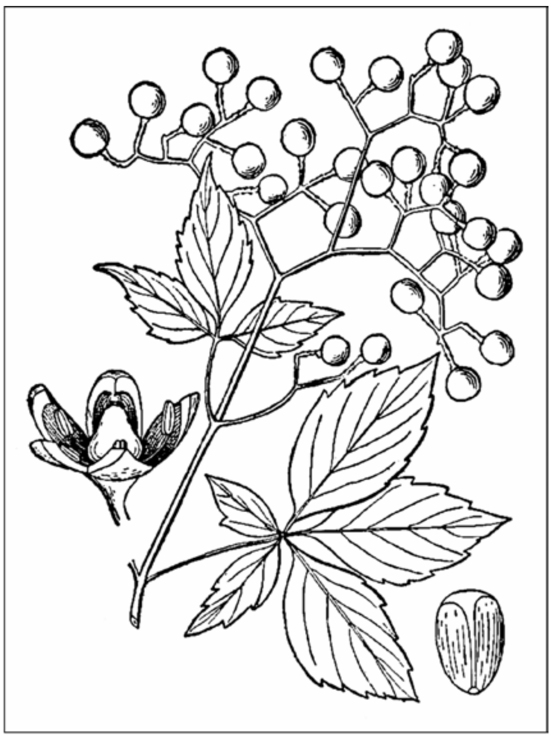
***Parthenocissus quinquefolia* (L.) Planch.** Virginia creeper
VITACEAE

Synonyms: *Amphelopsis latifolia* Tausch
Amphelopsis quinquefolia (L.) Michx.
Hedera quinquefolia L.
Vitis quinquefolia (L.) Lam.
Parthenocissus hirsute (Pursh) Graebn.
Parthenocissus inserta (Kerner) Fritsch (and other synonyms: Natural Resources Conservation Service 2003)

John K. Francis



General Description.—Virginia creeper, occasionally referred to as woodbine, thicket creeper, American ivy, and five-leaved ivy, is a deciduous woody vine that may reach 15 m or more into the crowns of trees or up masonry walls. Single or multiple stems are slender, round, light brown, and have prominent lenticels. Young growth is reddish. The vines adhere to surfaces by means of five- to eight-branched tendrils ending in cup-like, adhesive tips. The alternate leaves are palmately compound with five (sometimes three or four) leaflets. The leaflets are lanceolate, oblanceolate or obovate, 3 to 15 cm long, and 1.6 to 8 cm broad with singly or doubly serrate margins. Petioles are 15 to 20 cm long, and leaflets have distinct petiolules. Small, greenish-white to yellowish-green flowers are borne in terminal cymes or panicles positioned under the foliage. Fruits are berries, somewhat flattened at the apex, 4 to 6 mm in diameter, bluish-black with a definite bloom when ripe. Fruits usually contain two to three seeds (Dirr 2003, Nelson 1996, Rehder 1951, Welsh and others 1987).

Range.—Virginia creeper is native to all the conterminous States except Washington, Oregon, California, Nevada, Arizona, New Mexico, Utah, Idaho, Montana, Wyoming, and North Dakota (Natural Resources Conservation Service 2003). It is also native to northern Mexico and southeastern Canada from Nova Scotia to Ontario (Coladoanto 1991, Nelson 1996). It has naturalized in at least Utah, England, and France (Compton 2003, Services Culture Editions Ressources 2003, Welsh and others 1987). The species is cultivated as an ornamental in many moist temperate areas of the world.

Ecology.—Virginia creeper is found in most of the vegetation associations in the Eastern and Midwestern United States (Coladoanto 1991). It grows in most moist soils types. Virginia creeper grows well in full sun but also tolerates shade. When growing under a forest canopy, it attempts to ascend the tree trunks or obstacles it encounters. It is a mid- to late-seral species. It is sensitive to fire and is top-killed by most fires. Root crowns and occasional surviving stems sprout and partially renew burned stands (Coladoanto 1991).

Reproduction.—Virginia creeper flowers from June to August, matures fruits from August to October and drops fruits (or they are eaten by birds) from September to February. Good fruit and seed crops are frequent. There are 21,600 to 58,000 air-dried seeds/kg of which 44 to 99 percent are sound (Gill and Pogge 1974). The seeds are dispersed by birds (Dirr 2003). Seeds germinate the first or second spring after dispersal; germination is epigeal (Gill and Pogge 1974). It layers readily at the nodes when stems come in contact with the soil (Crandall and Crandall 1995).

Growth and Management.—Once well established, Virginia creeper grows rapidly. It often must be pruned to prevent it from getting out of control in ornamental settings. It can seed into nearby flower beds and wildlands. Virginia creeper should not be planted to climb up buildings with wooden siding because it is difficult to remove and because it increases the humidity and hastens rot (Gilman 1999). The species occasionally interferes with reproduction of pines and hardwoods and may be controlled with herbicides. Fire can also be an effective control agent (Coladoanto 1991). Fruits can usually be picked in quantity by hand. Seeds are separated from fruit tissue by maceration followed by floating off the pulp and empty seeds with water. However, maceration must be gentle because seed coats are soft and easily damaged. There are 16 to 27 g of seeds/100 g of fruits. The seeds may be fall-sown 1 cm deep in soil and mulched. Alternatively, seeds may be stratified in moist peat or sand at 5 or 6 °C for 60 days and sown in the spring. Forty-one to 94 percent of the seeds will germinate after 30 days. Seedlings are ready for outplanting when they reach 15 cm in height after 1 or 2 years in the nursery. The species can also be propagated with cuttings and layers (Gill and Pogge 1974).

Benefits.—Virginia creeper is important to the aesthetics of forests, helps protect the soil, and furnishes food and cover for wildlife. Cattle and white-tailed deer sometimes browse the foliage. Songbirds are the principal consumers of the fruits. The foliage, both as a ground cover and climber, provides cover for small mammals and birds (Coladoanto 1991). It has been planted for watershed protection and erosion control (Gill and Pogge 1974). The principal attraction of Virginia creeper is its fall color. The leaves turn fiery shades of purple, red, and scarlet after the first frost (Dirr 2003). The blue-black fruits and their stems (which turn red also) add color and interest after the leaves have fallen. The species is planted to cover building walls, run up tree trunks, and form trellises and arbors. It also makes a fine ground cover (Crandall and Crandall 1995). Native Americans took decoctions of the roots for diarrhea and difficult urination, infusions for jaundice, and applied decoctions and poultices topically for swelling and lockjaw (Moerman 1986). The fruits are reported to be poisonous by reason of the oxalic acid they contain (Russell and others 1997). However, consuming more than a small amount is unlikely due to their bad flavor (author, personal observation).

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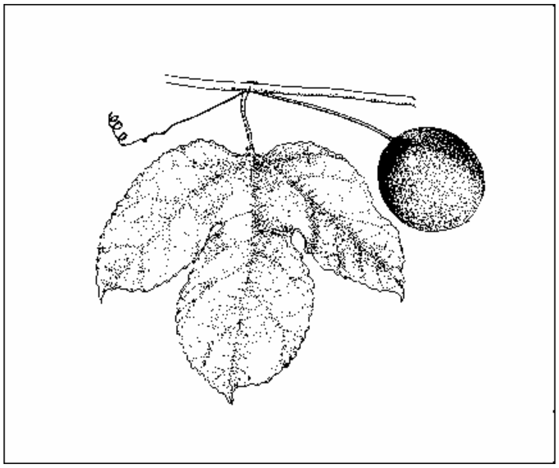
***Passiflora edulis* Sims** passionfruit

PASSIFLORACEAE

Synonyms: none

John K. Francis



General Description.—Passionfruit is also known as parcha, granadilla, maracuyá, ceibey, lilikoi, and linmangkon (Morton 1987). The English prefix "passion" derives from the passion of Christ suggested by the prominent four-branched style that appears in a few of the flowers. Passionfruit is a woody, perennial vine that bears a delicious fruit and occurs in purple- and yellow-fruited forms (*Passiflora edulis* Sims f. *edulis* and *P. edulis* f. *flavicarpa*) known as purple and yellow passionfruits. The plants have a weak taproot and extensive ivory-colored lateral roots. The stem is usually solitary, up to 7 cm in basal diameter, extends 5 to 10 m or more into the crowns of trees, and is covered by a thin, flaky, light brown bark. The stemwood is light and brittle. The twigs are yellow-green, turning brown, and support themselves on vegetation by means of tendrils that arise at the leaf axils. The leaves are alternate, green to yellow-green, three-lobed (on mature plants) with serrate edges. The petioles are 3 to 6 cm long and the blades are 5 to 11 cm long by 4 to 10 cm broad. Solitary flowers arise at the leaf axils. The flowers measure 5 to 7 cm across with five greenish-white sepals and five white petals topped with a fringe-like corona of straight purple and white rays. There are five stamens with large anthers and a triple-branched style. The fruit is globose or ovoid, purple or yellow and 4 to 7 cm in diameter. Inside a thick rind are many dark-brown to black seeds enveloped in small sacs filled with aromatic yellow or orange juice. The fruits of the purple passion fruit are smaller but more aromatic than those of the yellow form (Acevedo-Rodríguez 1985, Liogier 1994, Morton 1987).

Range.—The purple passionfruit is a native of southern Brazil through Paraguay to northern Argentina. The yellow form of passionfruit is probably native of the Amazon region of Brazil (Morton 1987). Passionfruit is cultivated today throughout the tropics and subtropics and has naturalized and escaped in many areas including Florida, Puerto Rico, U.S. Virgin Islands, Hawaii, Guam, and Western Samoa (Acevedo-Rodríguez 1985, Morton 1987, Pacific Island Ecosystems at Risk 2002).

Ecology.—Altitude and latitude do not appear to be a constraint other than through the temperatures associated with them. Purple passionfruit grows best in a subtropical climate, and the yellow passionfruit prefers a tropical climate with full-season warm days and nights. However, even yellow passionfruit can survive temperatures down to – 5 °C (Sentelhas and other 1996). Generally, annual rainfall should be at least 900 mm. Rainfall in Indian areas that grow passionfruit ranges from 1000 to 2500 mm/year (Morton 1987). The species is shallow-rooted but withstands drought by defoliating. Passionfruit tolerates a wide variety of soils and grows best on well-drained sandy loams with pH's of 6.5 to 7.5 (Morton 1987). Passionfruit is moderately intolerant of shade, requires trees, brush, or fences for support, and benefits from but does not require soil disturbance for reproduction. Wild plants are found in broken forests, stream-bottom galleries, fencerows, abandoned farms, and neglected city lots. Young plants are eaten by livestock, so passionfruit is almost never found in moderate to heavily grazed areas. A large number of insects, nematodes, fungi, and viruses attack the species (Morton 1987).

Reproduction.—The purple passionfruit blooms in spring and early summer and again for a shorter period in fall and early winter (Morton 1987).

Yellow passionfruit in Puerto Rico flower from April to September and yield fruits from June to October (Acevedo-Rodríguez 1985). In some areas, plants fruit twice each year (Popenoe 1920). Plants usually begin blooming and fruiting in their second year. Yellow passionfruit flowers have both male and female parts but are self-sterile. They rely mainly on carpenter bees (*Xylocopa* spp.) for pollination. Other insects and hummingbirds also visit the flowers. The flowers of purple passionfruit can self-pollinate (Morton 1987). Fruits of the naturalized yellow-fruited form range from about 45 to 120 g in Puerto Rico. There is a large variation between plants in size and shape of fruits. Small fruits are sometimes completely devoid of seeds, and large fruits may have over 200 seeds. A collection of seeds from naturalized plants in Puerto Rico averaged 0.0251 $\pm$ 0.0004 g/seed or 40,000 seeds/kg. Passionfruit is usually propagated from seeds but can be started from cuttings, layers, and grafts (Morton 1987). Seeds germinate best if allowed to ferment for a few days in the fruit pulp before cleaning and are lightly scarified by clipping or sandpapering (Morton 1987). A group of seeds in Puerto Rico were sown without pretreatment in commercial potting mix and began germinating in 14 days and completed germination in 24 days with 61 percent germinated. Plants are grown in beds or pots and transplanted when they reach about 25 cm in height. The seedlings are heavily watered after outplanting (Morton 1987). Seeds are disbursed in the wild by humans, animals especially pigs, and birds, and by vine extension.

Growth and Management.—Plants in fertile soil extend their stems about 3 m per year. Each year during the annual dry season, the leaves fall off and the twigs die, leaving the main stem and a few important branches alive to rebuild the crown after the rains begin. Because fruiting takes place on new wood, light pruning does not reduce yield. Plants live from 3 to 8 years and do not resprout. Commercial stands are managed in vineyards, somewhat like grapes. They are planted in trellised rows 4.5 m apart and spaced 4.5 m apart within rows. The orchards are replanted every 4 to 6 years (Bailey 1941). Alternately, vineyards may be established using small trees or bamboo as standards (Heenkenda and Punchikumarihami 1991). Fruiting plants can even be grown in pots under glass (Anonymous. 2001). Fruits fall after ripening on the vines and are picked up from the ground at least twice per week. The roots normally form mycorrhizal associations and benefit from inoculation with superior strains of fungi (Cavalcante and others 2001). Wild plants are usually scattered and attempts at management have not been reported.

Benefits.—By far the greatest benefit of passionfruit to humankind is its fruit and the delicious juice made from it. In addition to being collected by local people in the forests, the fruit is now grown in vineyards in dozens of countries. It is condensed, frozen, and shipped worldwide. The fruit pulp contains 2.2 percent protein, 0.7 percent fat, and 21.2 percent carbohydrates. In addition, the seeds contain 23 percent oil similar to sunflower or soybean oil, and the rind residue is used for cattle feed (Morton 1987). The fruits of native and naturalized stands furnish food for numerous species of wild mammals and birds. The whole plant, especially the leaves, contains alkaloids and a number of other phytoactive chemicals. Among these is passiflorine, a known sedative and tranquilizer (Morton 1987). Extracts of the leaves have been used for centuries as sedatives by native Brazilians. They prepare a drink from the flower to treat asthma, bronchitis, and whooping cough. The plant is also used as a diuretic to treat urinary infections (Rain-tree 2002).

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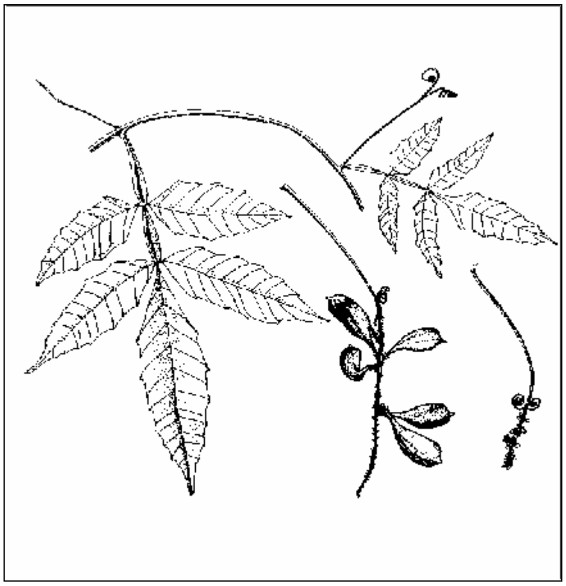
Paullinia pinnata L. bejuco de costilla
SAPINDACEAE

Synonyms: none

John K. Francis



General Description.—Bejuco de costilla is also known in Spanish-speaking areas as bejuco de paloma and bejuco de guajanilla and in English-speaking areas as supple jack. It is a stout and strong woody vine that forms mats in forest openings and ascends rocks and trees by means of forked tendrils to access full sunlight. It may reach 10 m of extension (Vélez and Overbeek 1950) and 12 cm or more of stem diameter. The name bejuco de costilla (rib vine) arises from the appearance of young stems. The young, green stems are angularly striated; the large, lower stems have a rounded triangular cross section. The plant is easily recognized from the leaves that have five serrated leaflets with prominent veins and a winged rachis and petiole. The fruits are red or dark pink when ripe (Acevedo-Rodriguez 1985, Howard 1989, Liogier 1994).

Range.—Bejuco de costilla is native to Cuba, Hispaniola, Puerto Rico, the Lesser Antilles, Trinadad, Central America, South America, and tropical Africa (Howard 1989, Liogier 1994).

Ecology.—Bejuco de costilla is found primarily in the moist (1000 to 2000 mm of annual rainfall) forests. It is also reported to occur in subtropical dry (less than 1000 mm precipitation) forest in Puerto Rico (Acevedo-Rodriguez 1985). Soils derived from limestone and other sedimentary rocks, and various igneous rocks at low and moderate elevations (below 400 m) are colonized. The species appears to be rare or absent from serpentine. It is present in both primary remnant and secondary forest stands.

Reproduction.—In Puerto Rico, the species blooms from June to November and fruits from July to December (Acevedo-Rodriguez 1985). The fruits are capsules that split in three valves when ripe to expose one to three black seeds partially covered by a white aril. A collection of fruits in Puerto Rico weighed 1.674 $\pm$ 0.0564 g. The fresh seeds recovered from those fruits weighed 0.150 $\pm$ 0.008 g and gave 5 percent germination. The seeds are recalcitrant (drying kills them). A later collection carefully protected from drying gave 100 percent germination. Germination is hypogenous. The seedlings grew rapidly and reached a maximum of 18 cm in 18 days after emergence. The seedlings quickly develop a deep and extensive tap and lateral root system. Moderate amounts of seed can be obtained by clipping the fruit clusters with a pruning pole and shelling out the seeds by hand. Seeds should not be picked up from the ground. Seed should be planted immediately or stored refrigerated in a closed plastic bag containing a moistened paper towel. Natural reproduction in forest stands is common to rare. Good survival and long life enable the species to maintain itself. More than one stem may arise from a horizontal root segment. Stems layer when they come in contact with the ground.

Growth and Management.—If needed for establishment during environmental restoration projects, containerized plants can be easily and quickly grown from seed. However, no planting projects are known. In forest management activity, it is more often desirable to eliminate vines than establish them. An effective method in closed forest stands is to cut the stems of vines near the ground a year before harvest. Although the vines resprout, most of the species, being shade intolerant, die or are seriously weakened and do not pose a serious threat to the reproduction stand. Herbicides can also be applied to the sprouts to make the method more effective, especially in more open stands. Bejuco de costilla is one of the alternate hosts of the tsetse flies (*Glossina palpalis* and *G. tachnioides*) and has become the target of eradication measures in some parts of tropical Africa (Morris 1944).

Benefits.—The stems of bejuco de costilla are used to make baskets. Ground leaves and seeds are used to stupefy fish and in preparing herbal remedies (Acevedo-Rodriguez 1985). The seeds and leaves of this species are poisonous to humans and are reported to have been used in arrow poisons (Liogier 1990). Aqueous extracts of bejuco de costilla from Africa demonstrated inhibitory effects against several important infectious organisms (Souza and others 1993). The white aril associated with the seed is reported to be edible (Vélez and Overbeek 1950).

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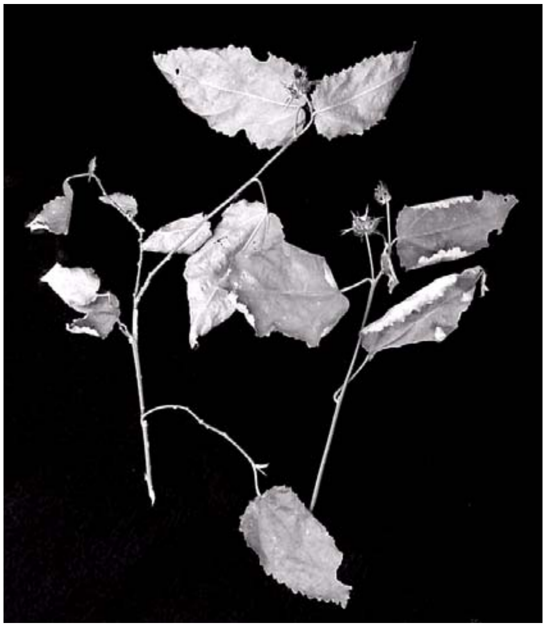
***Pavonia spinifex* (L.) Cav.** cadillo espinoso
MALVACEAE

Synonyms: *Hibiscus spinifex* L.
Malache spinifex (L.) Kuntze

John K. Francis



General Description.—Cadillo espinoso, also known as spiny abutilon, abutilon espinoso, mahot jaune, and coquelicot, is a suffruticose shrub usually 1 to 1.5 m in height, but occasionally reaching 5 m. The plant is supported by a shallow root system consisting of a weak taproot, lateral roots, and abundant fine roots. Older plants have multiple stems arising from the root crown and the lower 15 cm of stem. The plant dies back to the main stem or sometimes to the root crown during the dry season. The branches are slender and relatively few in number. The alternate leaves are ovate with rounded or cordate bases and pointed tips. The leaf blades are 4 to 12 cm long and have serrate edges. Bright, 2- to 3-cm yellow flowers are usually axillary and solitary and develop into fruits that are schizocarps, dividing into five mericarps. Each mericarp has three barbed spines, the central spine, the largest, being about 1 cm long (Howard 1989, Liogier 1994).

Range.—There is considerable confusion about the extent of the native range of cadillo espinoso. It is reported to be native from Bermuda through the West Indies and from Mexico to Peru and Argentina (Griffiths 1994, New York Botanical Garden 2002). Howard (1989) states that Southeastern United States and the West Indies are the only range; other claims are based on unsubstantiated reports or misidentifications of other species. Finally, Nelson (1996) refers to the populations in Florida as escapes from cultivation.

Ecology.—Cadillo espinoso grows in dry areas. It is found in Puerto Rico in habitat that receives from 750 to about 1100 mm of precipitation and at elevations from near sea level to about 600 m. The species grows in well-drained soils with a wide variety of textures and fertility levels. Cadillo espinoso is more common in areas of igneous rocks but does occur over limestone and other sedimentary rocks. Cadillo espinoso is moderately intolerant of shade. It grows in open areas but more frequently under low, open stands of small trees. The species competes well with tall grass, herbs, and brush, except on the most fertile sites where forest stands are dense. Probably because of competition, the plant is rarely found in bottoms and north slopes. Most of the areas where the species is common are recovering from past disturbance such as fire, severe overgrazing, or clearing. Cadillo espinoso tolerates all but the most severe grazing. It sprouts after fires. The species occurs as occasional plants or in mixture with other species, not as pure or dense stands.

Reproduction.—Cadillo espinoso flowers during the summer (July and August). Fruits mature at the start of the dry season (January-February) and are dispersed by sticking to the clothing or fur of animals. In addition to attaching directly from the shrub, fruits rest on the ground so that the central spine points up, so they may be picked up by the feet of passing animals. Seed production is reliable and moderately abundant. Air-dried fruits collected in Puerto Rico averaged 0.0258 ± 0.0005 g. Incubated in a plastic bag with moist peat, only 4 percent germinated in 10 months. Germination is epigeal.

Growth and Management.—Annual growth is rapid (about 1 m) from sprouts arising from established suffruticose plants. Growth begins during the early summer rains and continues through the fall rainy season. The leaves and branches dry out and die during the late winter-early spring dry season (in Puerto Rico). Individual plants probably live at least a decade. Except for the spiny fruits that cling to clothing, there seems to be little need to control cadillo espinosa in range or forest land. When necessary, the species probably could be controlled by spot spraying with broadleaf weed killer to eliminate individual plants. The development of a closed canopy forest eventually eliminates the shrub.

Benefits.—Cadillo espinoso is planted to a limited extent as an ornamental for its handsome yellow flowers. It contributes to the recovery of disturbed areas, furnishes cover for wildlife, and is eaten by grazing animals. In herbal medicine, infusions of the flowers are used to treat sore throats and skin problems, and infusions of leaves and twigs are used to treat stomach problems, gall stones, and liver pain (Liogier 1990).

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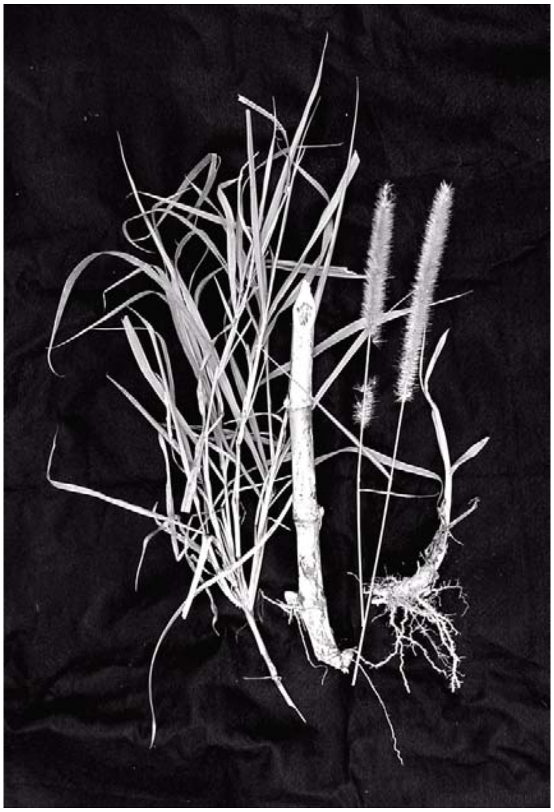
Pennisetum purpureum Schumacher elephant grass
POACEAE

Synonyms: none

John K. Francis



General Description.—Elephant grass is also known as napier grass, marker grass, Uganda grass, yerba elefante, capim elefante, herbe à elephants, fausse-cane à sucre, and a host of native African names (Burkill 1994, Holm and others 1977). The species is a robust grass with perennial stems. The plants produce short, creeping rhizomes 15 to 25 cm long with fine roots at the nodes and culms that are from 2 to 8 m in height, up to 2.5 cm in diameter at the base, and have a solid center. Older culms may branch several times. Leaf blades are 50 to 90 cm long and 1 to 3 cm wide, flat, and have a white midrib. Leaves of new, vigorous growth have wide, robust leaves; older culms have finer, narrow leaves. Leaf margins are rough (fine-toothed). The inflorescence is a compact, erect, bristly tawny or purplish spike 8 to 30 cm long and 1.5 to 3 cm wide. Spikelets are arranged around a hairy axis, and fall at maturity. The chromosome number is 2n = 27, 28, or 56 (Burkill 1994, Holm and others 1977, Long and Lakela 1971, Skerman and Riveros 1990).

Range.—Elephant grass is native throughout humid, tropical mainland Africa and the island of Bioko (Burkill 1994). It has been planted for forage and has naturalized in many tropical areas in Asia, the America's, and Oceania. It grows wild in the U.S. territories of Florida, Texas, California, Hawaii, Guam, American Samoa, Puerto Rico, and U.S. Virgin Islands (Natural Resource Conservation Service 2002, Pacific Island Ecosystems at Risk 2002).

Ecology.—Elephant grass will grow on poorly drained clay soils through the gamut of soil types to excessively drained sandy soils. Growth is best on rich, moist, well-drained medium-textured soils. Soil reaction should range from pH 4.5 to 8.2 (Center for New Crops and Plant Products 2002). Rainfall should be in excess of 1500 mm per year and temperatures for optimum growth should be from 25 to 40 °C (Skerman and Riveros 1990). In its native range, the species is a fire sub-climax to broadleaf tropical forest (Center for New Crops and Plant Products 2002). Elephant grass will grow in light shade but is does not survive under a closed tree canopy. In turn, it will suppress most grasses, herbs, and tree seedlings. A frost will kill the above-ground parts, but the soil must be frozen to kill the rhizomes (Center for New Crops and Plant Products 2002).

Reproduction.—Flowering takes place mainly in the fall and winter (Long and Lakela 1971, Holm and others 1977). Because of asynchrony of male and female flower parts, the plant relies on cross-pollination by wind. Elephant grass is an inconsistent seed producer and rarely develops seeds in some habitats. When seeds are produced, they are often of low viability (Holm and others 1977). About 3.8 million seeds per kg were reported for a United States source (Skerman and Riveros 1990). A collection of seeds from Puerto Rico numbered 1.78 million per kg (author's observation). The seeds are wind-dispersed.

Colonization of new habitats is slow (Skerman and Riveros 1990).

Growth and Management.—The growth of culms is vertical continually, but their weight bends them in the middle and lower part, causing a j-shaped habit. As the lower stem makes contact with moist soil, it roots at every node. Individual culms live more than 1 year, and by layering, they can continue until disturbed or a barrier is reached. New plantations are established by planting stem pieces with at least three nodes or with root cuttings (Skerman and Riveros 1990). In an agricultural research plot in Puerto Rico, elephant grass reached the height of 4 m in 3 months (Barrett 1925). The record yield for heavily fertilized elephant grass is 84,800 kg/ha/yr (Skerman and Riveros 1990). Not-withstanding its value as forage, elephant grass has become one of the worst weeds in the tropics because of the difficulty of controlling it in croplands and fallow areas. Cultivation alone is usually insufficient to control it in croplands (Skerman and Riveros 1990). Frequent mowing will cause it to be replaced by other grasses. The herbicide glyphosate provides acceptable control in at least aquatic sites (McCann and others 1996).

Benefits.—Elephant grass makes up the bulk of the diet of forest elephants in West Cameroon (Tchamba and Seme 1993). The species is an important forage and pasture grass in its native Africa and throughout the Tropics, especially for cattle. It is also cut for hay and fermented for silage. A number of forage samples of different ages of grass from several countries varied from 4 to 15 percent in crude protein, from 28 to 40 percent in crude fiber, from 10 to 16 percent in ash, from 0.9 to 3.8 percent in fat, and from 39 to 49 percent in nitrogen-free extract (Skerman and Riveros 1990). The species has been employed successfully using sown cuttings to replace *Imperata* swards in the Phillippines (Agus and others 1996, Skerman and Riveros 1990). It is planted as hedgerows for erosion protection and forage production in the alley cropping system of agroforestry (Magcale-Macandog and others 1998, Menz and others 1999). The plant is also effective as a windbreak for agricultural crops (Karschon and Heth 1958). Lines of plants are used to mark boundaries between plots and properties. Elephant grass is planted on riverbanks to prevent erosion. In Africa, the plant is used for thatch, and the thick culms are made into fences, screens, and reinforcement for mud huts. The young leaves and young shoots are eaten in soups and stews (Burkill 1994). Elephant grass is used for mulch in East Africa where a 25-cm depth of mulch is needed for good weed control (Nishimoto 1994). Extracts of the plant are strongly diuretic and are used for that purpose in Africa. It is also used in a number of other herbal remedies (Burkill 1994). The seeds are eaten by many bird species. However, because of the aggressive spread of the species, it is a menace to native vegetation in the Galapagos Islands (Mauchamp 1997) and at the margins of swamps and streams in Florida (Miami-Dade County 2002).

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***Penstemon ambiguus* Torr.** sand penstemon
SCROPHULARIACEAE

Synonym: *Leiostemon ambiguus* (Torr.) Greene

James E. Nellessen

General Description.—Sand penstemon is also known by the names bush penstemon, prairie or pink plains penstemon, moth penstemon, gilia penstemon, phlox penstemon, and cow-tobacco. This species occurs in sandy soils of plains, and mesas, and somewhat hilly terrain. The plant generally ranges from 20 to 60 cm in height, sometimes to 1 m, is highly branched, the stems are slightly hairy, and become distinctly woody well above the bases. Leaves are simple, linear, opposite, 6 to 30 mm long, enrolled, smooth to slightly hairy, with slightly rough edges (Carter 1997, Epple 1995, Great Plains Flora Association 1986, Kearney and others 1951, Martin and Hutchins 1981). There are two recognized varieties: *P. ambiguus* var. *ambiguus* and *P. ambiguus* var. *laevissimus* (Keck) N. Holmgren (Kartesz 1994, Allred 2002). Both varieties have also been classified as subspecies. Variety *laevissimus* differs from the typical in that it has smooth stems, with the leaf edges smooth or very slightly rough. The chromosome number is reported as n = 8, which is common to many members of this genus (Nisbet and Jackson 1960).

Range.—This species occurs from eastern Colorado, western Kansas, Oklahoma, and Texas, through eastern and central New Mexico, then west into Arizona, Utah, and Nevada, at elevations from about 850 m to 2,000 m. Variety *ambiguus* occurs in the northern and eastern portions of this range while variety *laevissimus* occurs in the southern and western portions of this range.

Ecology.—Sand penstemon occurs on alluvial plains, valleys, and in sandy hill country. It is considered one of the major shrub species comprising Plains-Mesa Sand Scrub vegetation that occurs along drainages of the Rio Grande, Pecos River, San Juan River, and areas within the Llano Estacado ("staked" plains) of western Texas and eastern New Mexico (Dick-Peddie 1993). It is common in the Painted Desert of Arizona (Kearney and others 1951). A couple of hybrid swarms between *P. ambiguus* and *P. thurberi* Torr. (*P. ambiguus* x *thurberi* Nisbet and Jackson) are known from: 1) an area near Magdalena, Socorro County, and 2) another near Carrizozo, Lincoln County, both in New Mexico (Nisbet and Jackson 1960). *P. thurberi* has a similar shrubby habit and occurs in sandy soils. Hybrids have shown a wide range of characteristics between the two species. Although generally considered a separate species, *P. thurberi* has also been classified as a variety of *P. ambiguus* (*P. ambiguus* Torr. var. *thurberi* Gray).

Biochemical Ecology.—Several iridoid glucosides have been isolated and identified from sand penstemon: catalpol, speciocide, nemoroside, ambiguuside; as well as two phenylpropanoid glycosides: verbascoside and martynoside (Arslanian and others 1990). Iridoids are a group of bitter tasting terpenoid toxins also referred to as monoterpene lactones (Harborne 1988). These compounds may be toxic to birds and insects, hence functioning as a chemical defense against herbivory.

Reproduction.—Each plant has numerous many-flowered inflorescences, and each inflorescence is narrow, with one to two flowers per peduncle, the flowers spreading. The calyx is 2 to 3 mm long, the corolla 15 to 25 mm long, pale to deep pink, the five corolla lobes whitish, the upper ones reflexed at an oblique angle to the tube, the lower one projecting forward, making it distinctive from most other penstemons. The opening of the tube is bearded with short hairs, in two prominent guidelines at the base of the throat (Nisbet and Jackson 1960, Martin and Hutchins 1981, Carter

1997). The sterile stamen (staminode) is beardless (hairless), a feature different from most penstemons (beardtongues), hence the alternate genus name *Leiostemon*, leio meaning smooth and stemon for stamen (Kirkpatrick 1992, Weber and Wittman 2001). It blooms from May to as late as October, depending on local environmental conditions, although mass blooming generally occurs from June through July. The hybrid, *P. ambiguus* x *thurberi* has smaller corollas, 12 to 15 mm long, corolla lobes white to blue-purple, the throat and tube pale pink to deep reddish purple. The fruit is a capsule from 5 to 10 mm long that contains many very small (1.2 to 2 mm) seeds. Seed germination characteristics (for example, the amount of cold stratification) vary as a function of the elevation of the source population (Meyer and others 1995). Sand penstemon seeds have a physiological dormancy requiring 8 to 15 weeks of cold stratification before germination will occur (Kitchen and Meyer 1991, Baskin and Baskin 2001).

Growth and Management.—Seedlings take a few years becoming established before this long-lived plant becomes larger and more conspicuous in the landscape. Only a few flowers may be produced the first year of blooming, before the plant gains enough mass and root reserves for the large floral displays that make this plant so characteristic.

Benefits.—Since this species' typical habitat is in sandy, unstable type soils, it acts as a soil stabilizer. Because of its conspicuous and colorful floral displays, it is a welcome addition to habitats that might otherwise appear drab. This is an attractive plant for native plant landscaping (Morrow 1995, Warnock 1974), and in full bloom with the numerous stems and flowers per stem, it makes for an attractive display of pink bouquets.

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***Philadelphus lewisii* Pursh** Lewis mock orange
HYDRANGEACEAE

Synonyms: *Philadelphus gordonianus* Lindl.
Philadelphus cordatus Petz. & Kirchn.
Philadelphus grahami Petz. & Kirchn.
Philadelphus columbianus Koehne

Nancy L. Shaw

Illustration credits: E.G. Hurd, and Hitchcock and others 1961

General Description.—Lewis mock orange, also known as Indian arrowwood, Lewis syringa, mock orange, syringa, or western syringa, was named for Captain Meriwether Lewis, the famous Western explorer, who made the first collection of the species in 1806. The state flower of Idaho, Lewis mock orange is a long-lived and highly variable deciduous species, ranging from densely branched and rounded to erect, open shrubs 1.5 to 2.5 m in height. Clusters of arching stems develop on older specimens. Bark on young branches is red to chestnut brown, turning gray and exfoliating with age. Leaves are 2 to 8 cm long and 1 to 4 cm wide, opposite, and ovate to oblong with acute to acuminate tips. Terminal cymes of showy, perfect, four-merous, fragrant white flowers develop on lateral branches. The fruit is a woody, four-celled capsule containing numerous tiny, fusiform seeds (Hitchcock and others 1961, Welsh and others 1987).

Range.—Lewis mock orange is distributed from British Columbia south to northern California and east to southwestern Alberta and western Montana. It is most common at mid-elevations but grows from near sea level to 2,100 m (USDA Forest Service 1937). Lewis mock orange exhibits wide ecological amplitude, growing in communities ranging from *Pseudotsuga menziesii* (Mirbel) Franco and *Sequoia sempervirens* (Lamb. ex D. Don) Endl. to *Artemisia* L., chaparral, and *Pinus contorta* Dougl. ex Loud and *Pinus ponderosa* P. & C. Lawson.

Ecology.—Lewis mock orange grows on soils ranging from dry, rocky, gravelly loams on open hillsides, to well-drained deep, rich alluvial loams near riparian zones (USDA Forest Service 1937). It is found in early to late seral as well as in climax communities. It occurs as small thickets, isolated plants, or in association with other shrubs on talus slopes, cliffs, canyons, or rocky hillsides and in transition zones of riparian areas (Hitchcock and others 1961, Hopkins and Kovalchik 1983). It is most common on northern and eastern exposures (USDA Forest Service 1937). The species is classified as fire resistant because it resprouts from the root crown following burning. It also regenerates from seeds that accumulate in the soil seed bank (Kramer and Johnson 1987). Lewis mock orange exhibits moderate drought and shade tolerance.

Reproduction.—Lewis mock orange flowers in late spring to early summer. Capsules mature in late summer and dehisce in September or October. Seeds are dispersed by wind and gravity. They are harvested by hand-stripping the capsules before the valves begin to open. Dried capsules are crushed to release the seeds, and trash is removed with an aspirator or fanning mill. There are 7,716,000 to 17,637,000 seeds/kg of clean seed (Stickney and others 2001), but seed fill is often low. Seed may be stored in airtight containers for up to 1 year. Wet prechilling for 8 weeks at 5 °C is required to release embryo dormancy (Stickney and others 2001). Intermittent exposure to light may be required for germination. Seeds may be broadcast seeded on a rough seedbed and covered using a Brillion seeder or similar device. They may also be spot seeded in selected, prepared areas that are well-drained and free of herbaceous competition. Seeds may be mixed with other shrub seeds that require shallow or surface planting. Bareroot stock may be produced by fall seeding or by seeding moist, prechilled seeds in spring. Seedlings develop rapidly and can be transplanted as 1-year-old stock (Stickney and others 2001). Container stock is grown from seed or propagated from hardwood or softwood cuttings (Marchant and Sherlock 1984). Rooted suckers and crown divisions are also used.

Growth and Management.—Lewis mock orange seedlings establish well on a wide variety of soils but should be protected from competition and browsing. Plants grow at a moderate rate, flower reliably, and are generally free of insect and disease problems. Seedlings, however, are sometimes susceptible to damping off. Plants grown from seed may begin flowering in the second or third year (Everett 1957). Flowers are produced on twigs of the previous year; hence, landscape plants should be pruned after flowering.

Benefits.—Seedlings or larger planting stock of Lewis mock orange are transplanted into steep, rocky, unstable slopes where they provide soil stabilization and vegetative cover. The species is also useful in transitional areas of degraded riparian zones. Lewis mock orange is usually not grazed heavily by livestock, but in some areas it does receive fair amounts of use by cattle (*Bos* spp. L.) and sheep (*Ovis* spp. L.) (Leege 1968, USDA Forest Service 1937). It frequently occurs with other species that are more palatable to big game, and consequently, it may receive little use, except under severe conditions. However, it can provide good browse for deer (*Odocoileus* spp. Rafinesque) and elk (*Cervus canadensis* Erxleben), especially on winter ranges (Kufeld 1973, Leege 1968, Marchant and Sherlock 1984, USDA Forest Service 1937). New growth is generally highly palatable to big game (Leege 1968). The species provides food and cover for birds and other small animals. Lewis mock orange is a valued landscape species because of its showy, white flowers. It is used in borders, screens, hedges, and as specimen plants (Marchant and Sherlock 1984). Several commercial cultivars of Lewis mock orange have been developed. The flowers are used in preparing perfumes and teas (Taylor 1972). Native Americans made arrow shafts from the long woody shoots (USDA Forest Service 1937).

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***Philadelphus microphyllus* Gray** littleleaf mock orange

HYDRANGEACEAE

Synonyms: *Philadelphus occidentalis* A. Nels.
Philadelphus argenteus Rydb.
Philadelphus minutus Rydb.
Philadelphus nitidis A. Nels.
Philadelphus stramineus Rydb.

Nancy L. Shaw

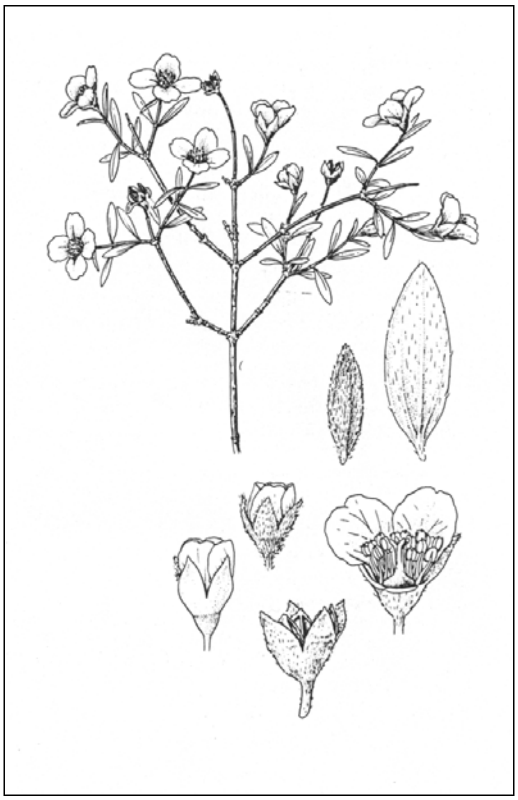

Illustration source: Cronquist and others 1997

General Description.—Littleleaf mock orange, also known as desert mock orange, is a small, rounded, multistemmed shrub 0.9 to 2.1 m tall with a crown diameter of about 1.2 m. New woody growth is strigose, while bark of mature stems is gray to yellowish and exfoliating. Some stems may be subspinose. Leaves are opposite, entire, short petiolate, 8 to 25 mm long, 2 to 13 mm wide, elliptic to lanceolate or linear, and sometimes revolute. Flowers are solitary or in clusters of three at the ends of branches produced the previous year. They are showy, white or creamy, fragrant, and four-merous with numerous stamens. Fruits are four-chambered loculicidal capsules containing numerous black, short-caudate seeds. The chromosome number is 2n = 26 (Cronquist and others 1997, Hickman 1993, Munz and Keck 1973, Welsh and others 1987).

Range.—Littleleaf mock orange is distributed from southern California east into southern and central Nevada; most of Utah; southwestern Wyoming; western, central, and southern California; Arizona; New Mexico; central Texas; and central Mexico (Cronquist and others 1997). The species exhibits considerable morphological variability and has been subdivided into a number of species or subspecific taxa by various authors.

Ecology.—Littleleaf mock orange grows in *Pinus* spp. L.-*Juniperus* spp. L., *Quercus* spp. L., mountain brush, *Populus tremuloides* Michx., *Pinus contorta* Dougl. ex Loud., *Pseudotsuga menziesii* (Mirb.) Franco, and *Abies concolor* Lindl. communities at elevations from 1,200 to 3,100 m (Cronquist and others 1997, Hitchcock 1943, Welsh and others 1987). A drought-tolerant species, it is often found growing in cracks or fissures in rocky surfaces and in other dry, sandy, gravelly, or rocky areas.

Reproduction.—Plants flower in May to September depending upon location. The capsules mature in late summer. Mature capsules are harvested by hand just after they have begun to dehisce. Dried capsules are crushed with a barley debearder to permit seed extraction. Seed is separated from debris using an aspirator or air-screen machine. Littleleaf mock orange is readily propagated from seed (Sutton and Johnson 1974, Swingle 1939). Germination of a New Mexico seed collection was 12 times greater when incubated at 15 compared to 20/10 °C (8 hrs/16 hrs) for 28 days (Stickney and others 2001). Germination was improved by a 28-day moist prechill at 3 to 5 °C when seeds were subsequently incubated at 20/10 °C, but not at 15 °C. Germination is epigeal.

Growth and Management.—Little data are available on the propagation of littleleaf mock orange, but species of the genus *Philadelphus* are generally easily propagated from softwood or hardwood cuttings, rooted suckers, divisions, or layers (Hartmann and others 1990, Macdonald 1986). Littleleaf mock orange is easily transplanted (Sutton and Johnson 1974). Seeds of *Philadelphus* spp. are tiny and may be broadcast seeded on a rough seedbed and covered lightly or spot seeded on prepared seedbeds (Stevens and others, in press). Seeds may also be surface-planted using a Brillion or similar seeder. Best results are obtained if seeds are planted in well-drained sites free of herbaceous competition. Seeds may be mixed with other shrub seeds that require surface or shallow planting. Growth of littleleaf mock orange is moderate to rapid (Sutton and Johnson 1974).

Benefits.—Littleleaf mock orange provides good cover for small animals. It is used to some extent by mule deer (*Odocoileus hemionus* Rafinesque) (Patton and Ertl 1982). Although the species receives little use in revegetation, it has potential for planting on disturbances on steep, rocky, unstable slopes within its native range (Stevens and others, in press). Seedlings or larger stock are recommended for such use. The species might also be used to advantage in drier areas of degraded riparian zones. Littleleaf mock orange is an attractive ornamental because of its showy flowers and fall coloration. It was first cultivated in 1883 (Rehder 1940). It can be used in borders, screens, hedges, or as isolated specimens in sunny areas. It can also be used for low maintenance landscaping and in recreational area plantings. The small seeds were eaten by Native Americans (Cronquist and others 1997).

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Phoradendron quadrangulare **(Kunth) Griseb.** guacimilla de canario
VISCACEAE (sometimes placed in LORANTHACEAE)

Synonyms: *Phoradendron randiae* (Bello) Britt.
Loranthus quadrangularis Kunth in Humb.
Viscum quadrangulare (Kunth) DC.
Phoradendron rubrum sensu Griseb.
Viscum trigonum D. Dietr.

John K. Francis

General Description.—Guacimilla de canario is an evergreen, epiparasitic shrub that obtains water, minerals, and support from its tree hosts and produces stems up to 1 m long and 1 cm thick. The woody stems are much branched, brown, and lightly furrowed in their lower parts with a swelling at the point of attachment to the host. The bark of branches and twigs is green. The young branches especially are square or rhombic in cross section. The stem wood is light-colored and brittle. The dull green leaves have a leathery-fleshy texture. They are linear, lanciolate, or oblanciolate with a tapered base and acute to obtuse apex. Inflorescences are small spikes, one to three in number at the leaf axils, and support small flowers. The yellow, globose fruits are 3 to 4 mm in diameter (Howard 1988, Liogier 1985). However, fruits in Costa Rica range from pale yellow to red-orange (Missouri Botanical Garden 2002). Within the pigmented skin is a layer of sticky jelly and a flat, green seed with longitudinal striations (author's observations).

Range.—Guacimilla de canario is native to Central America, South America, and the West Indies (Howard 1988, Liogier 1985).

Ecology.—Guacimilla de canario colonizes a number of tree species, especially *Guazuma ulmifolia* Lam. in Puerto Rico (author's observation). The former species, as well as *Amphitecna latifolia* (Mill.) A.H. Gentry, *Cordia stellifera* I.M. Johst., *Erythrina* sp., *Malvaviscus arboreus* Cav., and *Persea Americana* Miller, are mentioned as hosts in a Costa Rican herbarium collection (Missouri Botanical Garden 2002). Most of the guacimilla de canario plants occur in the mid-crown of the affected trees. After the parasite becomes general throughout a tree crown (a process that takes many years), trees are weakened and sometimes die as a result. More often, parasitized trees die of other causes or old age before they succumb to the parasite. Trees in forest, rangeland, farmland, roadside, and cities are attacked. Guacimilla de canario grows at lower and middle elevations in Puerto Rico (Liogier 1985), that is, from sea level to about 600 m. These areas range from 750 to about 2400 mm of annual precipitation. In Ecuador, the plant may be found from near sea level to 1,000 m in elevation (Jorgensen and León-Yánez 1999).

Reproduction.—Fruits collected in Puerto Rico weighed an average of 0.0294 $\pm$ 0.0004 g/fruit. Seeds cleaned from those fruits weighed (air-dried) an average of 0.0017 $\pm$ 0.0000 g/seed or 600,000 seeds/kg. Sown without any pretreatment on moist filter paper, 59 percent germinated within 35 days of sowing. After 4 days, mesoscopic roots emerged followed at 17 days by a shoot that extended hypogenally (author's observation). Birds transport the seeds (the fruits are sticky and adhere to their feet or beaks) to new trees or stands. After fruits stuck to the bark of a suitable host tree, they require a rainy period long enough to allow the roots of the germinating seed to penetrate the phloem of the host, or the seed or plantlet will desiccate. Once established in a new tree, the guacimilla de canario spreads by seeds within the crown of the host tree. It does not spread vegetatively.

Growth and Management.—The growth rate of guacimilla de canario is not known. Although it is a parasite and does harm its hosts, the plant takes many years to become sufficiently abundant to seriously weaken a host tree. *Guazuma ulmifolia* and most of the other hosts are not used as ornamentals and are not commercially valuable. If control is desired, probably the best method is to clip the guacimilla de canario plants from the limbs each year or until they die. This will prevent it from bearing fruit and spreading within the tree. Alternately, one may prune out the infected limbs of the parasitized tree.

Benefits and Detriments.—Guacimilla de canario contributes in a minor way to biodiversity, to tree canopy density, and to biomass production. It furnishes fruits for wildlife food. On the other hand, a few trees/km^2 are attacked, some are weakened, and an occasional tree dies as a result. Parasitized trees are often unsightly.

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***Phragmites australis* (Cav.) Trin. ex Steud.** common reed
POACEAE

Synonyms: *Phragmites communis* Trin.
Phragmites phragmites (L.) Karst.

John K. Francis

Drawing source: Britton and Brown 1913

General Description.—Common reed is also known as giant reed, giant reedgrass, roseau, roseau cane, yellow cane, and cane (Uchytil 1992). It is a shrub or perennial woody graminoid herb that grows annually from woody rhizomes to heights of 2 to 4 m (occasionally to 6 m). The normally unbranched, hollow, jointed stems (culms) reach nearly 2.5 cm in diameter but usually measure 1.0 to 1.5 cm in diameter. In addition to rhizomes, plants occasionally produce stolons. Alternate leaves are glabrous except for being strongly scabrous at the margins. They are flat, 1 to 5 cm wide, and up to 50 cm long. Terminal plume-like panicles are 15 to 50 cm long with branches ascending to nodding and densely flowered. The panicles are initially grayish purple, becoming whitish, and finally weathering to light brown. There are 2n = 36, 48, and 54 chromosomes (Duke 1998, Gould 1975, Harrington 1964, Uchytil 1992, Welsh and others 1987).

Range.—Common reed occurs in every state in the Continental United States except Arkansas (probably present but undocumented), in Puerto Rico (Natural Resources Conservation Service 2003), southern Canada, and Mexico. In fact it is found on all continents except Antarctica (Harrington 1964). It is native to the United States and is known from the archeological record. However, genetic analysis has shown that more aggressive European genotypes have replaced the native genotype in much of the former American range and have invaded new areas (Blossey 2002).

Ecology.—Common reed is a warm-season grass that starts its growth after the last frost has occurred but remains green until frost in temperate areas (Uchytil 1992). Wide climatic tolerance is indicated by its range that stretches from the tropics to cold temperate areas and habitat from sea level to elevations of at least 1,980 m (Harrington 1964, Welsh and others 1987). Common reed typically forms pure stands that contain up to 205 stems/m^2 (Uchytil 1992). In Gulf Coast marshes, it is often codominant with *Spartina cynosuroides* (L.) Roth. (Duke 1998). The species grows on the shores of streams and lakes, and in marshes, both fresh and brackish. Although common reed grows best in clay, it occurs in a wide variety of soils. The species tolerates flooding, frost, high pH, salt, and weeds (Duke 1998). Stands in the Nile River Delta tolerate soil pH's of 7.0 to 9.3 (Serag 1996). Standing dead material often totals twice as much biomass as current growth, allowing stands to burn even during the growing season. New stands arise from rhizomes that are under the soil or water. The species also tolerates late season drought (author, personal observation). Moderately deep rooting (to 1 m, Uchytil 1992) undoubtedly imparts drought resistance. A large number of fungal species and at least one nematode have been isolated from the species, none of which cause extensive damage (Duke 1998).

Reproduction.—Common reed blooms mostly from July through November (Diggs and others 1999). It apparently blooms and fruits throughout the year in frost-free areas (Gould 1975). Under favorable artificial conditions, germination begins 1 day after sowing and may reach nearly 100 percent (Ekstam and Forseby 1999). Although common reed is a relatively good seed producer and seeds are added annually to the soil seed bank, successful seedling establishment is rare (Uchytil 1992). New stands can also be started by flood-borne pieces of rhizome. Once a new plant is established, it spreads by vegetative means.

Growth and Management.—Because stems are renewed each growing season, annual height growth is from 2 to 4 m per year. Growth can reach 4 cm/day. In southern Manitoba, stems reach their full height by the end of July (Uchytil 1992). During periods of falling water, colonies can increase in width by as much as 15 m in a single season (Fewless 2003). Annual productivity ranges from 7.5 to 63 metric tons/ha (Duke 1998). If harvested during the dormant season, productivity is not affected, except through compaction. New stands are established by planting rhizome segments (Duke 1998). This is normally not recommended because of the invasive nature of the species. Eliminating stands is difficult. The best approaches are heavy grazing by cattle, and spraying with amatrol, dalapon, or glyphosate with follow-up treatments. Stands can be degraded by cultivation or summer mowing (Uchytil 1992).

Benefits and Detriments.—Common reed aggressively colonizes large areas of shoreline and shallow marsh, and with its thick sod and heavy stand of stems effectively prevents wave- and current-caused erosion (Uchytil 1992). It also traps sediment and pollutants. In fact the species has been used to aid in settling and drying sewage sludge (Graduate College of Marine Studies 2003). The dense single-species stands completely displace other native marsh communities (Fewless 2003) and many of the fauna they support (Weinstein and Balletto 1999). On the other hand, strong declines in populations in many European countries have occurred during the last two decades (Clevering 1998). Native Americans used the sap from green stems to loosen phlegm and sooth lung pain, especially during pneumonia, and to treat stomach problems and diarrhea (Moerman 1986). There are numerous other applications in herbal medicine throughout the world. The stems were used as arrow shafts by Native Americans (Duke 1998). Native people of Tasmania used the hollow stems to make rafts, jewelry, baskets, and light spears (Australian National Botanic Gardens 2003). Common reeds are harvested today in Britain for thatching (Tyler-Walters 2002). They were once harvested for fuel where better sources were unavailable and may hold promise as an energy crop in the future. Stands yield 415 calories/100g (Duke 1998). Early in the growing season, common reed is high-quality forage for cattle and horses and may be cut for hay. It contains 11.4 percent protein, 2.3 percent fat, 42.1 percent carbohydrates, 31.1 percent crude fiber, and 10.8 percent ash (Duke 1998). It becomes woody and unpalatable later in the season. The seeds are eaten by waterfowl and the roots are eaten by muskrats. The edges are occasionally used for nesting by ducks and the interior of the stands are nesting habitat for snowy egrets, black-crowned night herons, and yellow-headed blackbirds. A few species such as deer use the stands for escape cover (Uchytl 1992). It is important habitat for wildlife in Britain and supports such species as the bittern, the reed bunting, and the marsh harrier (Tyler-Walters 2002). Throughout the world the stems have been used for building materials, lattice work, baskets, and mats. The young shoots and rhizomes are sometimes eaten, and the rhizomes processed for starch. The stems are processed into pulp, paper, and fiberboards. Stalks contain over 50 percent cellulose and have fibers 0.8 to 3.0 mm long by 5.0 to 30.5 μm in diameter. The dried plumes are used for decorations and a variegated variety is employed as an ornamental (Duke 1998).

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Physocarpus malvaceus **(Greene) Kuntze** mallow ninebark
ROSACEAE

Synonyms: *Spiraea oputifolia* var. *pauciflora* Torr. & Gray
Neillia malvaceae Greene
Opulaster malvaceus Kuntze
Physocarpus pauciflorus Piper

John K. Francis

General Description.—Mallow ninebark, also known as ninebark, mallow-leaved ninebark, mountain ninebark, few-flowered ninebark, and shallow ninebark, is a multistemmed, deciduous shrub 1 to 2 m (rarely 3 m) in height. The stems and branches are slender and covered with a brown bark that exfoliates in papery strips on older branches. The 3- to 5-cm, alternate leaves are round to ovate, three to five lobed, and doubly serrate or crenate. The petioles are 1 to 2 cm long. Inflorescences are terminal, corymbose with five to 30 flowers. The hypanthium of the flowers is stellate-pubescent; twigs, petioles, and leaf blades vary from pubescent to glabrous. The flowers have five sepals and five white, rounded petals 3.5 to 6.5 mm long. Each produces two inflated, brown follicles united for two-thirds their length. Each fruit may contain one to several shiny, pair-shaped, straw-colored seeds (Abrams 1950, Welsh and others 1987).

Range.—Mallow ninebark is native to British Columbia, Alberta, Washington, Oregon, Idaho, Montana, Wyoming, Colorado, Utah, and Nevada (Abrams 1950, Natural Resources Conservation Service 2003). It is not known to have naturalized outside its native range.

Ecology.—Mallow ninebark grows on a wide variety of soils derived from igneous, metamorphic, and calcareous and noncalcareous sedimentary rocks. Textures range from sandy loams to silty clay loams and surface pH ranges from 5.5 to 7.1. In Idaho and Montana, the average duff layer thickness was 6.5 cm with an effective rooting depth of 38 cm. In northern areas, mallow ninebark is found mainly in areas with no exposed rock on mountain slopes, ridges, and streambanks (Habeck 2003); in Utah, it often grows in skeletal soils and rubble in steep canyons and mountainsides. It occurs at elevations of 1,600 to 3,300 m at the southern end of its Utah range (Welsh and others 1987) and at somewhat lower elevations farther north. The species is associated with *Abies lasiocarpa* (Hook.) Nutt., *Abies grandis* (Dougl. ex D. Don) Lindl., and *Picea engelmannii* Perry ex Engelm. in cool/moist habitat and with *Pseudotsuga menziesii* (Marbel) Franco and *Pinus ponderosa* P. & C. Lawson in warmer, moist sites (Habeck 2003). While associated with these trees, mallow ninebark usually grows in disturbance-caused openings or diffuse stands. It also grows on nonforested shrubland sites. Some common shrub associates are *Holodiscus discolor* (Pursh) Maxim., *Symphoricarpos albus* (L.) Blake, *Symphoricarpos oreophilis* Gray, *Spirea butilifolia* Pallas, *Amelanchier alnifolia* (Nutt.) Nutt. ex M. Roemer, and *Mahonia repens* (Lindl.) G. Don (Habeck 2003). Mallow ninebark is fire resistant, sprouting after topkill from surviving root crowns or horizontal rhizomes (Palouse Prairie Foundation 2003). Having 36 to 99 percent of its roots buried in mineral soil enables it to escape the heat of surface fires (Habeck 2003). Mallow ninebark stands often owe their existence to logging or fires. The species is an obligate pioneer that increases and grows rapidly following disturbance, but as competition, particularly overhead shade, increased, it decreases in mean height and gradually disappears (Habeck 2003). The species is generally free of insect and disease problems, although it is occasionally attacked by foliage-eating and seed-eating insects (Youngblood and others 2003).

Reproduction.—Flowering takes place between late May and late July, depending on altitude, and fruits ripen between late August and late September (Habeck 2003). Seed weights are reported (geographic source unspecified) at 165,000 seeds/kg (Youngblood and others 2003). Seeds collected by the author in Utah averaged 158,000 seeds/kg. Viability is usually less than 50 percent (Youngblood and others 2003). The fruits split open at maturity but most of the seeds do not immediately fall. Dispersal is by gravity, wind, and probably by browsing animals. Seeds in the soil seedbank are reported to be 11 percent viable and will germinate when the surface is scarified (Habeck 2003). Ripe fruits can be picked by hand or beaten off shrubs onto a tarp. Fruits may be threshed by rubbing for small quantities or passed through a hammer mill for larger quantities and screened and blown to clean them. They may be stored cool and dry for at least 5 years. Seeds may be sown in the fall, or in the spring after 30 days of prechilling. Seeds should be sown to a depth of 3 mm and mulched with another 6 mm of sawdust (Youngblood and others 2003). Mallow ninebark can easily be vegetatively reproduced with misted softwood cuttings or by planting hardwood cuttings directly in the field (Youngblood and others 2003).

Growth and Management.—Mallow ninebark shrubs in northern Idaho reached their maximum height by the fourth growing season after a fire (Habeck 2003). Although stems are added and lost continuously, shrubs do not grow taller. Individual plants may live for many years if growing conditions permit. Mallow ninebark is sometimes planted for soil stabilization and other conservation objectives. Killing the shrubs to make room for more desirable species is sometimes attempted. Several herbicides can be effective if sprayed early in the season from late foliar development to flowering or in early fall before leaves change color. Sprouts will sometimes appear later and will have to be sprayed again (Habeck 2003).

Benefits.—Mallow ninebark helps protect the soil during secondary succession until the shrub is replaced by taller vegetation. It adds beauty to forest openings and shrublands when its leaves turn russet-red in the fall (Clark 1976). The species provides cover for both large and small animals. It is one of the principal nesting sites of the dusky flycatcher (*Empidonax oberholseri*) (Sedgwick 1993). The shrub is not browsed by cattle and is utilized only to a limited extent by deer, bighorn sheep, and domestic sheep. The upper third of the annual growth of plants from a burned area contained 1.3 percent N, 0.3 percent P, and 1.2 percent Ca. Plants in an unburned site contained even lower levels (Habeck 2003). Early summer sheep grazing increases the nutritional quality of mallow ninebark for fall and winter browse (Alpe and others 1999).

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***Picramnia pentandra* Sw.** Florida bitterbush

SIMAROUBACEAE

Synonyms: *Tariri pentandra* (Sw.) Baill.
Picramnia antidesmoides Griseb.
Picramnia cubensis Turcz.
Picramnia micrantha Tulasne
Picramnia oblongifolia Turcz.

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General Description.—Florida bitterbush is also known as bitterbush, doctor-bar, wild-coffee, guarema, hueso, aguedita, palo de peje, palo de paz, roble agalla, quina del país, bois poison, vaillant garcon, and bois montagne. It is an evergreen shrub or small tree usually less than 6 m in height and 10 cm in stem diameter. The plant usually has a single slender stem with smooth, gray bark and relatively few, slender branches. The inner bark is brown. The wood is light colored, hard, and heavy. The inner bark, roots, leaves, fruits, and seeds have a strongly bitter taste. The alternate, compound leaves are 10 to 30 cm long and contain five to nine, usually seven, 5- to 10-cm leaflets. The elliptic to ovate, papery leaflets have short stalks, smooth edges, and long points. The side leaflets are subopposite. The leaflets are green tinged with red, have a net-like structure of fine veins when viewed against the light, and are shiny when dried. Male and female flowers occur on different trees (dioecious) in branched terminal clusters. The tiny flowers are five-parted, green with a reddish tinge. Fruits (berries) are scarlet to almost black when ripe, oblong to obovoid, 9 to 15 mm long, and contain one to three shiny brown seeds 6 to 10 mm long (Howard 1988, Liogier 1988, Little and Wadsworth 1964, Long and Lakela 1976).

Range.—Florida bitterbush is native to southern Florida, the Bahamas, the West Indian Islands, and Colombia and Venezuela in northern South America (Howard 1988, Little and Wadsworth 1964). It is not known to have naturalized outside its native range.

Ecology.—Florida bitterbush occurs in coastal hammocks in southern Florida and the Keys (Long and Lakela 1976). It grows in both remnant forests and secondary forests (logged, pastured, and abandoned fields) in Puerto Rico. During old-field or pasture succession, Florida bitterbush invades during the brushy stage. The species adapts to a wide variety of well-drained soils derived from most parent materials. It usually does not grow on the most fertile sites (where competition is severe) or on the worst, such as eroded, rocky ridge tops. Elevations vary from near sea level to 600 m or more, and mean annual precipitation ranges from 750 mm to about 2400 mm. Florida bitterbush is moderately intolerant to shade, being able to grow under the canopy of low basal-area forests as well as in openings. Seedlings are apparently more tolerant than adults and are able to progress from the understory into the canopy of low forests (Pascarella 1996).

Reproduction.—Florida bitterbush flowers and fruits nearly throughout the year in Puerto Rico (Little and Wadsworth 1964). It blooms March through July in Florida. Flowers of both sexes attract small, generalist insect pollinators with scent, pollen, and small amounts of nectar. Peak ripening occurs in November and December (Pascarella 1996). Fruit and seed production is moderately abundant and consistent from year to year. Fresh fruits collected in Puerto Rico weighed an average of 0.231 $\pm$ 0.043 g/fruit. Air-dried seeds separated from them averaged 11,900 seeds/kg. Placed on moist filter paper without pretreatment, 100 percent germinated, beginning 14 days after sowing (Francis and Rodríguez 1993). Pascarella (1996) noted fruits collected in Florida weighed an average of 0.483 $\pm$ 0.034 g and that 85 to 90 percent of the fruits contained just one seed. Most seeds fall under the parent trees but some are dispersed by birds. Seedlings are relatively common in forests where the species grows.

Growth and Management.—Growth rate of Florida bitterbush is slow to moderate. Weaver (1979) followed the growth of two plants in a forest in Puerto Rico with characteristic slow growth and found diameter growth rates over the 24-year period of about 0.2 cm/year. Florida bitterbush in Puerto Rico live about 30 to 60 years (author's observation). Plants begin flowering and fruiting when they are about 1.5 to 2 m in height if sufficient light is available. Fruits are easily collected in quantity by hand and with short pruning poles. They may be cleaned by macerating or by working them against a screen under running water. Production of seedlings, at least to the pricking-out stage, is straightforward. Where a seed source is available in favorable habitat, natural reproduction is usually adequate. Florida bitterbush has not been reported to cause any problems in forests and therefore control measures are probably not needed.

Benefits.—Florida bitterbush helps protect the soil and contributes to the biodiversity and aesthetics of forest stands. A number of bird and animal species eat the fruits. It furnishes larval food for the bush sulphur butterfly, *Urema dina helios* (Institute of Food and Agricultural Sciences 2003). Florida bitterbush is a honey plant (Little and Wadsworth 1964). The wood is little used, except occasionally for fuel. Florida bitterbush is planted in Florida and Cuba as an ornamental (Little and Wadsworth 1964). A bitter tonic is made from tissues of the species in the Caribbean to treat fevers, anorexia, and stomach problems and as an enema to treat for worms (Liogier 1990). Qualitative tests indicated the presence of antioxidants, phenols, terpenoids, and alkaloids in ethanol extracts of tissues. A number of bacteria and fungi were treated with ethanol extracts of various tissues. Growth reductions of *Bacillus cereus*, *Bacillus subtilis*, and *Pseudomonas aeruginosa* were observed which was enhanced by exposure to long-wave ultraviolet radiation (O'Neal and others 2002).

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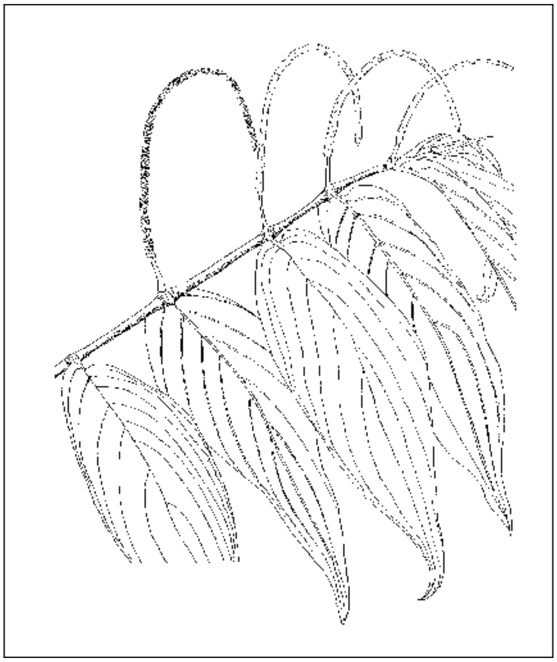
***Piper aduncum* L.** bamboo piper

PIPERACEAE

Synonyms: *Artanthe adunca* Miq.
Piper hebecarpum C. DC. in Urban
Piper martinicense C. DC. in Briq.
Piper stehleorum Trel. in Stehlé
Piper subrectinerve C. DC. in Urban

John K. Francis



General Description.—Bamboo piper is also known as jointwood, spiked pepper, false kava, cow's foot, higuillo, higuillo de hoja menuda, cordoncillo, anisillo, guayayo, Santa María negra, aperta ruão, and matico. It is a multistemmed evergreen shrub or small tree 1 to 6 m in height and up to 10 cm or more in stem diameter. The wood is whitish, hard, and brittle with a thick, solid pith, and no annual rings. The stems have swollen nodes and bark that is smooth and gray or green. Plants are supported by abundant lateral roots and, at times, proproots arising from nodes near the base. The green twigs are not abundant. The alternate leaves have short petioles and elliptic to lanciolate blades 12 to 20 cm long. All plant parts have a peppery taste and odor. The cordlike spikes are borne opposite leaves and contain many, minute flowers that soon develop into numerous tiny, imbedded drupes with brown or black seeds (Howard 1988, Liogier 1985, Little and Wadsworth 1964, Stevens and others 2001).

Range.—Bamboo piper is native to the Greater and Lesser Antilles and on the mainland from Mexico to northern Argentina. The species has been widely planted as an ornamental and has spread by the movement of equipment between land masses. It has escaped and established itself in Florida, Southeast Asia, and a number of Pacific Islands (Instituto de Botánica Darwinion 2002, Howard 1988, Pacific Island Ecosystems at Risk 2002, Plant Protection Service 2001, Stevens and others 2001).

Ecology.—Bamboo piper grows in areas that receive from about 1500 to over 4000 mm of mean annual rainfall. It grows in Puerto Rico from near sea level to over 400 m in elevation. Most soils are colonized including fill dirt, but not salty soils and excessively well-drained soils at the dry end of the range. Disturbance, which is required for establishment, includes removal of the forest canopy to allow light to enter and the creation of a bare soil surface, although plants occasionally establish themselves on rotting logs and stumps. Bamboo piper is moderately intolerant of shade. It can survive and grow slowly under a moderate overstory but requires at least partial exposure to grow large and flower. The species commonly grows in clearcuts, tree-fall gaps, shade-grown coffee and other tree plantations, brushy pastures, roadsides, and landslides. Bamboo piper grows as individual plants or in thickets. As many as 2,632 plants/ha were reported in areas invaded in the Philippines (Philippine Council of Agriculture 2002).

Reproduction.—Bamboo piper flowers and fruits throughout the year (Little and Wadsworth 1964). Air-dried seeds from a Puerto Rican source averaged 0.000237 g/seed or 4.2 million/kg. Only 7 percent germinated when placed on moist filter paper (author's observation). The seeds are dispersed by bats, birds, and possibly arboreal rodents (Plant Protection Service 2001). Seedlings are fairly common on disturbed ground. Established plants thicken into clumps by suckers arising from the root crown (Pacific Island Ecosystems at Risk 2002). Plants are established for agroforestry purposes in Papua New Guinea by shoving cuttings into moist soil (Bourke 1997).

Growth and Management.—The growth of bamboo piper is moderately rapid after the early seedling stage. Sprouts and suckers grow more than a meter in their first year. Producing seedlings by means of seed is difficult. Propagating plants with cuttings, which need no hormonal treatment, in the nursery or directly in the field, is recommended. Individual stems live 2 to several years; by sprouting, plants live much longer. Infestations of bamboo piper can be controlled by uprooting young plants and spraying older plants with broadleaf weed killers such as 2,4-D. Treated areas should be checked in a few weeks and treated again if regrowth has occurred (Plant Protection Service 2001).

Benefits.—Bamboo piper helps revegetate disturbed areas and contributes to the biodiversity and biomass of forests. It also is a source of food and cover for wildlife. Bamboo piper established in contour rows for soil erosion brakes helps facilitate agroforestry on steep land in Papua New Guinea (Bourke 1997). The wood is useful for fuel, stakes, fences, and rude construction (Philippine Council of Agriculture 2002). However, exposed wood rots quickly (Vélez and van Overbeek 1950). The species is planted as an ornamental. The peppery fruits have been used to season food (Little and Wadsworth 1964). Essential oil content of bamboo piper tissue (leaves and twigs), of which dillapiole is the major component, ranged from 1.2 to 3.4 percent (Maia and others 1998). Teas and other extracts of the leaves and roots of bamboo piper are used in herbal medicine as a tonic to ease diarrhea, dysentery, vomiting, ulcers, and to control bleeding (Liogier 1990). The chemical 2', 6'-dihydroxy-4'-methoxychalcone isolated from bamboo piper inhibited 98 percent of the growth of *Leishmania amazonensis* parasites *in vitro* with low host cell toxicity (Torres-Santos and others 1996). In addition, the essential oils have shown strong insecticidal, molluscicidal, and antibacterial effects (Gómez and others 1997, Ibrahim and others 1996, Orjala and others 1992).

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***Piper amalago* L.** higuillo de limón
PIPERACEAE

Synonyms: *Enckea amalago* (L.) Griseb.
Enckea seiberi Miq.
Piper medium Jacq.
Piper seiberi (Meq.) DC.

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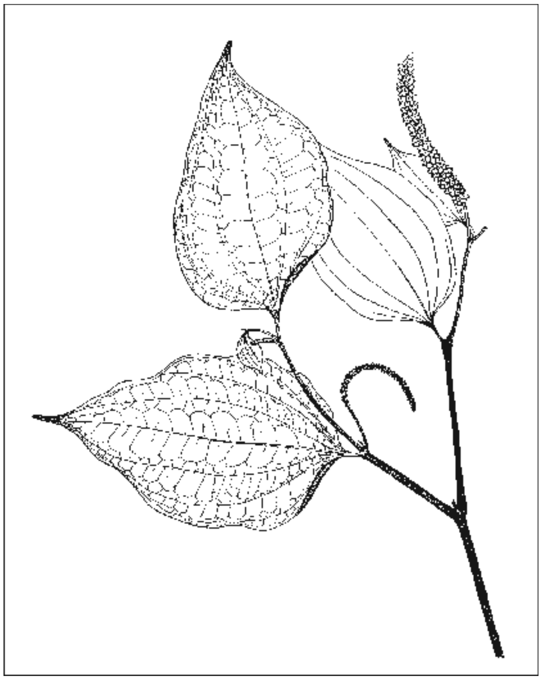

General Description.—Higuillo de limón is a Spanish name meaning lemon pepper. Although the species is a pepper with the characteristic peppery taste of foliage and seeds, the pungent, disagreeable odor of crushed leaves, stems, and fruits hardly suggests lemon. Other common names include joint wood, soot-soot, guayuyo, cordoncillo, anisillo, alcotán, anisetto, and malimbé (Little and others 1974).

Higuillo de limón is a shrub that sometimes becomes a small tree. It is recognized by its enlarged, ringed nodes on smooth, green stems with many brown lenticels. Stems on older plants become gray. Higuillo de limón often has multiple stems from the base, but usually does not branch further until the crown is reached. The crowns have relatively few branches and may be flattened in older individuals. The wood is of moderate density and brittle. A taproot forms in seedlings, but secondary roots that fan out and down later match it in size, and even become thickened in older plants. The alternate, dark green, hairless leaves are 4 to 14 cm long and 2 to 7 cm broad. They are pointed at the tip, ovate to elliptic, and have palmate venation with five main veins. Tiny flowers are borne in compact, cord-like, gray-green spikes 6 to 12 cm long. At maturity, the small (1.5 mm) fruits (drupes) are closely packed along the spike (Liogier 1985, Little and others 1974).

Range.—Higuillo de limón is native to tropical Mexico, Central America, South America, and the Greater and Lesser Antilles (Howard 1988).

Ecology.—Higuillo de limón is primarily an understory species of old growth and secondary forests. It is also found in openings and along roads. The species will endure all but the densest shade under stands, but needs openings or at least intermediate crown positions in open forest or brush thickets to reproduce. However, higuillo de limón is rarely among the pioneers that colonize disturbed sites, tending instead to invade after a low stand of trees or brush has become established. It endures competition with herbs, trees, and shrubs, but does not survive in deep grass swards. The species will grow in soils with textures from sand to clay and in all drainage classes except excessively drained and very poorly drained. It does not appear to be sensitive to differences in soil parent material. In Puerto Rico, higuillo de limón grows in areas receiving from about 1200 to 2500 mm of annual precipitation and from near sea level to more than 600 m in elevation.

Reproduction.—Higuillo de limón flowers and fruits throughout the year (Little and others 1974). In Costa Rica, frugivorous bats are the most and perhaps the only important dispersers of higuillo de limón seeds (Elizondo 2000, Fleming and others 1977). One sample of fruits from Puerto Rico yielded 890,000 seeds/kg. On moist filter paper, these seeds gave 77 percent germination between 8 and 37 days after sowing.

Growth and Management.—In Puerto Rico, higuillo de limón reaches 5.5 m in height and 8 cm in diameter (Little and others 1974). The species may become a tree to 15 m in high forests in Mexico, although it remains a shrub or small tree in successional forests and gaps (Chazdon and others 1988). Its stems have no visible annual rings and are therefore difficult to age. Judging age by stem internodal segments, individual stems in Puerto Rico appear to reach 5 to 10 years old. Because resprouting occurs from the roots, individual plants may live much longer. Natural regeneration of higuillo de limón occurs readily in early secondary forest and in open stands of older forest when seed sources are present. Stands can be easily manipulated to encourage it. Small quantities of seed have been separated by hand with tweezers after mashing the fruit. Larger quantities probably can be obtained by gentle maceration and wet sieving. Germination on the surface of wet soil or peat is recommended. Plantations could be established using containerized seedlings, although no plantings have been reported.

Benefits.—Higuillo de limón is eaten by cattle after the more desirable grasses and forbs are gone. Infusions of the leaves are said to alleviate colic and intestinal gas. The roots are used as a diuretic and to treat water retention (Liogier 1990). The fully ripe fruits and their seeds have the same taste as black pepper, *Piper nigrum* L., and are sometimes used as a substitute for it, especially in Jamaica. The fruits are usually dried whole and ground as needed (Grieve 2001).

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***Piper swartzianum* (Miq.) C. DC.** higuillo
PIPERACEAE

Synonyms: *Ariantha swartziana* Miq.

John K. Francis

General Description.—This shrub, known by its Spanish name higuillo in Puerto Rico (Little and others 1974), has been assigned the name Spanish elder in English (Natural Resources Conservation Service 2002). The species is an evergreen shrub that may take on vine-like or tree-like form. Higuillo usually has heights of 1.5 to 3 m but may reach 4.5 m in height and 7.5 cm in stem diameter (Little and others 1974). Plants are supported by relatively abundant lateral and fine roots. White mycorrhizal fungi associated with the fine roots are clearly visible. The shrubs usually have multiple stems that have arisen as sprouts from the root crown. The stems are gray with many raised lenticels and have enlarged nodes and a thick pith. The wood is light brown and brittle. The twigs are light green turning gray and often have a zig-zag form. The inner bark, twigs, and leaves have a pleasant spicy odor when crushed, and a peppery taste. The leaves are dull green to dark green, alternate in two rows, with minute gland dots. The leaf blades are oblong to lanceoate, 11 to 24 cm long by 3 to 7 cm broad, long-pointed at the apex and unequally rounded at the base. The flowers and fruits are grouped in 5- to 11-cm cord-like spikes, 4 mm thick borne singly opposite leaf attachments near the branch tips. The spikes are white during flowering, turning light green or yellow-green as the fruits mature. The individual fruits are imbedded within the spike in spirals (Liogier 1985, Little and others 1974).

Range.—Higuillo is native to Puerto Rico and Hispaniola (Liogier 1985). It is relatively common to rare in the moist and wet portions of Puerto Rico, specifically the public forests of Guajataca, Maricao, and Río Abajo (Little and others 1974), and private lands nearby. Higuillo was misidentified as *P. tuberculatum* Jacq. in Little and others (1974) (Liogier 1985).

Ecology.—Higuillo inhabits middle and late secondary and remnant forests. It is shade tolerant and is usually found in the understory, often in fairly deep shade. Higuillo does not compete well in tall, dense thickets of vigorous shrubs and young trees. At the lower end of the rainfall range (about 1200 mm/yr), the species is confined to extra-humid situations such as deep ravines. It is most common in forests that receive from 1600 to 3000 mm of precipitation. Higuillo grows on sites from a few meters above sea level to more than 1,000 m in elevation on a wide variety of soils derived from all types of parent material including ultramafics and limestone.

Reproduction.—In order to flower and fruit, mature higuillo plants need breaks in the forest canopy that admit over-head sun for part of the day. Vigorous plants flower and fruit continuously (Little and others 1974). Air-dried seeds weighed an average of 0.00156 g/seed or 641,000 seeds/kg (author’s observation). The seeds are probably disbursed by fruit bats that eat the fruits. Seedlings are widely scattered and uncommon.

Growth and Management.—New seedlings grow slowly. Well-established plants and sprouts grow about 0.5 m/year in height. Individual stems live 3 or 4 years and are replaced by other sprouts so that established plants can live indefinitely. No management experience has been published. Natural reproduction could probably be encouraged by disturbance that exposes mineral soil under a moderately shady tree canopy.

Benefits.—Higuillo contributes to the biodiversity, scenic beauty, and stability of the soil of the forests where it grows. Like other pipers, its fruits are food for fruit bats.

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***Piptocoma antillana* Urban** Antilles velvetshrub

ASTERACEAE

Synonyms: *Piptocoma rufescens* auct. non Cass.

John K. Francis

General Description.—Antilles velvetshrub is an evergreen, narrow-crowned, upright shrub usually 1 to 2 m in height but sometimes reaching 4 m in height and 5 cm in basal diameter. Mature plants often have several stems arising from the root crown or low on the stem. Lower stems are furrowed and gray; branches are relatively few, slender, straight, and covered with gray bark. The pale yellow wood is of moderate density, moderately strong, and has a dark brown pith at the center of the stem. Plants are supported by flexible, weak roots covered by corky, brown bark. The species is easily recognized by the narrow leaves that are dark green above and bright white beneath. The narrowly elliptic to lanceolate leaves are 3 to 8 cm long and 0.5 to 2.5 cm broad and have petioles up to 5 mm long. Inflorescences are corymbs of numerous campanulate heads. The seeds are straw-colored achenes about 2 mm long, tipped with a pappus about 4.5 mm long (author's observation, Liogier 1997).

Range.—Antilles velvetshrub is native to Puerto Rico and the Virgin Islands (Liogier 1997). Previous reports (Liogier and Martorell 1982) that it occurred in Hispaniola were based on misidentification of *P. rufescens* Cass. Antilles velvetshrub is not known to have been planted or naturalized outside its native range.

Ecology.—Antilles velvetshrub grows in coastal and upland sites from near sea level to 500 m or more in elevation. Mean annual rainfall varies from about 750 mm to 2000 mm. It is most common on ridges and hillsides of areas underlain with ultramafic rocks and limestone. Antilles velvetshrub is sometimes seen on road cuts and the center between the tracks of abandoned roads. Soils are excessively well or well drained, have pH's from about 5.5 to 7.7, and vary widely in texture and quantity of stones in the profile. Antilles velvetshrub is drought tolerant--leaves wilt but the plants usually do not defoliate. The species tolerates competition from shrubs, herbs, and a moderate amount of grass. It grows in openings or under partial shade of low basal-area forests and may be found in remnant stands and mid- to late-secondary forests. The species probably requires bare soil or small-scale disturbance to establish itself. Antilles velvetshrub occurs as scattered to occasional plants.

Reproduction.—Antilles velvetshrub blooms annually, apparently near the end of the wet season. Seeds were collected by the author in Puerto Rico in March (dry season). The air-dried seeds averaged 0.00046 g/seed or 2,150,000 seeds/kg. Placed on moist filter paper without pretreatment, 8 percent germinated between 11 and 14 days after sowing. Germination is epigeal. Seeds are dispersed by wind. Seed crops can be moderately abundant, but seedlings are uncommon.

Growth and Management.—Antilles velvetshrub grows 0.5 to 1.0 m per year. The stems do not live long--perhaps 2 to 5 years--but plants can renew themselves and live longer by sprouting from the root crown. Planting and management experience have not been published. Because the species is not abundant or aggressive, control should not be necessary.

Benefits.—Antilles velvetshrub helps protect the soil, furnishes cover for wildlife, and adds to the aesthetics of the forest. If means of propagation can be developed, the species would be valuable for background and accent in naturalistic landscaping.

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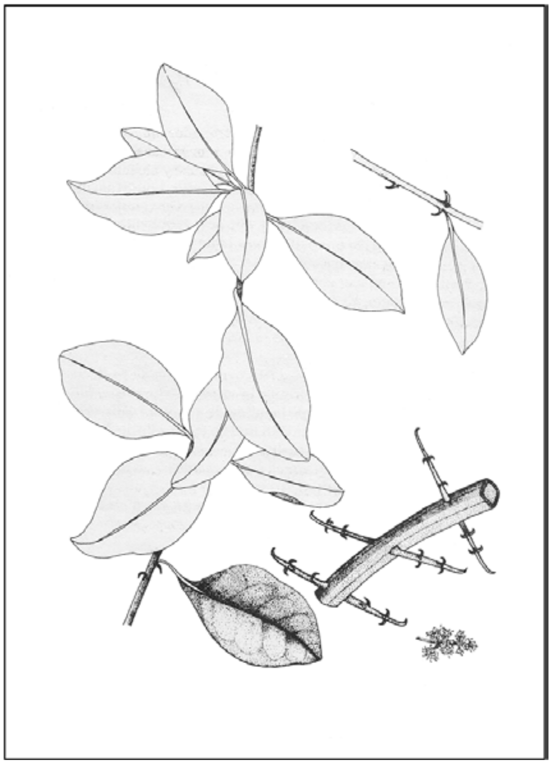
Pisonia aculeata L. pull-back-and-hold
NYCTAGINACEAE

Synonyms: *Pisonia helleri* Standley
Pisonia yaguapinda D. Parodi

John K. Francis



General Description.—Pull-back-and-hold (a name used in Florida) is a species known by a large number of common names worldwide. Other names used in U.S. territories are devil's claw (Florida), wild bougainvillea (Texas), escambrón (Puerto Rico), and prickly mampoo (U.S. Virgin Islands). Pull-back-and-hold is a large, scrambling and climbing woody shrub (vine) that rarely becomes a small tree. It is reported as a medium to large tree in Costa Rica (Enquist and Sullivan 2001). Its stems and branches are smooth, dark gray, and usually support opposite, stout, hooked and branched spines. The spines aid in clinging to tree crowns. Pull-back-and-hold may have one to several branches arising near the base, and then the stems are relatively free of branches until they reach increased light, usually in the canopy of trees where they branch profusely. Seedlings have a taproot and finer laterals. In older plants the lateral roots become extensive and diffuse. The fine roots are tough and fibrous. The species may be evergreen or deciduous depending on the climate. The leaves are variable, ovate to elliptical and 2.5 to 15 cm long by 1.5 to 6 cm broad. They are light to dark green, leathery to somewhat fleshy. The flowers are small axillary cymes that are succeeded a few months later by 11 to 15 mm long fruits (anthocarps) with five single or double length-wise rows of sticky glands (Acevedo-Rodríguez 1985, Howard 1988, Liogier 1985).

Range.—Pull-back-and-hold is native to most of the humid tropical and subtropical areas of the world including five continents, most of the islands of the Caribbean and many of the Pacific islands. Its range includes southern Florida and the Rio Grande Valley of Texas (Florida 4-H Foundation 2001, Friend 2001, Howard 1988).

Ecology.—Pull-back-and-hold grows from near sea level in coastal areas to as much as 1,000 m in elevation in continental areas (Múlgura 2000). In Puerto Rico, the species grows in sites receiving from 750 mm to over 2000 mm of precipitation. These shrubs grow well in soils with textures from sand to clay, with drainage from somewhat poorly drained to excessively well drained in limestone, igneous, and alluvial areas. In Florida, the species grows on hummocks and pinelands (Florida 4-H Foundation 2001). Seedlings and young plants survive in broken sunlight, but to reproduce, a plant must be relatively large and must have reached nearly full sunlight. This usually means growing in the crowns of trees or sometimes on rocks or fences

Reproduction.—In Puerto Rico, pull-back-and-hold flowers from December to May (the dry season) and fruits in August (just before the wet season) (Acevedo-Rodríguez 1985) although fruiting of occasional individuals may occur at almost any time of the year. Plants in Costa Rica fruit late in the wet season (Enquist and Sullivan 2001). A large plant can produce thousands of seeds during a fruiting episode. Fruits from a Puerto Rican collection averaged 0.077 $\pm$ 0.028

g/fruit. Seeds extracted by hand, which have the appearance of grains of wild rice, averaged 0.041 ± 0.011 g/seed. It is not necessary to extract seed because they germinate satisfactorily within the fruit. Seventy-five percent of seeds from the above Puerto Rican collection, sown as fruits in commercial potting mix, germinated between 21 and 49 days after sowing. Pull-back-and-hold is susceptible to damping-off as seedlings in germination beds. Seedlings are ready to prick out into containers about 1 month after germination. The sticky seeds can cling to birds while on the trees; then, after they fall, still attached to the infrutescences, stick to the clothing or fur of passing humans and animals.

Growth and Management.—Although pull-back-and-hold has only a moderate growth rate, it can live for several decades and become quite large. Plants may reach 20 m of extension (Acevedo-Rodríguez 1985) and 20 cm of stem diameter in Puerto Rico. It is sometimes desirable to remove pull-back-and-hold from forest stands. This increases safety during timber harvest and helps ensure that the regenerating stand will not be suffocated by resurgent vines. A time-honored method is to cut the vines hanging from trees 1 year before harvest and then to cut or spray the few surviving sprouts just before harvest.

Benefits.—Pull-back-and-hold may be used as a hedge or a foundation plant in landscaping, but it requires regular pruning to keep it under control (Friend 2001) An occasional plant occurs entirely free of spines. Perhaps these could be propagated vegetatively for ornamental use. The wood of wild pull-back-and-hold is sometimes used for fuel. It is hard, heavy, and often available in good diameters and considerable lengths. Root extracts have been used in herbal medicine as a purgative, and extracts from leaves and bark are used to treat arthritis (Acevedo-Rodríguez 1985).

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***Pithecellobium unguis-cati* (L.) Benth.** bread-and-cheese

FABACEAE

Synonyms: *Mimosa unguis-cati* L.
Zygia unguis-cati (L.) Sudw.

John K. Francis

General Description.—Bread-and-cheese is the common name used in the Virgin Islands and the English-speaking Lesser Antilles. The species is also know as cat's claw and black bead in Florida and doctor long, groven eye, uña de gato, rolón, bois crabbe, griffe-chatte, collier-diable, tendra à caulilou-rivière, and bébèl elsewhere (Howard 1988, Liogier 1988, Little and others 1974). Bread-and-cheese is a shrub or small tree usually 3 to 9 m in height and 4 to 13 cm in stem diameter (Little and others 1974). However, it occasionally grows to impressive proportions. The national record tree, found in Camino Real, Florida, measures 22 m in height and 121 cm in diameter (Champion Tree Project 2001). The plant usually has multiple stems arising at or below ground level. The stems and branches are gray and nearly smooth with lenticels and rings at the nodes. The paired spines are persistent. Bread-and-cheese produces a taproot and abundant lateral and fine roots. Alternate hairless leaves have petioles 2 to 5 cm long and leaf blades 2 to 6 cm long. There are four obliquely obovate or oblong leaflets per leaf. The greenish-yellow, yellow, or pink flowers form terminal or axillary racemes or panicles in heads. The legume, 5 to 10 cm long, is coiled or curved and splits open to reveal 4- to 6-mm shiny, black seeds surrounded by white to red fleshy arils (Howard 1988, Liogier 1988, Little and others 1974). Bread-and-cheese is easily confused with *P. dulce* (Roxb.) Benth., which grows as an exotic in many Caribbean islands. The latter is a tree with somewhat smaller leaves, coarser twigs, larger fruits, and less pronounced rings at the nodes.

Range.—Bread-and-cheese ranges from Florida through the Greater and Lesser Antilles, Trinidad and Tobago, Bonaire, Curacao, Aruba, Guyana, and Venezuela (Liogier 1988, Little and other 1974). Planting has not been reported outside its native range.

Ecology.—Bread-and-cheese grows in Puerto Rico from near sea level to about 450 m in elevation on soils derived from both igneous and sedimentary rocks (author's observation). The species prefers well-drained soils, but all soil textures appear to be tolerated. With few exceptions, it grows in areas receiving less than 1000 mm of annual precipitation. Because of reduced competition from trees, the species tends to grow on sand dunes, coastal strands and keys, and on shallow rocky soils, sometimes forming thickets (West and Arnold 1952). It does survive and grow in the understory of open, dry forests, but maintains thin crowns and seldom flowers in these situations. Bread-and-cheese appears to tolerate salt spray and salty groundwater.

Reproduction.—Bread-and-cheese flowers and fruits irregularly through the year (Little and others 1974). Seed yield can be heavy but inconsistent from year to year. A sample of seed collected in Puerto Rico contained 14,300 seeds/kg and germinated at 31 percent, beginning 3 days after sowing (Francis and Rodríguez 1993). Artificial propagation is by seed; it is one of the easiest shrubs to grow (Workman 1980). Natural seedlings are seldom abundant. The shrubs resprout readily after cutting or fire.

Growth and Management.—Plants started from seed grow relatively slowly at first and somewhat faster after deep rooting. Supplemental watering and fertilization are unnecessary. As a landscaping plant, it can be easily pruned and shaped (Workman 1980). In the poor habitat where the species usually occurs in the wild, growth is very slow and plants live for several decades.

Benefits.—Although it is difficult to harvest because of the spines, the wood of bread-and-cheese is used for fuel. It is heavy and hard and has an oven-dry heat of combustion of 19.05 megajoules/kg (Timyan 1996). The fleshy aril is edible, although not highly desirable because of the lingering flavor. The seeds of bread-and-cheese are used to make necklaces. The species is planted to form impenetrable hedges (UVI Wetlands Reserve 2001). Bread and cheese is listed as a nitrogen fixing species (Winrock International 2001). The fruits are one of the food plants of the endangered yellow-shouldered amazon parrot (*Amazona barbadensis*) in Venezuela, and the islands of Margarita, La Blanquilla, and Bonaire (Island Resource Foundation 2001). The large orange sulfur (*Phoebis agarithe* Boisduval) and the Miami blue (*Hemiargus thomasi* Clench) butterflies both use bread-and-cheese as rearing plants for their larva (Association of Florida Native Nurseries 2001). A small treehopper insect (Homoptera) has developed an extended thorax that mimics a bread-and-cheese thorn and serves as protective camouflage (Workman 1980).

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***Pluchea carolinensis* (Jacq.) G. Don** cure-for-all
ASTERACEAE

Synonyms: *Conyza symphytofolia* sensu Gillis
Pluchea odorata authors, non *P. odorata* (L.) Cass.
Conyza carolinensis Jacq.
Conyza coresii Kunth
Pluchea cortesii (Kunth) DC.

John K. Francis

General Description.—Cure-for-all, also known as sourbush, sweetscent, wild tabacco, cattle tongue, salvia, sauge rouge, guerit-tout, tabak djab, zówèy mouten, is a shrub 1 to 3 m in height and up to 6 cm in basal stem diameter. Stem wood is moderately soft and brittle. Older plants are supported by many flexible, lateral roots and may be sparsely branched to somewhat branchy. The twigs are stout. The foliage is concentrated on the branch ends. Leaves have petioles 1 to 3 cm long, and ovate to elliptic blades 6 to 20 cm long with rounded bases, pointed ends, usually entire edges, upper surfaces glabrate to densely pubescent, and lower surfaces velvet-pubescent. The terminal inflorescences are broadly rounded corymbose panicles of heads of over 500 flowers each. The corollas are usually pink, but vary from light purple to white. The achenes are brown, 0.6 to 0.8 mm long, and have a pappus of 10 to 15 yellowish-white bristles. Chromosome number is 2n = 20 (author's observation, Howard 1989, Liogier 1997, Long and Lakela 1976, Stevens and others 2001)

Range.—Cure-for-all is native to Florida, Bermuda, the Bahamas, the West Indies, Mexico, Central America, and Colombia, Venezuela, and Ecuador in South America (Stevens and others 2001, Natural Resources Conservation Service 2002). The species has naturalized in Hawaii, Guam and other Pacific Islands, Taiwan, West Africa, and probably in many other places in the tropics (Peng and others 1998, Pacific Islands Ecosystems at Risk 2002, Stevens and others 2001).

Ecology.—Cure-for-all is adapted to a wide variety of soils and sites. It tolerates excessively-well to poorly-drained soils, the full range of soil textures, acid and alkaline reactions, salt and salt spray, and compaction. A minimum of about 1000 mm of mean annual precipitation is required in upland sites, but it grows in much drier climates along streams and near mangroves and marshes. Cure-for-all may be found from near sea level to 1,000 m in elevation in Hawaii (University of Hawaii Botany 2002). The species is intolerant and cannot endure overhead shade or severe competition from brush or grass. It is common in disturbed areas such as construction sites, riverbanks, the margins of hammocks, road cuts and fill, vacant lots, eroded sites, landslides, burned areas, and abandoned fields. In Hawaii, cure-for-all quickly invades burned areas, but being early successional, is soon replaced by other species (Smith and Tunison 1992). Plants sprout after fires if they are not too intense (University of Hawaii Botany 2002).

Reproduction.—Cure-for-all blooms in spring and summer in Florida (Long and Lakela 1976) and produces seeds prolifically. A collection of seeds from Puerto Rico weighed an average of 0.000025 g/seed or 40 million seeds/kg. Because the seeds failed to germinate on moist filter paper, it is not known whether this represents a reasonable estimate for the species (author's observation). The seeds are wind-dispersed and probably require wet, bare soil to germinate and establish themselves.

Growth and Management.—In Puerto Rico, most cure-for-all live for 2 to 4 years before dying or dying back to the root and resprouting. Sprouts grow about 1.5 m in the first year. Establishment of new plants can probably be assured by scarifying the soil before the wet season in the presence of a seed source. Where it is necessary to eliminate cure-for-all, grubbing out the plants or spraying with broadleaf herbicides is recommended until tested treatments are available. A seed insect, *Acinia picturata* (Diptera: Tephritidae), was introduced in Hawaii and although now well established, has had no significant effect on the shrub (Alyokhin and others 2001).

Benefits.—Cure-for-all has an excellent ability to colonize and stabilize disturbed areas and act as a nurse crop for later-successional species. Although not specifically reported, as other members of the family, it probably provides a source of nectar and pollen for honeybees and other insects. It has several herbal applications including aromatic baths, control of fever, treatment of uterine fibroids, relief of sore throat and stomach pain, poultices for wounds and skin ulcers, as an analgesic, and for the treatment of malaria (Balick and others 2000, Liogier 1990, Vélez and van Overbeek 1950). Analgesic and antiinflammatory effects have been demonstrated in laboratory trials with rats (Gavilán-Yodú and Hechavarría 2002).

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Prosopis glandulosa Torr. honey mesquite
FABACEAE

Synonyms: *Prosopis chilensis* (Molina) Stuntz
Prosopis odorata Torr. & Frém.

Juanita A.R. Ladyman

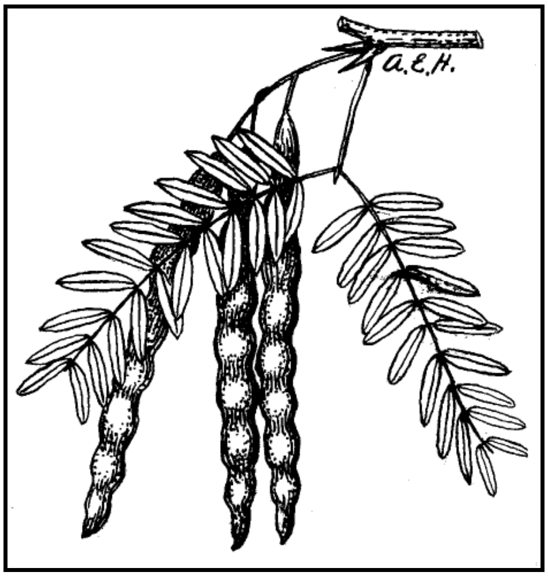

Illustration source: USDA-Forest Service collection, Hunt Institute

General Description.—*Prosopis glandulosa* is commonly known as honey mesquite, mesquite, glandular mesquite, prairie mesquite, algarobo, and la péchita. The Spanish conquistadores named it "algaroba" as it reminded them of the algarroba, or carob tree of Spain (USDAFS 1988). Mesquite are deciduous shrubs, or small trees, armed with one or two, rarely absent, straight, stout, stipular spines and pinnately twice-compound leaves. Flowers are in fragrant, globose heads and the fruits are straight, slightly curved, long (approximately 20 cm) pods with partitioned and embedded seeds (Barneby 1989, Vines 1986). Typically the plants are 1- to 2-m high shrubs but may develop into 10 m tall trees (Bowers 1993). An unusually large individual in Texas was reported to be 12.8 m tall with a 15.8 m crown spread and 2.4 m girth (Powell 1998). In some habitats the plants remain less than 0.5 m tall (USDAFS 1988). Three varieties of *P. glandulosa* are recognized: var. *torreyana,* var. *prostrata*, and var. *glandulosa* (Kartesz 1994). *Prosopis glandulosa* has been known erroneously as *P. juliflora* (Kartesz 1994) that grows in the West Indies. Inter- and intraspecific hybridization within mesquites is common and identification of the intermediate forms may be difficult (Uchytil 1990). The mesquite introduced into Hawaii is also called "algarroba" but is a different species (Sohmer and Gustafson 1987).

Range.—Honey mesquite is a common shrub in Oklahoma, southern Kansas, Texas, New Mexico, extreme southwestern Utah, Arizona, southeastern California, and southern Nevada, and in Nuevo Leòn, Tamaulipas, and Coahuila in Mexico (Barneby 1989, Powell 1998).

Ecology.—Honey mesquite grows at elevations below 1,800 m in a variety of soils and habitats. It is an aggressive plant and will occupy disturbed soils. It has a very deep (to 20 m) and wide root system that confers drought tolerance (Dayton 1931, Kearney and others 1960). It grows in areas of Death Valley that receive only 5 cm annual rainfall (Bainbridge and others 1990). It is moderately frost tolerant. It has always had a wide geographical range but has been reported as being historically restricted to moist, rather narrow habitats such as arroyos, floodplains, and canyons (Dick-Peddie 1993, Powell 1998). However, contrary to these reports mesquite was not totally restricted to these more moist habitats but was a component of upland communities prior to European settlement and may have been over-looked by early explorers as it tended to be a low, small shrub obscured in thick grasslands (Smiens and others 1992). This breadth of habitat is consistent with its hardiness to adverse environmental conditions.

Reproduction.—Honey mesquite flowers in March to May, and the fruits mature before the summer rains in June through September (Bowers 1993, Vines 1986). However, depending upon environmental conditions, flowering may extend into September (Everitt and Drawe 1993, Vines 1986). The fragrant, creamy-yellow to yellowish-green flowers are insect pollinated (Everitt and Drawe 1993, Uchytil 1990). The fruit is a many-seeded, brown, shiny, dehiscent pod (legume).

Scarified seeds germinate readily and can remain undigested and viable as they pass through animal digestive tracts (Wright 1982). The germination rate typically ranges from 75 to 90 percent (Vines 1986). Seeds frequently contain weevil larvae (Vines 1986). The pollen is reported responsible for some hay fever (Kearney and others 1960) implying that it is also disseminated by wind.

Growth and Management.—Since livestock grazing was introduced in the Southwestern United States and Northern Mexico, honey mesquite has increased to such an extent as to be considered a pest. However, mesquite is a valuable soil binder and slows erosion of otherwise denuded land. The increase in honey mesquite has been attributed to a variety of factors. The two most often cited are a reduction in perennial grasses, which when healthy and dense reduces mesquite seedling establishment, and the reduced incidence of fire due to livestock over-grazing and fire suppression (Bahre 1995, Humphrey 1958, Fisher 1977). Other reasons include: reduced effectiveness of invertebrate seed predators, increased dissemination of seed by livestock and/or kangaroo rats, land clearing and cultivation, soil compaction by livestock that hinders grass establishment, decreased activity of jackrabbits and wood rats, and climate change (Bahre 1995, Glendening 1952). Depending upon the situation, herbicide and mechanical treatments are often both economical and effective in controlling scattered and dense stands of mesquite (Schmutz and others 1992). Chaining and burning the trees destroy above-round tissue, but old stumps of honey mesquite readily resprout. Burning is effective only on small mesquite plants and where fuel is adequate to carry a fire (Schmutz and others 1992).

Benefits.—Honey mesquite plants bind soils, and plantings are recommended for erosion control (Graham 1941, Rorabaugh 1995). Mesquite, particularly var. *torreyana,* is tolerant of saline soils and is a particularly useful cover in degraded areas (Rorabaugh 1995, Schmutz and others 1992). It has been used, with limited success, in revegetating copper mine wastes (Norem and others 1982). Mesquite has been used in riparian restoration projects and provides excellent habitat for many species of wildlife and birds (Rorabaugh 1995). In one study, the number of quail using an area decreased as a consequence of mesquite removal (Goodwin and Hungerford 1977). Honey mesquite also provides shelter for the germination and development of forbs, grasses, and cacti such as *Peniocereus greggii* Britt. and Rose (Tull 1987, author's personal observation). It is not clear whether this is due to a favorable microclimate or a response to grazing pressures. Seeds of mesquite are nutritionally rich and are important food for a large number of wildlife species (Graham 1941, Tull 1987). Honey mesquite seeds may constitute 5 to 37 percent of scaled quails' diets year round (Davis and others 1975). Deer, javelina, and smaller wildlife species such as jackrabbits, feed on both pods and vegetation. It is important livestock feed, especially in times of drought. However, if livestock eat too large amounts, rumen stasis, impaction, and death may result (Stubbendieck and others 1993). It is an important "honey plant" and bees that forage its flowers produce excellent quality honey (Dayton 1931). It provides a good source of nectar and food for butterfly adults and larvae (Taylor and others 1997). The wood is resistant to termites and decay, and is used for building. It is also prized as bar-b-cue fuel as it is a hard, close-grained wood that burns hot and slowly (Barneby 1989, CWAR 2002). Honey mesquite was essential to Native Americans who made breads from the pods, fuel and utensils from the wood, medicines from the stems and leaves, rope from the roots, and dye from the black pitch of the trunks (Moerman 1998, Tull 1987). The gum exudates of the bark may be a substitute for gum arabic and have been used to mend pottery (Powell 1998). An intoxicating beverage is made from fermented meal (Bowers 1993).

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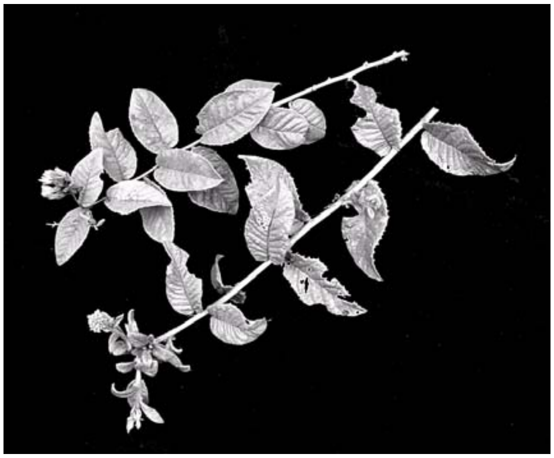
Proustia vanillosma C. Wright sweet yellowcrown
ASTERACEAE

Synonyms: *Proustia krugiana* Urban
Perezia vanillosma Molinet & Gómez

John K. Francis



General Description.—Sweet yellowcrown, a name assigned by the Natural Resources Conservation Service (2003), is a clambering woody shrub reaching 1 to 3 m in height and 5 m of extension. The species usually has multiple stems that sometimes reach 2 cm in diameter. They are covered with a lightly striated, gray-brown bark and a green inner bark, and have a brittle, greenish-white wood with a 2-mm pith. The stems layer (root) whenever they come in contact with the soil. The roots are brown and flexible. Wood of branches is flexible, strong, and hard. The alternate, light-green leaves are thin to leathery with a rough surface, elliptic to narrowly ovate, pointed to rounded at the tips, have margins rough to dentate, and are up to 9 cm long. The fragrant inflorescences are leafy, terminal panicles of heads that have three to seven florets. The corolla is yellow, 8 to 10 mm long. The seeds have an 8-mm straw-colored pappus (Liogier 1997). Turner (1993) proposed a new genus, *Berylsimpsonia*, to replace *Proustia* in the Greater Antilles.

Range.—Sweet yellowcrown is native to Puerto Rico, Hispaniola, and Cuba (Liogier 1997). It is not known to have been planted or naturalized elsewhere.

Ecology.—The species occurs in dry and moist areas of Puerto Rico that receive from about 750 to 1800 mm of mean annual precipitation from a few meters above sea level to elevations of about 550 m. Sweet yellowcrown grows on a wide variety of well-drained soils derived from sedimentary (including limestone), igneous, and metamorphic (including ultramaphic) rocks. It is moderately tolerant to shade, growing under open to moderately dense forest stands, as well as in openings and at forest edges. The species is most common in remnant primary stands and secondary forests that have never been completely converted to agriculture. Sweet yellowcrown slowly invades abandoned fields and pastures after they become forested. Although occasionally common and forming small thickets, plants are usually scattered (author's observations).

Reproduction.—Sweet yellowcrown in Puerto Rico flowers near the end of the wet season (November and December) and matures seed at the beginning of the dry season (January and February). A group of seeds collected in Puerto Rico averaged 0.000654 g/seed or 1,529 seeds/g. Sown on moist blotter paper, 88 percent of the seeds germinated within 13 days. Germination is epigeal. Seeds are dispersed by wind. Seedlings occur infrequently in forests. Once established, plants spread locally by layering (author's observations).

Growth and Management.—Sweet yellowcrown has a moderate growth rate (about 0.5 m of stem extension/year) and can live for at least a decade. Apparently plants (clones) survive longer than individual stems. No planting or natural stand management experience is published or known to the author.

Benefits.—Sweet yellowcrown helps protect the soil, furnishes cover for wildlife, and adds to the aesthetics of the forest.

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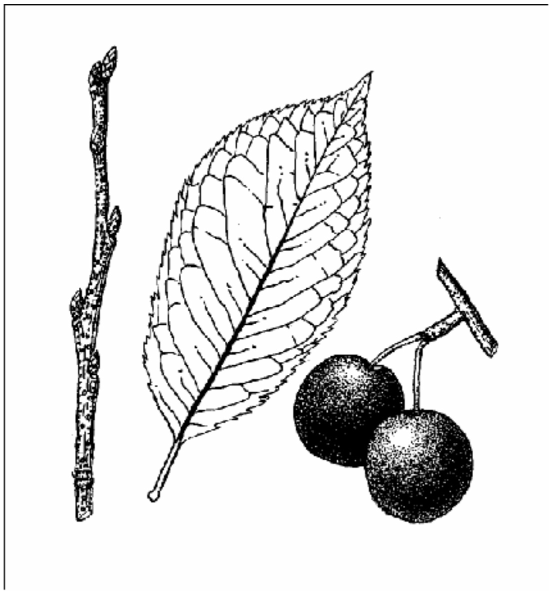
***Prunus americana* Marsh.** American plum
ROSACEAE

Synonyms: *Prunus americana* Marsh. var. *floridana* Sarg.
Prunus domestica L. var. *americana* (Marsh.) Castigl.

John K. Francis



General Description.—American plum, also known as Pottawattami plum, wild plum, yellow plum, red plum, river plum, goose plum, hog plum, and ciruela, is a shrub or small gnarled tree generally 1 to 8 m in height (rarely to 11 m) with stem diameters up to 30 cm. Maximum size depends on the environment. It usually produces a single stem and branches low to the ground but forms thickets by suckering from the roots. Stem bark is about 1.25 cm thick, gray or dark brown tinged with red, with the outer layer separating into thin, persistent plates. The twigs are green at first, becoming orange-brown and darker as they age. The plants become branchy and somewhat thorny, especially in older individuals. The wood is hard, heavy, and close-grained, with reddish-brown heartwood and light tan sapwood. Leaves are dark green, elliptic to obovate, 4 to 10 cm long, with an elongated point at the tip and a rounded base, margin serrate or doubly serrate, and having usually glandless petioles 1.5 to 2 cm long. Flowers are white, five-petaled, about 2.5 cm across, growing in two- to five-flowered lateral umbels. They are unpleasantly aromatic. Fruits (globose to oblong drupes) are 1.8 to 2.5 cm long and red to yellow (usually orange-red) when ripe. The fruits have a thick skin and sweet-tart, yellow flesh. The brown stone forms a flattened oval, ridged on one edge and grooved on the other (Britton and Shafer 1908, Sargent 1923).

Range.—American plum is native to southeastern Canada and the conterminous states of the United States except Texas, Washington, Idaho, Oregon, Nevada, and California where it is planted and probably naturalized (Natural Resources Conservation Service 2003, Sargent 1923). It has been suggested that the current broad range is, in part, the result of planting by Native Americans and white settlers (Treeguide 2003). The species is widely planted in temperate areas of the World and probably has naturalized in some of them.

Ecology.—Across its vast range, American plum grows in a wide variety of sites. In the eastern and mid portions of the continent, it grows on roadsides, old fields, vacant lots, fencerows, gullies, clearings, edges of woodlots, and open prairies. In the West, it grows in riparian areas and ditch banks, at the edges of fields, and in moist foothills. American plum grows at elevations up to 2,300 m in Utah. The species grows on sand through clay soils on moist to somewhat dry sites. It tolerates a moderate amount of salt in the soil (Forest Service 2003). American plum is intolerant of shade and will not grow in the understory of forest or persist if overtopped by trees (Treeguide 2003). Other members of the genus and presumably American plum recover rapidly from fires by sprouting (Forest Service 2003).

Reproduction.—Flowering occurs from March through May and fruit ripens from late June through October, depending on habitat (Forest Service 2003, Oklahoma Biological Survey 1999). The flowers are pollinated principally by honeybees (*Apis mellifera* L.). Good fruit and seed crops are borne every 1 to 2 years (Grisez and others 2003). Fresh fruits collected by the author in Utah averaged 6.572 $\pm$ 0.139 g/fruit. Air-dried seeds separated from them averaged 0.5336 $\pm$ 0.0095 g/seed or 1,874 seeds/kg. Grisez (1974) reported 1,918 cleaned seeds/kg, and that 60 percent germinated after cold stratification. Germination is hypogeal (Young and Young 1992). Seeds are dispersed by mammals and birds. Animals that ingest the seeds, such as black bear (*Ursus americanus*), are more effective dispersers than those that do not (Forest Service 2003). Seeds ingested by coyotes (*Canis latrans*) had a significantly lower germination rate than uneaten seeds (Cypher and Cypher 1999). Seeds may remain in the soil seed bank for many years until disturbance creates conditions for growth (Treeguide 2003). After dispersed plants become well established, they begin forming clonal thickets. Suckers may appear as much as 3 m away from the parent plants (Colorado Springs Utilities 2003).

Growth and Management.—American plum is only capable of a moderate growth rate, usually less than 30 cm in height per year (Michigan State University Extension 2003). Minimum seed-bearing age is 4 years (Grisez and others 2003). Individual stems rarely live longer than 20 years (Treeguide 2003). However, clones may last much longer. American plum fruits should be collected when fully mature for best quality seed. This can be done by hand stripping or shaking or beating onto a tarp spread under the shrub or tree. The seeds should be cleaned of all pulp by macerating and washing. The seeds are usually 96 to 100 percent filled. Seeds of this species can be stored at room temperature for up to 30 months without loss of viability. Seeds to be stored for longer should be surface dried and placed in a sealed container at 1 to 5 °C. Stratification of 90 to 150 days at 2 to 5 °C before planting is recommended for after-ripening of the seed. Alternately, seed may be sown in nursery beds 2.5 to 5 cm deep in the fall. Seedlings are ready for lifting (bare-root) at the end of one growing season (Grisez and others 2003). Plantings may be made with bare-root stock and potted nursery seedlings. Direct seeding in the fall with unstratified seed or spring with stratified seed in prepared seedspots will normally yield new seedlings. The species can be grafted or used as root stock, and it has been successfully propagated from stem cuttings (Forest Service 2003).

Benefits.—American plum is an early spring bloomer and with its white flowers beautifies the forests and prairies for a week or more each year. The species also helps protect the soil and provides benefits to wildlife and humans. The browse value of the plants to domestic ruminants and wild game animals varies from good to poor depending on the animal species and the location (Forest Service 2003). The cover provided by American plum thickets is important to many wild animals. The fruits are eaten by a number of species including bluejays (*Cyanocitta cristata*), brown thrashers (*Toxostoma rufum*), mockingbirds (*Mimus polyglottos*), red-headed woodpeckers (*Melanerpes erythrocephalus*), bobwhite quail (*Colinus virginianus*), white-tailed deer (*Odocoileus virginianus*), raccoons (*Procyon lotor*), squirrels (*Sciurus* spp.), and coyotes (*Canis latrans*) (Cowley 2003, Cypher and Cypher 1999, Kaiser 2001). The flowers furnish nectar food for great purple hairstreak [*Atlides halesus* (Cramer)] and Sweadner's Jupiter hairstreak [*Callophrys gryreus* (Hübner)] butterflies (Cowley 2003). Fruits are eaten raw or cooked, made into jams and jellies, and were dried for winter food in former times by Native Americans and pioneers. Several horticultural varieties of plum have been derived from American plum. It has also been used in hybrid crosses with other species of plums (Bircher and Bircher 2000). The wood, which has a specific gravity of 0.73 (Britton and Shafer 1908), makes excellent firewood except for being crooked and limby. American plum is used in amenity planting for wildlife and in revegetation projects.

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***Prunus emarginata* (Dougl. ex Hook.) D. Dietr.** bitter cherry

ROSACEAE

Synonyms: None

Christopher Ross

General Description.—Bitter cherry ranges from a shrub to a tree of 10 m. It often forms dense thickets. Clustered, deciduous elliptic to obovate, crenate-serrate leaves 20 to 65 mm in length are on 3 to 12 mm petioles (Wilken 1993, Mozingo 1987). The leaves, stems, and flowers all have a very strong cyanide odor (bitter almond) when crushed.

Range.—Bitter cherry is found in cooler parts of Arizona, California, far western Nevada, Idaho, Utah, New Mexico and Montana and north to British Columbia (Mozingo 1987, Esser 1995).

Ecology.—Bitter cherry site dominance may not peak until three decades after disturbance, suggesting that it is not an obligate seed bank species (Oakley and Franklin 2001). However, in some cases following fire it may quickly dominate a site (personal. observation.). However, others (Morgan and Neuenschwander 1988) have considered it an obligate seed bank species. It may achieve major dominance of disturbed sites, which persists for a long time but does not occur until late in the post-disturbance seral progression. Seed dispersal is by animals (Halperin 1989, personal observation).

Reproduction.—Three to 12 five-petaled flowers on 3- to 12-mm pedicels occur in sometimes flat-topped racemes. The sepals and hypanthium are glabrous to puberulent. White petals are 4 to 8 mm long. Fruits are obvoid to round about 7 to 14 mm long, smooth, with a red to purple fleshy pulp (Wilken 1993). Seeds may at times undergo heavy predation and mortality while green, apparently from sawflies of the genus *Hoplocampa* (Weaks 2001). Rodents, including chipmunks, eat the seeds (John Francis and Maurice Beck, personal communication).

Fire Effects.—Although bitter cherry is a prolific sprouter after fire, Leege (1979) found that repeated fires eventually result in heavy plant mortality. However, in those cases, seedlings developed to replace mature plants lost to fire.

Growth and Management.—Bitter cherry has been effectively controlled on conifer planting sites by application of the herbicide 2,4,5-T (now banned in the United States) (Bock and others 1978). It may be heavily attacked by tent caterpillars and other insects at times.

Benefits.—Blue grouse and other birds are fond of the fruits of bitter cherry. They are also a preferred summer and fall food of black bears (Unsworth and others 1989). Leaves are browsed by sheep and cattle, despite their cyanogenic properties, which have caused reported stock poisonings (Mozingo 1987). In the Pacific Northwest, bitter cherry is eaten by deer and elk (Crouch 1968), although it is not a preferred forage (Leege 1979, Klebenow 1965). Native Americans used long fibrous strips of bark for twine and basketry, and used the roots for a variety of medicinal purposes but made little use of the bitter fruit (Turner and Bell 1973). Bitter cherry essence is marked by herbalists, who claim that it aids patience and short attention spans. Bitter cherry has also been used for mine and highway reclamation (Everett and others 1980 and personal observation).

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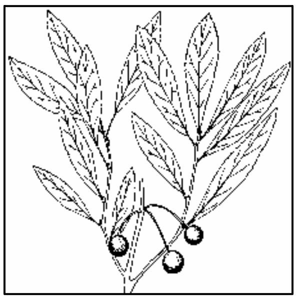
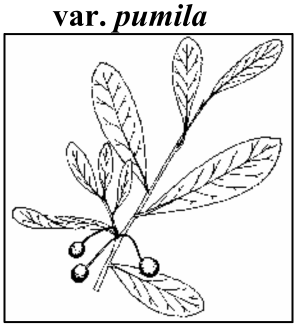
***Prunus pumila* L.** sand cherry
ROSACEAE

Synonyms: *Cerasus pumila* (L.) Michx.
Prunus susquehanae Willd.
Prunus cuneata Raf.
Prunus depressa Pursh.
Prunus besseyi Bailey.

Don C. Bragg



var. *pumila*



var. *cuneata*

Illustration source: (used with permission) Cranbrook Institute of Science

General Description.—Sand cherry, also called beach plum, "cerise de sable" (Fernald 1923), or dwarf American cherry, is a diffusely-branched, low growing (0.5 to 3 m tall, depending on variety and habitat) to sometimes decumbent or prostrate shrub (Fernald 1923, Gleason 1952, Lamson-Scribner 1891). Older stems develop a grayish, glabrous bark, while younger twigs are often tannish- to reddish-brown or brown. Its alternate leaves have glandular petioles up to half the blade length. While Fernald (1923) listed three different species of sand cherry (*P. pumila*, *P. susquehanae*, and *P. depressa*), Gleason (1952) recognized four varieties of *P. pumila*:*P. pumila* L. var. *pumila*, the Great Lakes sand cherry, has narrow (10 to 18 mm wide) oblanceolate leaves, narrowly cuneate at their base, acute or acuminate at their apex, lustrous on their top surface and pale below. Stems are erect and diffusely branched, with some decumbent branches on active dunes.

P. pumila L. var. *cuneata* (Raf.) Bailey, the Appalachian sand cherry, has oblong to oblong-obovate leaves with acute bases, often 20 to 30 mm wide at maturity, pale green above and glaucous below. Stems are erect or diffusely branched. This variety is most common on dry or rocky sites.

P. pumila L. var. *depressa* (Pursh) Gleason, the flat sand cherry, has leaves that are narrow (10 to 20 mm wide), oblanceolate, often with obtuse, long-tapering bases, pale green above and whitish below. Stems are prostrate, forming low mats up to 2 m wide. New shoots are reddish, highly lustrous, and often freely rooted.

P. pumila L. var. *besseyi* (Bailey) Gleason, the western sand cherry, has leaves that are somewhat glaucous underneath, oblanceolate, up to 18 mm wide, with acute to acuminate tips and long-cuneate bases.

Range.—Sand cherry is widely distributed in the northern half of the United States and eastern Canada, from New Brunswick down the Atlantic Seaboard to North Carolina, westward to Utah, Wyoming, and Montana, and as far north as northern Ontario and Quebec (BONAP 1999, Cusik 1985). The varieties of sand cherry are generally geographically distinct (BONAP 1999, Gleason 1952). *Prunus pumila* var. *pumila* is most common in the Great Lakes region, especially in Michigan, Minnesota, and Wisconsin. *Prunus pumila* var. *depressa* has been reported from New Brunswick to Pennsylvania and New Jersey, with isolated populations in Wisconsin, Tennessee, and possibly Kentucky. *Prunus pumila* var. *cuneata* ranges from Maine to Minnesota (and possibly Arkansas), southeast to Indiana and North Carolina. *Prunus pumila* var. *besseyi* is primarily a western subspecies, extending from Minnesota to Kansas westward to Utah and Montana, with isolated subpopulations noted as far east as

Michigan. The widespread distribution of sand cherry has helped to conserve the species, although it is considered locally threatened by some States (e.g., Arkansas, Ohio) because of the rarity of the sometimes specialized habitats it occupies (Arkansas Department of Planning 1974, Cusik 1985, Emmitt and Cusik 1983).

Ecology.—As its name suggests, sand cherry is abundant in sandy areas, although var. *cuneata* is most common on rocky sites (Billington 1943, Gleason 1952). In the Great Lakes region, sand cherry is often found on deep, excessively drained glacial sand plains or sand dunes bordering major bodies of water (Cowles 1899, McAtee 1920, Walp 1935). Sand cherry also grows along gravel bars or shorelines, cliff faces, rocky slopes, or even on calcareous, saline, or serpentine soils (Fernald 1923, Gleason 1952). The habitat preferences of sand cherry have restricted its abundance in many parts of its range. For example, the sand cherry in Arkansas appears to have been limited to two locations on remnants of the Grand Prairie in Prairie County (Smith 1988). Sand cherry is opportunistic in its distribution, frequently colonizing road cuts, gravel pits, or railroad beds (Cusik 1985, Fernald 1923, Stevens 1961). Preferred habitat is typically open, with few trees, other shrubs, or herbs to compete for light, nutrients, and water on the harsh sites it occupies. However, some have reported sand cherry as abundant in closed forests (Gysel 1966). Human activities and habitat alteration from changing natural disturbance regimes have been blamed for localized extinctions of sand cherry (Arkansas Department of Planning 1974, Cusick 1985, Drayton and Primack 1996).

Reproduction.—Depending on geographic location, from April to June a sand cherry may produce two to four white insect-pollinated flowers in umbels scattered amongst its leaves. Voss (1954) reported that butterflies pollinated sand cherry flowers in northern Michigan. Sand cherry fruits ripen by late July or August and are typically reddish- or purplish-black to nearly black, without bloom, subglobose to globose, and 10 to 15 mm in diameter (Billington 1943, Fernald 1950, Gleason 1952). *Prunus pumila* var. *pumila* is virtually inedible for humans (Rehder 1958), though Fernald (1923, 1950) mentions the palatability of var. *cuneata* and var. *besseyi*. Given their size, fleshy and edible fruit, and large stone, seed dispersal is primarily through birds and small mammals. Sand cherry can also vegetatively propagate (Olson 1958).

Growth and Management.—Sand cherry growth is best under open canopy conditions. As with many other species that specialize on poor sites, rates of growth are usually better on higher quality locations (i.e., those with abundant moisture and nutrients). However, these conditions also promote the growth of competitors that can exclude this low-growing, shade-intolerant species. Sand cherry's inconspicuous stature and spreading root system leave it vulnerable to overshading, trampling, soil compaction, erosion, and other surface disturbances (Cusick 1985, Emmitt and Cusick 1983). Road grading, for example, may have destroyed the two known pockets of sand cherry in Arkansas (Arkansas Department of Planning 1974). Habitat protection coupled with the restoration of openings should help conserve this species.

Benefits.—The small stature of sand cherry has minimized its economic benefits, as it does not produce merchantable wood and fruit production is generally limited. At least one cultivated hybrid is commercially available. Popular for its colorful foliage, the purpleleaf sand cherry [*P.* x *cistena* (N.E. Hansen) Koehne] is a cross between *P. pumila* and *P. cerasifera* Ehrh. Fernald (1923) fondly described the fruit of sand cherry along the rivers of New England and southeastern Canada: "...its juicy black 'plums' are highly prized either raw, cooked or as the source of a rich syrup-like jelly," suggesting that specialty food markets may be possible. While the ecological benefits of sand cherry are poorly understood, the vanishing habitats occupied by this species often have considerable value. For example, var. *cuneata* was one of the primary floristic components of the Albany Pine Bush in northern New York, which is an important local refuge for numerous amphibians and reptiles (Stewart and Rossi 1981). Sand cherry may also play a critical pioneering role in the ecosystems where it is abundant. Its deep root network and dense thickets help to stabilize shifting sand, allowing for the invasion of other plant species and colonization by important invertebrates such as ants (Olson 1958, Talbot 1934). Soil stabilization and organic matter production by sand cherry also contribute to nitrogen biogeochemistry in dune habitats (Robertson and Vitousek 1981).

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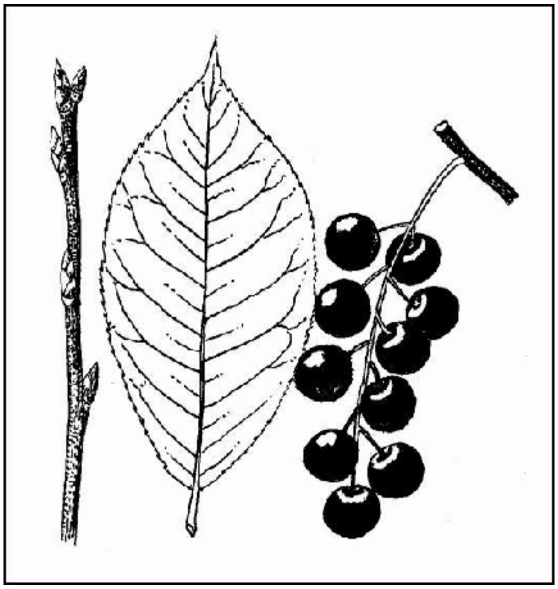
***Prunus virginiana* L.** chokecherry
ROSACEAE

Synonyms: *Cerasus demissa* Nutt.
Cerasus virginiana L.
Padus demissa Nutt.
Padus melanocarpa A. Nelson
Padus virginiana L.
Prunus demissa Nutt.

Bruce L. Welch



General Description.—Chokecherry is a thornless, deciduous shrub or small tree that grows to 8 m tall (Cronquist and others 1997). Young stems are finely puberulent, greenish at first then become glabrous and reddish in color. Older stems are ashy-gray with a reddish-brown undertone (Cronquist and others 1997, Welsh and other 1987). The alternate leaves are simple. A pair of reddish glands appears on the petioles near the base of the leaves. Leaves are 2 to 10 cm in length and 1.5 to 7 cm in width. Leaves are elliptic to oblong-ovate, finely serrated and abruptly acuminate apically. At the base, the leaves are acute to rounded. Leaves are dark green above and pale beneath. The midrib is impressed above and prominent beneath. (Cronquist and others 1997, Welsh and others 1987). Inflorescence is a raceme that is 4 to 20 cm long with leafy peduncles 2 to 8 cm long. The white perfect flowers are 10 to 20 mm wide and numerous with 4 to 17 mm long pedicels. Petals are white and are 4 to 6 mm long and suborbicular. Sepals are fringed and glabrous. Hypanthium and pedicels are also glabrous. The mature fruit 6 to 8 mm thick, known as a drupe, is dark red to black in color (Cronquist and others 1997, Welsh and other 1987). The diploid chromosome number of chokecherry is 16, 26, or 32 (Cronquist and others 1997).

Taxonomy.—Two varieties of chokecherry are recognized: var. *melanocarpa* and var. *demissa* (Cronquist and others 1997). They are in the words of Cronquist and others 1997: "weakly separated as follows: 1. Leaves glabrous or rarely with a few tufts of hairs in the axils of the lateral leaf veins beneath; drupe blackish.........var. *Melanocarpa* (A. Nelson) Sarg. 2. Leaves pubescent; drupe dark red; California, in White Mountains and Sierra Nevada, westward ......var. *demissa* (Nutt.) Torr."

Range.—Chokecherry occupies a variety of sites across Canada and the United States (Little 1976). It grows in 20 ecosystems and occurs in 47 of Kuchler's plant associations (Pacific Southwest Experiment Station. 2002). The Society of American Foresters list chokecherry as occurring in 51 of its cover types, and the Society for Range Management finds chokecherry growing in 40 of its rangeland cover types (Pacific Southwest Experiment Station 2002). It ranges from Newfoundland in eastern Canada to British Columbia in the west (Little 1976). Scatted stands can be found as far north as the southern portion of the Northwest Territories of Canada and as far south as western Texas, Southwest, and southern California (Little 1976). In the United States chokecherry occurs in the Northeast, Midwest, Central Plains, Pacific Northwest, and Intermountain regions (Little 1976). Isolated patches occur in Virginia, West Virginia, Tennessee, Kentucky, North Carolina and Oklahoma (Little 1976).

Ecology.—Usually chokecherry can be found growing in canyon bottoms, sheltered slopes, along streams and roads. It grows in a wide range of soils, ranging from Entisols to Mollisols that have textures ranging from sandy loams to clays. It can be found from 177 (Michigan) to 3,100 (Utah) m in elevation where the combinations of soil and topography permit greater than average accumulation of moisture (Pacific Southwest Experiment Station. 2002). Weakly salty soils are tolerated by chokecherry, but it cannot tolerant soils that are poorly drained or suffer from prolonged flooding. It grows in soil pH ranges from 3.5 to 7.6. It is found in numerous habitat and plant associations that range from post disturbance invaders to early successional to climax or stable (Pacific Southwest Experiment Station 2002). Chokecherry is intolerant to intermediate in tolerance of shade and resprouts from root crowns and rhizomes readily, thus giving it the ability to persists under open or forest canopies of moderate densities. It is well adapted to disturbance by fire. Chokecherry is a primary host of the eastern tent caterpillar and a fungus *Plowrightia stansburiana,* which causes black knot-like tumors on stems (Pacific Southwest Experiment Station 2002). Western X virus can kill entire stands of chokecherry.

Reproduction.—Chokecherry is among the first of the deciduous woody shrubs to leaf out and to flower in the spring. It can reproduce sexually from seeds and asexually from root crowns and rhizomes. Seeds are encased in a stony endocarp and have an after-ripening requirement for germination. Heat treatment improves germination. Seeds weigh about 0.095 grams (Grisez 1974). Passing through digestive systems of mammals and birds may enhance germination (Auger and others 2002). Also a number of birds and mammals may be responsible for long distance dispersal (Auger and others 2002). Chokecherry seeds persists in the soil seedbank .

Growth and Management.—Heights of this species vary greatly as to variety and site quality. Chokecherry may grow as high as 12 m with a truck diameter 20 cm on some sites in the Great Basin. It has a deep root system that can grow to depths exceeding 1.8 m with lateral roots more than 10.6 m in length. Rhizomes ranging from 1 to 2 cm in diameter are produced by this species. Chokecherry rhizomes sprout at a faster rate with a higher percentage of sprouts than Gambel oak. It is moderately tolerant of browsing. However, excessive livestock grazing has damaged some populations in many areas of the northern Great Plains. Hydrogen glycoside prunasin is a toxin produced by chokecherry that could be poisonous to grazing livestock. Highest levels (5 percent) are found in new stems and leaves. These levels diminish over the growing season to 1.2 to 2.2 percent.

Benefits.—Chokecherry adds to the biodiversity of a multitude of ecosystems. It provides habitat and food for a number of wildlife species, and watershed protection. Fruits, leaves, or twigs are eaten by bears, moose, bighorn sheep, pronghorn, elk and deer. A number of small of mammals also consume chokecherry including coyotes, snowshoe hares, red foxes, bobcats, raccoons, and porcupines. Chokecherry fruits are eaten by many birds including robins, western, eastern, and mountain bluebirds, European starlings, and Columbian sharp-tailed grouse. Livestock also eat chokecherry. Winter twigs contain 38.9 percent total digestible nutrients, which is lower than a number of winter shrubs (Dietz 1972, Welch 1981.) Winter protein, calcium, and phosphorus levels are above average. Fruits are harvested to make wines, syrups, jellies, and jams. Chokecherry plants are planted as ornamentals, for enhancing backyard wildlife habitats, and as windbreaks.

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***Psidium guajava* L.** guava

MYRTACEAE

Synonyms: *Psidium pumilum* Vahl
Psidium guajava L. var. *pumilum* (Vahl) Griseb.
Psidium guajava L. var. *cujavillum* King & Urban

John K. Francis

General Description.—Guava, also known as guayaba, guayabo, arazá-puitá, goyavier, and gobiabiera, is an evergreen shrub or small tree 2 to 8 m in height and up to 40 cm in diameter at breast height. Plants may have a single stem, especially if crowded in secondary forest, but individuals receiving ample light usually develop secondary stems arising from the main stem near the ground. The branches and stems are usually crooked and have a smoothish, cream to reddish-brown bark between thin, irregular scales that peel off. Guava bark is 5 to 8 mm thick (Pennington and Sarukhan 1968). The sapwood is light brown and the heartwood is reddish brown, hard, heavy (specific gravity of 0.8), and strong (Little and Wadsworth 1964). The roots are slender. The young twigs are four-angled, slightly winged, and green, turning brown with age. The leathery and light green or yellow green opposite leaves have petioles 4 to 7 mm long, and elliptic or oblong blades, 8 to 14 cm long that are short or round pointed at both ends. The foliage is aromatic when crushed. The axillary flowers are usually solitary with four or five white petals. Fruits (berries) are globose or pear-shaped, with a prominent, persistent calyx. They are at first hard and green, becoming softer, and yellow at maturity and 3 to 5 cm long. Inside the thin rind is a sweet-tart flavored pink or yellow pulp containing many hard, angular, yellow seeds about 2 mm long. The species has 2n = 21, 22, 30, or 33 chromosomes (Howard 1989, Liogier 1994, Long and Lakela 1976, Pennington and Sarukhan 1968, Stevens and others 2001).

Range.—Guava originated somewhere in the Neotropics and was spread nearly to the extent of its adapted climate before the arrival of Europeans (Morton 1987). Seeds found in Peruvian archeological sites seem to indicate that it originated in that area (Rain-tree 2002). Guava has been planted in nearly every tropical and frost-free subtropical country and has naturalized in most of them (Howard 1989).

Ecology.—Guava grows on soils of all textures derived from most parent materials. Well-drained and poorly drained soils, soils with pH's from 4.5 to 9.4, mildly salty soils, and soils both rich and poor in basic cations are tolerated. Guava grows at near sea level in coastal environments up to 2,300 m in elevation in Ecuador (Morton 1987). It grows naturally in areas of Puerto Rico that receive from about 1000 to 3000 mm of mean annual precipitation. Guava withstands drought very well. The species is moderately intolerant of shade. It develops a broad, low crown if open grown, grows a more vertical crown with side shade, and becomes tall and spindly in intermediate crown positions. Saplings can endure a few years in the understory of low basal-area secondary forests. Guava survives the competition of weeds, grass, and brush well. Growth is benefited by root association with arbuscular mycorrhizal fungi (Samarao and Martins 1999). Although they rarely kill the plants, a number of insects and diseases affect the species. As many as 80 percent of unprotected fruits may be attacked by

Mediterranean fruit flies (*Ceratitis capitata* Wied.) (Popenoe 1948). This thin-barked species is easily top-killed by fire and is sensitive to frost (von Carlowitz 1991).

Reproduction.—Guava flowers and fruits nearly throughout the year (Little and Wadsworth 1964). Many individual plants bear just once per year but not necessarily synchronized with other guava plants in the area. Honey bees (*Apis mellifera*) are the chief pollinators (Morton 1987). Time from flowers to ripe fruits ranges from 102 to 124 days (Samson 1986). Thirty-one ripe fruits collected from wild plants in Puerto Rico averaged 32.8 g and ranged from 13.5 to 61.8 g. Air-dried seeds averaged 0.0079 $\pm$ 0.0001 g/seed or 127,000 seeds/kg. Sown on moist peat, 63 percent germinated between 15 and 60 days of sowing. Germination was epigeal (author's observation). Birds and mammals disperse the seeds (Invasive Species Specialist Group 2002). Root cuttings are often used for commercial propagation of improved varieties (Morton 1987). Branches and stems layer (root) when they come in contact with moist soil (author's observation), and suckers also arise from roots near the trunk. Established plants coppice readily and withstand repeated cutting (Advisory Committee on Technology Innovation 1983).

Growth and Management.—Guava seedlings grow at a moderate rate, but older plants grow more slowly. Under good conditions, guava begins bearing fruits in 3 or 4 years. Plants live 40 years or more (Popenoe 1948). It is probably unwise and unnecessary to plant wild guava because the species is tough and aggressive and often invades agricultural (especially cattle pasture) and forest lands. Control is sometimes attempted, especially in cattle pastures and plantations. Sheep and goats graze the leaves and strip the bark and have been used to control it. Several herbicides are effective in controlling infestations (Pacific Island Ecosystems at Risk 2002). Repeated heavy plowing or repeated burning are also effective measures (Mune and Parham 1956).

Benefits.—Guava helps protect the soil and can be a major participant in reforestation of disturbed areas and abandoned pastures. It furnishes food and cover for wildlife. Domestic animals eagerly consume the fruits. Guava is one of the most important fruits in the tropics and is exported to temperate areas. It is consumed fresh and made into juice, jams and jellies, and paste or "cheese." The fruit rinds are candied or stewed in syrup. Nearly all the commercial production comes from improved varieties with large fruits and few seeds. The ripe fruits contain the following components: water 84 percent, ash 0.7 percent, protein 0.8 percent, fiber 5.6 percent, total sugars 5.4 percent, starch 2.5 percent, and fat 1.0 percent (Popenoe 1948). The fruit pulp is rich in vitamins A and C (Morton 1987). Guava wood is used for tool handles, carving, and fuel (Advisory Committee on Technology Innovation 1983). In folk medicine, extracts of roots, bark, and leaves are used to treat gastroenteritis, vomiting, diarrhea, dysentery, wounds, ulcers, toothache, coughs, sore throat, inflamed gums, and a number of other conditions (Morton 1987). Guava leaf tea is widely used to control blood sugar of diabetics in Japan and elsewhere. It has been shown to be effective *in vitro*, in mice, and in human volunteers (Deguchi and others 1998). The basis for herbal treatment of diarrhea was established by demonstrating inhibition of eight bacteria species and amoebas, and antispasmodic activity (Tona and others 1999).

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***Psorothamnus scoparius* (Gray) Rydb.** broom dalea
FABACEAE

Synonyms: *Dalea scoparia* Gray
Parosela scoparia (A. Gray) Heller

James E. Nellessen

General Description.—Broom dalea is also known as broom indigobush and purple sage (Dick-Peddie 1993, Ivey 1995). This is a highly branched shrub with slender twigs and small leaves. Its overall growth form gives it a broom-like appearance. It may reach heights of 1.5 m or more, but is typically about 1 m when mature. Horizontal spread is likewise about 1 m but in older plants may be as much as 2 m or more. Leaves are alternate, linear to linear-spatulate, from 1 to 2 mm in width and 0.5 to 1.9 cm in length, sometimes trifoliate, and gland-dotted (Carter 1997, Martin and Hutchins 1980-81). Populations in New Mexico are actually much more frequently trifoliate than some floras would indicate. Flowers are pealike, dark blue, grouped in semi-spherical clusters, and fragrant.

Range.—Broom dalea occurs from far western Texas through central and southern New Mexico into eastern Arizona and northern Mexico (Kearney and others 1951, Martin and Hutchins 1980-81, Warnock 1974). It occurs at elevations from about 915 m to 1,830 m in upland desert scrub habitat, usually in sandy soils.

Ecology.—This species is common in Plains-Mesa Sand Scrub habitats and can be one of the dominant shrubs in this vegetation type. It is a deep-sand tolerant or deep-sand adapted shrub. It may occur on gypsum sands as well as quartz sands. More specifically it occurs in a mixed shrub series in association with *Artemisia filifolia* Torr., *Atriplex canescens* (Pursh) Nutt., *Oryzopsis hymenoides* (Roem. & Schult.) Ricker ex Piper, *Sporobolus* spp., and other mixed grasses and forbs (Dick-Peddie 1993).

Reproduction.—Broom dalea often appears relatively dormant, with little new growth, until summer monsoon rains begin, whereupon it rapidly enters the blooming stage. The dark blue flowers are grouped in semi-spherical spikes, of a few to several flowers, the clusters 1 to 2 cm in diameter (Carter 1997, Martin and Hutchins 1980-81). The fragrant blooms attract numerous pollinating bees. Fruits are short, egg shaped pods with hairs and glands. Under proper moisture conditions seeds may germinate the following year. New plants may reach reproductive status in as little as 3 to 6 years depending on local environmental conditions.

Pollination.—Numerous species of bees are attracted to the blue flowers and collect pollen from broom dalea. The plant emits a noticeable sweet, aromatic scent when in bloom. During the peak of summer blooming, these shrubs are often focal points for bee foraging activity. Some bees visiting broom dalea include crepuscular (twilight active) bees of the family Colletidae (yellow-faced and plasterer bees), subfamily Diphaglossinae, species C*aupolicana ocellata* Michener; and family Anthophoridae (cuckoo, digger, and carpenter bees), subfamily Anthophorinae, Tribe Eucerini, species *Martinapis luteicornis* (Cockerell) (Rozen and Rozen 1986). These bee species were observed in southeastern Arizona. Both groups of bees nest in the ground, in crevices in rocks or walls, in plant stalks or other cavities. Both groups use the pollen, or pollen mixed with nectar as a food source.

Growth and Management.—This species grows relatively quickly and can reach 1 m in height or diameter within 4 to 7 years depending on local environmental conditions. The sandy Plains-Mesa Sand Scrub habitats in which this shrub may be a dominant are by nature poor rangelands for livestock.

Benefits.—Broom dalea is an important natural stabilizer of dune and other sandy soils. Its relatively rapid growth rate allows for reasonably quick establishment in situations of shifting and disturbed soils. Like many members of the legume family, it is a nitrogen fixer and forms rhizobial root nodules (Allen and Allen 1981). In fact, this species has been documented to transmit the rhizobial bacteria to another genus within the legume family, *Crotalaria* (Wilson 1939). Broom dalea is not an important range or browse plant for livestock and may increase under grazing. It is not substantially browsed, likely due to oils contained within the glands (Warnock 1974). Very little, until recently, has been known about the volatile oil composition of this species. Sixty-four volatile compounds have been identified (Lucero and others 2002). The three most abundant compounds were gamma-terpinene (22.3 percent), p-cymene (14.0 percent), and alpha-pinene (9.0 percent). Some of these are known deterrents to herbivore browsing in other plant species and may serve the same function in broom dalea.

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***Psychotria brachiata* Sw.** palo de cachimbo
RUBIACEAE

Synonyms: *Psychotria neurotricha* DC.
Cephaelis polycephala Schltdl.
Palicourea caerulea (Ruiz & Pav.) Roem. & Schult.

John K. Francis

General Description.—Palo de cachimbo is an evergreen shrub occasionally reaching 5 m in height but usually 2 to 3 m in height and 3 to 6 cm in basal diameter. The shrub usually has several stems formed by suckers from the lateral roots a few cm out from the central stem and by branches low on the principal stems. The wood has a moderately low density, is moderately strong, and has faint annual rings. Palo de cachimbo plants are supported by relatively shallow lateral root systems, at least in soils that have poorly aerated subsoil. The roots are tan colored and flexible. The branches and twigs are green, slender, and usually paired. Shiny, dark-green leaves are ovate to lanceolate, entire and pointed at both ends, 7 to 20 cm long and 3 to 8 cm broad, with a 1- to 3-cm petiole. Small yellow to greenish-white flowers are tightly clustered in open terminal panicles. The 4-mm ellipsoidal berries are tightly clustered. They are dark purple or dark blue at maturity and usually contain two hemispherical seeds having the inside face concave and the outside face with five ridges (Croat 1978, Liogier 1997, Stevens and others 2001).

Range.—Palo de cachimbo is native to the Greater Antilles, Trinidad, and Guatemala to Peru (Liogier 1997). The Missouri Botanical Garden (2002) lists some 73 herbarium specimens from South America. However, some researchers (Croat 1978, Stevens and others 2001) contend that the South American range is based on missidentification of the similar *P. caerullea* Ruiz & Pav. Palo de cachimbo is not known to have been planted or naturalized elsewhere.

Ecology.—Palo de cachimbo grows mostly in wet forest areas that receive from 2000 to 3000 mm of mean annual precipitation. It occurs at elevations from near sea level to 800 m in Nicaragua (Stevens and others 2001). Palo de cachimbo is intolerant of shade. Plants compete well with herbs and other shrubs in openings but do not survive long after a forest canopy closes over them. The species is common to uncommon in roadsides, secondary forest, and openings in primary forest. Plants sampled in secondary forest in Puerto Rico had the following nutrient levels in their leaves: 2.36 $\pm$ 0.03 percent N, 0.12 $\pm$ 0.00 percent P, 2.08 $\pm$ 0.25 percent K, and 12.66 $\pm$ 0.71 percent ash. Lower levels of those nutrients were reported for twigs and stem (Lugo 1992).

Reproduction.—Palo de cachimbo flowers from February to August and fruits from July to April in Nicaragua (Stevens and others 2001). The species is a good producer of fruits and seeds. A collection of fresh fruits from Puerto Rico weighed an average of 0.1569 $\pm$ 0.0125 g/fruit. Air-dried seeds separated from them averaged 0.0048 $\pm$ 0.0002 g/seed or 208,000 seeds/kg. Placed in commercial potting mix, 48 percent germinated between 34 and 57 days following sowing. Seeds are presumably dispersed by birds. Seedlings are common in the vicinity of fruit-producing plants.

Growth and Management.—Palo de cachimbo grows slowly in the early seedling stage. It grows

0.5 to 0.8 m/year for 2 or 3 years from sprouts. Individual stems probably live from 10 to 20 years, but plants may persist longer by sprouting. Natural regeneration probably can be encouraged by disturbance designed to create forest openings. Planting and management experience have not been published.

Benefits.—Palo de cachimbo contributes to the biodiversity of forests, helps protect the soil, and furnishes food and cover for wildlife.

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***Psychotria deflexa* DC.** garricillo

RUBIACEAE

Synonyms: *Psychotria patens* of authors, not of Sw.
Psychotria flexulosa of authors, not of Willd.
Palicourea patens (Sw.) Urban

John K. Francis

General Description.—Garricillo (a Panamanian name), sometimes referred to by the general name "cachimbo," is an evergreen shrub usually 1.5 to 2.0 m and 1.0 to 2.0 cm in basal diameter, sometimes reaching 3 m in height. Multiple stems are common, but not thick clumps. The wood is moderately hard with faint annual rings. The angular twigs and the foliage are glabrous. Persistent, bilobed, long-pointed stipules are characteristic of the species. Paired, dark-green, elliptic to oblong lanceolate leaves are 5 to 18 cm long with 3- to 10-mm petioles. Inflorescences are few-flowered terminal panicles. The small, sessile flowers are white. Fruits are subglobose, 3 to 5 mm in diameter, white or pale blue. Normally, there are two hemispherical seeds per fruit that are striated on the convex surface and have a medial groove on the opposite, flat or slightly concave surface (Croat 1978, Liogier 1997, Stevens and other 2001).

Range.—Garricillo is native to the Greater Antilles, Trinidad, southern Mexico, Central America, and South America to Bolivia (Croat 1978, Liogier 1997, Stevens and others 2001). It is not known to have naturalized outside the native range.

Ecology.—Garricillo is a shrub of moist and wet forests, areas receiving from about 1600 mm to over 3000 mm of mean annual precipitation. Although the species may occur from a few meters above sea level to over 1,000 m in elevation (Instituto Nacional de Biodiversidad 2002), it generally grows at medium to high elevations (Liogier 1997) because there is greater available moisture. The species grows on poorly drained to well drained soils generally with loamy to clayey texture and pH's from about 4.5 to 6.5. Garricillo is intermediate in tolerance to shade and grows in the forest understory (if not too dark), at forest edges, in overgrown fencerows (Molano and others 2002), and in openings. Most fruit and seed production takes place in openings or situations with increased to full sunlight. The species competes well with herbs and low brush.

Reproduction.—Garricillo flowers from May to July and matures fruits mostly from August to December in Panama (Croat 1978). The flowers are both insect-pollinated and self-pollinated (Faivre 2002). Fresh fruits collected in Puerto Rico weighed an average of 0.0758 $\pm$ 0.0006 g/fruit. Air-dried seeds separated from them weighed an average of 0.0057 $\pm$ 0.0001 g/seed, or 175,000 seeds/kg. There was an average of 1.7 seeds/fruit in this sample. Sown without pretreatment in moist potting mix, 69 percent germinated between 68 and 117 days after sowing. Fruit and seed production is good and consistent. Birds disperse the seeds (Molano and others 2002). Seedlings are common but suffer high mortality. Damaged plants resprout. Prostrate stems of young plants layer (root) readily when in contact with the soil.

Growth and Management.—Seedlings of garricillo grow slowly at first. Older plants and sprouts add from 20 to 40 cm to their height each year. Individual stems live about 10 years; plants may last longer by producing new sprouts. Although the species is more or less common, it does not appear to cause any difficulties for forest users.

Benefits.—Garricillo contributes to the biodiversity and biomass of forest communities, helps protect the soil, and furnishes food and cover for wildlife.

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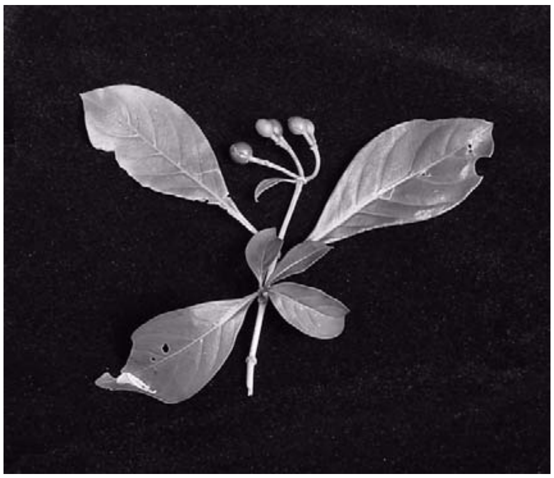
***Psychotria microdon* (DC.) Urban** thicket wild coffee
RUBIACEAE

Synonyms: *Psychotria pinularis* Sessé & Moc.
Rondeletia microdon DC.

John K. Francis



General Description.—Thicket wild coffee, also known as café bâtard, and café marron, is a semideciduous arching or scrambling shrub 1 to 3 m in height with a basal diameter of up to 4 cm. There is usually a single stem from the ground in undisturbed plants with multiple branches low on the stem. The arching stems sometimes extend 2 or 3 m horizontally and tend to be very branchy. The wood is of medium density, moderately weak and brittle. Stem and branch bark is smooth and tan outside and green within. The plant is supported by a tap-and-lateral root system of dark tan and flexible roots. The foliar display is medium to thin. Membranous, glabrous, obovate to oblanceolate, light-green leaves are 4 to 11 cm long with 10- to 18-mm petioles. The inflorescences are terminal corymbiform cymes with three to five rays. The flowers have a five-toothed white corolla tube 5 to 10 mm long. Fruits are red or red-orange ellipsoidal berries about 7 mm long. They usually contain two tan seeds that are flattened on one side and rounded on the other (Howard 1989, Liogier 1997, Stevens and others 2001).

Range.—Thicket wild coffee is native to the Greater Antilles (except Jamaica), the Lesser Antilles, from Central Mexico south through Central America to Bolivia and eastwards to Guiana (Howard 1989, Liogier 1997, Stevens and others 2001). It is not known to have been planted or naturalized elsewhere.

Ecology.—Thicket wild coffee is occasional to relatively common in secondary and remnant forests from near sea level to 840 m (Stevens and others 2001). Mean annual precipitation for the species in Puerto Rico ranges from 750 to about 1700 mm. It grows on a variety of well-drained soils that developed from alluvium, and igneous and sedimentary (including limestone) rocks. Thicket wild coffee is moderately intolerant to intermediate in tolerance to shade. It will grow and fruit in openings and low basal-area stands and survives in forest stands with moderate basal areas. The species endures light grazing but disappears under heavy grazing pressure.

Reproduction.—In Nicaragua, thicket wild coffee flowers May through September and fruits August through September (Stevens and others 2001). Fruit and seed production is moderate. A collection of fresh fruits from Puerto Rico weighed an average of 0.259 $\pm$ 0.005 g/fruit. Air-dried seeds separated from them averaged 0.0187 $\pm$ 0.0004 g/seed or 53,000 seeds/kg. Sown without pretreatment on moist blotter paper, 78 percent germinated between 65 and 217 days after sowing. Germination is epigeal. The seeds are apparently dispersed primarily by birds. Tapirs eat the fruits, but the seeds are destroyed in the process (Olmos 1997). Seedlings are common near seed sources in Puerto Rico. Survival to adulthood is relatively rare, however.

Growth and Management.—Thicket wild coffee is slow growing as a new seedling and grows at a moderate rate as a sapling and adult. Plants survive at least 5 years and perhaps much longer. Planting and management experience has not been published. The species is not common enough or aggressive enough to warrant control.

Benefits.—Thicket wild coffee contributes to the biodiversity of forests, helps protect the soil, and furnishes food and cover for wildlife. The fruits are slightly sweet and edible but not highly desirable. The species is a larval host for the *Xylophanes pluto* (Fabricius) moth in Puerto Rico (Torres-Bauzá 2000).

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***Psychotria nervosa* Sw.** shiny-leafed wild coffee
RUBIACEAE

Synonyms: *Psychotria undata* Jacq.
Psychotria chimarrhoides DC.
Psychotria lanceolata Nutt.
Psychotria hirsuta Spreng.
Psychotria oligotricha DC.
Psychotria portoricensis DC.

John K. Francis

General Description.—Shiny-leafed wild coffee, also known as wild coffee, Bahaman wild coffee, wood balsam, Seminole balsamo, café marrón, palo moro, ti café marron, ti kafé mawon, and remaroogu, is a 1- to 3-m erect shrub. Stem-like low branches are common, and multiple stems are formed in response to damage to the trunk. The stems, sometimes up to 7 cm in diameter, are covered with a bone-colored, smooth bark that is hairy in some variants. The plant is supported by stiff tap and lateral roots and abundant fine roots. Relatively few branches and twigs are formed with foliage maintained only near the tips. The leaves are shiny light or dark green, opposite, simple, glabrous or nearly so, elliptic to lanceolate, with sunken veins and elongated tips. A large, flattened bud is almost always visible between the youngest pair of leaves. The flower clusters, which are terminal or axillary, are nearly globose and contain a number of small, white flowers. The clusters become more diffuse as the fruits mature. The fruits (drupes) are bright red, elliptic or globose at maturity and 6 to 7 mm long (Howard 1989, Liogier 1997, Nelson 1996, Stevens and other 2001). They are fleshy and juicy with little flavor. Each contains two seeds that have a rounded side with shallow striations and a flattened side with a division down the middle like a coffee bean (author's observation).

Range.—Shiny-leafed wild coffee is native to Florida, the West Indies, Southern Mexico, Central America, and Colombia, Ecuador, and Venezuela in South America (Liogier 1997, Stevens and others 2001).

Ecology.—Shiny-leafed wild coffee grows in dry and moist forests that receive from about 700 to 2000 mm of mean annual precipitation. At the moist end of the precipitation range, it tends to be found only on excessively drained sites. It is cold-sensitive, tolerating temperatures only to about freezing (Dolan 2002). It grows well above the frost line in Florida; presumably shiny-leafed wild coffee freezes to the ground and resprouts later. Well-drained soils with the range of textures and both igneous and sedimentary (especially limestone) parent materials are colonized. Wild coffee is moderately tolerant of shade, usually growing in the understories of low basal area forests. The shrub may also be found in natural and artificial openings. In Florida, it is usually found in shell ridges, hammocks, and pinelands (School of Forest Resources and Conservation 2002). Shiny-leafed wild coffee is occasionally found in pure clumps, but more often it grows as well-distributed plants.

Reproduction.—Shiny-leafed wild coffee blooms in spring and summer in Florida (Nelson 1996) and irregularly through the year in Nicaragua (Stevens and others 2001). The flowers are visited by honeybees and butterflies (Dave's Garden Network 2002) that presumably pollinate them. A collection of fruits from Puerto Rico weighed an average of 0.256 ± 0.009 g/fruit. Air-dried seeds from those fruits weighed an average of 0.0175 ± 0.0004 g/seed or 57,000 seeds/kg. About 85 percent of fruits from the collection contained two seeds; the reminder contained one filled seed and one aborted seed. Sown in commercial potting mix, 95 percent of the filled seeds germinated between 64 and 164 days after sowing (author's observation).

Growth and Management.—Shiny-leafed wild coffee has a moderate growth rate. Small wildlings and pruned larger plants transplant well. They also can be grown easily from seed. Once established in a garden or natural area, they will reproduce and eventually fill the area (Workman 1980). Where a seed source is available, probably the best strategy to promoting natural establishment is to manipulate the stand for an open understory.

Benefits.—Shiny-leafed wild coffee is a widespread and important understory plant in dry and moist forest and as such contributes to the biodiversity and biomass accumulation, and protects against soil erosion. It is frequently planted in Florida as a native landscape plant in both formal and natural gardens (Workman 1980). It is appreciated for its attractive foliage and bright red berries and because it attracts birds and butterflies (Dave's Garden Network 2002). The fruits are food for tapirs (Olmos 1997), a number of bird species (School of Natural Resources and Conservation 2002), and probably many other animals. Shiny-leafed wild coffee contains the alkaloid dimethyltryptamine, which is hallucinogenic (Ted 2002) and may eventually prove to have medicinal applications. The seeds were once used as a coffee substitute (Dave's Garden Network 2002).

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Purshia tridentata (Pursh) DC. antelope bitterbrush

ROSACEAE

Synonyms: *Kunzia tridentata* Spreng.
Tigarea tridentata Pursh

Nancy L. Shaw and Stephen B. Monsen

Illustration source: USDA Forest Service 1937

General Description.—Antelope bitterbrush, also known as antelope brush, antelope buckbrush, deerbrush, or quininebrush, is an intricately branched, deciduous shrub varying widely in growth habit from low, decumbent, spreading forms to upright arborescent plants over 4 m in height (Blauer and others 1975, Welsh and others 1987). Leaves are alternate, simple, pinnatifid or apically three-toothed and sometimes glandular. Flowers are insect-pollinated and borne on short spurs of previous year's growth. They are numerous and white to yellow with petals 5 to 9 mm long (Welsh and others 1987). The fruit is a cartilaginous achene with a persistent tapering style and a dark pinkish gray pyriform seed (Blauer and others 1975). *Purshia* DC. ex Poir. likely derived from *Cowania* (D. Don) (Jabbes 2000, McArthur and others 1983) and hybrids between *Cowania* and *Purshia* are common. *Purshia glandulosa* Curran is considered a stabilized hybrid between *Cowania* and *Purshia tridentata*.

Range.—Antelope bitterbrush is widely distributed from British Columbia southward on the east side of the Cascade and Sierra Nevada Mountains to California and northern Arizona and eastward into western Montana, the Black Hills of South Dakota, and northwestern New Mexico (Cronquist and others 1997, Welsh and others 1987).

Ecology.—Antelope bitterbrush grows on well-drained, slightly basic to slightly acidic soils at elevations from 60 to 3,510 m (Nord 1965). It often grows as the dominant shrub with bluebunch wheatgrass and a variety of forbs. It is also a common associated species in many big sagebrush (*Artemisia tridentata* L.), mountain brush, pinyon–juniper (*Pinyon* L.-*Juniperus* L.), ponderosa pine (*Pinus ponderosa* P. & C. Lawson), and occasionally lodgepole pine (*Pinus contorta* Dougl. ex Loud.) communities (McArthur and others 1983, Nord 1965). It is a pioneering species on steep, rocky, unstable disturbances. Erect forms generally do not survive wildfires, but layering forms may resprout. Antelope bitterbrush is sometimes associated with the nitrogen-fixing actinomycete *Frankia,* but root nodulation varies with factors such as moisture availability and soil chemistry (Righetti and others 1983). Emerging seedlings are susceptible to a number of damping-off organisms, while seedlings and mature plants may be damaged by grasshoppers, Great Basin tent caterpillars (*Malacosoma fragile* Stetch), and other insects (Nord 1965, Shaw and Monsen 1983).

Reproduction.—Plants flower in April to June, and fruits ripen in late June to August depending upon elevation and latitude (Nord 1965). Seed production is related to precipitation and leader growth in the previous year, but yields are often drastically reduced by insect predators (Shaw and Monsen 1983). Seeds dehisce rapidly at maturity. High percentages of the achenes are cached by rodents, and most successfully establishing natural recruitment is from these caches (Evans and others 1983, Nord 1965, Van der Wall 1994). Large quantities of seed are hand harvested from wildland stands each year. Dry seed may be stored in a warehouse for up to 15 years (Stevens and others 1981). A 28-day moist prechill is required to release seed dormancy (AOSA 1993, Booth

1999, Meyer 1989). Site-adapted seed sources should be selected for plantings. Antelope bitterbrush should be drill seeded in late fall or winter to provide overwinter prechilling. It may be seeded with other native species that are not highly competitive. Seeding failures resulting from rodent predation of seed can be avoided by seeding in late fall on fairly large disturbances that do not provide cover for the rodents (Evans and others 1983). Containerized or 1-0 bareroot seedlings are easily grown, but fungicide treatments may be required to reduce losses to damping-off organisms. Nursery stock can be planted on steep, rocky slopes that are inaccessible to seeding equipment. It establishes best if planted in early spring when antelope bitterbrush in the surrounding area is yet dormant. Herbaceous vegetation must be cleared around each seedling to reduce competition.

Growth and Management.—Antelope bitterbrush seedings, plantations, and wild stands are vulnerable to heavy use by wild or domestic ungulates and predation by gophers, mice, birds, and insects. Seedlings are not competitive with weedy annuals or most introduced perennial grasses. Many mature stands are damaged by continuous and close browsing by deer and livestock.

Benefits.—Next to sagebrush, antelope bitterbrush is probably one of the most widespread shrubs in the Great Basin region, although its prevalence has been reduced by range fires and exotic plant introductions (Mozingo 1987). It is important for a host of wildlife and provides nutritious browse and essential cover on fall, winter, and summer mule deer ranges (Plummer and others 1968). Protein content varies among populations depending upon over-winter leaf retention. New growth may also be heavily used in spring and summer. Because of the varied growth forms, attractive foliage, and showy flowers, antelope bitterbrush has potential as an ornamental in low-maintenance landscapes. Populations of antelope bitterbrush with distinctive attributes have been recognized and are commercially harvested and sold. Native Americans reportedly used bitterbrush as a remedy for smallpox, measles, tuberculosis, and pneumonia, and as an antiseptic for rashes and insect bites (Mozingo 1987).

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Quercus havardii Rydb. Havard shin oak
FAGACEAE

Synonyms: None

James E. Nellessen

General Description.—Havard shin oak is also known as just Havard oak, shin oak or shinnery oak, but the names sand shinnery oak, sand scrub oak, panhandle oak, and midget oak have also been applied to it (McCoy 1981). Peterson and Boyd (1998) supply a fairly comprehensive review of this species. Havard shin oak grows to 1 m tall at maturity, but hybrids with other white oak species may attain greater height. It forms dense thickets because of an extensive underground system of horizontal rhizomes. The rhizomes are usually 3 to 10 cm in diameter but may be as thick as 15 cm. Most of the rhizomes and roots occur in the upper 60 cm of soil, but the plant is known to root to depths of 9 m. The bark is gray becoming papery scaly to rough with age. The twigs are brown to grayish, smooth to densely hairy with short yellowish or grayish hairs. The buds are dark red-brown, semi-globose, and lightly hairy. The leaves are simple, alternate, leathery, somewhat variable in shape, oblong, ovate, or lanceolate in outline, with rounded shallow lobes, although sometimes they may be more coarsely toothed than lobed (the teeth are not bristle-tipped), lustrous green and often smooth above, sometimes with hairy patches, densely yellowish to brownish green felty-hairy below, the veins prominent. The leaves range in length from 1.5 to 10 cm, and in width from 1.2 to 5.5 cm, with occasionally curled or wavy margins (Carter 1997, Correll and Johnston 1970, Flora of North America 1997, Great Plains Flora Association 1986, Martin and Hutchins 1980). Havard shin oak is a member of the white oak group, (i.e. it does not bear bristle tips on the leaves and the fruits mature in the first year). There are two varieties: _Q. havardii_ var. _havardii_ and _Q. havardii_ var. _tuckeri_ Welsh (Kartesz 1994).

Range.—This species occurs from western Oklahoma, and western Texas, into the southeastern portion of New Mexico, with outlying populations elsewhere in these states and as far west as Utah and Arizona (Great Plains Flora Association 1986, Peterson and Boyd 1998). Havard shin oak has recently been documented from Kansas for the first time (Freeman 2000). The elevational range of habitats in which shin oak may occur is from 500 m to 1,525 m. Variety _tuckeri_ occurs in the Four Corners area (Utah and Arizona populations); these populations appear to be hybrids between shin oak and _Q. turbinella_ Greene (scrub live oak) and _Q. gambelii_ Nutt. (Gambel oak) (Flora of North America 1997).

Community Ecology.—Havard shin oak historically covered an estimated 5 to 7 million acres within the southern Great Plains (Peterson and Boyd 1998). Of this, 1 million acres occurred in Oklahoma, 1.5 million acres in New Mexico, and 3.5 million acres in Texas. About 30 percent of the acreage in Texas has been converted to cropland and grassland, and about 10 percent has been converted in Oklahoma and New Mexico. Shin oak occurs on deep sandy soils and plains, including sand dunes, and is the major shrub species comprising Plains-Mesa Sand Scrub vegetation in southeastern New Mexico and similar sandy soil habitats in western Texas including portions of the Llano Estacado ("staked" plains) (Dick-Peddie 1993). The shin oak or shinnery vegetation series variously places Havard shin oak in dominance with _Schizachyrium scoparium_ (Michx.) Nash (little bluestem), _Artemisia filifolia_ Torr. (threadleaf sagebrush), _Andropogon hallii_ Hack. (sand bluestem), _Aristida purpurea_ Nutt. (purple three-awn), _Bothriochloa saccharoides_ (Sw.) Rydb. (silver beardgrass), _Yucca campestris_ McKelvey (plains yucca), *Atriplex canescens* (Pursh) Nutt. (four-wing saltbush), *Sporobolus airoides* (Torr.) Torr. (alkali sacaton), and *Eriogonum annuum* Nutt. (annual buckwheat). But there are a wide variety of other shrubs, forbs and grasses comprising numerous other vegetation series within the greater shinnery community. The tall grasses such as sand bluestem, big bluestem (*Andropogon gerardii* Vitmann), and Indiangrass [*Sorghastrum nutans* (L.) Nash] have been reduced in abundance through overgrazing of Havard shin oak communities. Havard shin oak itself may remain stable or also decrease with overgrazing, the cover of grass and Havard shin oak often being positively correlated. Stands of Havard shin oak on sites with shallow water tables, such as in Chavez County New Mexico, may contain cottonwoods. Hybrids with other oak species, such as *Q. stellata* Wang (post oak), occur and may be found within typical Havard shin oak stands, the hybrids often attaining greater height (2 to 3 m), and stand out as readily visible clumps from the surrounding shorter plants. These hybrids tend to have intermediate characteristics such as larger leaves and smaller acorns. These hybrids tend to be more common within the eastern portion of Havard shin oak's range (Correll and Johnston 1970, Flora of North America 1997, Peterson and Boyd 1998). Havard shin oak also hybridizes with *Q. mohriana* Buckley ex Rydb. (Mohr shin oak) that occurs within the rocky "breaks" area of the Texas panhandle. Hybrids are intermediate in characteristics and habitat location (Muller 1952).

Autoecology.—The plant primarily spreads by its underground rhizomes to form large clonal clumps that may range in size from as small as 2 to 15 m in diameter to as large as 0.8 ha. Isozyme electrophoresis identified 37 clones/ha, larger clones being free of interclonal growth, and the sample population was outcrossing based on Hardy-Weinberg expected genotype ratios (Mayes and others 1998). There are no data on horizontal growth rates but they are believed to be slow. The plants are long-lived, estimated at hundreds to thousands of years (Peterson and Boyd 1998). The rootstocks are massive, comprising the bulk of the plant mass (73 percent); the above-ground shoots are merely small side shoots to the below ground parts. Above-ground biomass has been measured at 1,821 kg/ha (Sears and others 1986) and annual production has been estimated to be anywhere from 550 to 4,500 kg/ha depending on the site (reviewed in Peterson and Boyd 1998). The roots (which are mycorrhizal) and rhizomes absorb considerable amounts of water during wet weather with up to 50 percent of their mass being water. This gives the plant a great ability to survive drought. During spring drought it may not leaf out or may defoliate and leaf out later once water becomes available. It generates more negative leaf water potentials, -25 to -32 bars, than many other species in the surrounding community. Soils under shin oak, in addition to being sandy, are low in nitrogen (0.017 percent), low in organic matter (0.36 percent) neutral to slightly alkaline in pH, and low in clay and carbonates (a caliche layer is inhibitory). Havard shin oak has been reported to have allelopathic effects on other plant species.

Reproduction.—Shin oak flowers in April to May. As with other oaks, male flowers are born in pendulous catkins, the female flowers solitary or a few clustered within leaf axils. The male catkins are 2 to 3 cm long and densely flowered. The female catkins are 3 to 7 mm long with one to five flowers. For a small shrubby oak, the acorns are quite large, 12 to 25 mm long, up to about 20 mm wide, brown, ovoid to oblong in shape. They are born solitary or in pairs and the cup, 10 to 12 mm deep, covers about a third to a half of the fruit. The fruits mature from mid-July into September during the first year of development on the current season's branches (Carter 1997, Correll and Johnston 1970, Flora of North America 1997, Great Plains Flora Association 1986, Martin and Hutchins 1980). Acorns of the white oak group, show little or no dormancy, and will germinate immediately (Young and Young 1992). Acorn moisture content for this group cannot drop below 30 to 50 percent otherwise seed viability will be lost. Within a particular clone, acorn crops generally only occur every 3 to 10 years. Within a larger landscape scale area containing many different clones, at least one or a few clones will have acorns. Most acorns are attacked by weevils and will decompose quickly. There is little reproduction by seed because of the short lifespan of the acorn, the need for good environmental conditions for germination and establishment at the time of acorn drop, attack by weevils, and decomposers.

Growth and Management.—For purposes of agriculture and livestock, shin oak has generally been managed as an undesirable species. Havard shin oak has sometimes been classified as an increaser under livestock grazing, but reports do not substantiate this (reviewed in Peterson and Boyd 1998). Its poor reproduction by seed restricts its spread primarily to the slow growing rhizome system. An estimated 100,000 acres of land in New Mexico have been treated with the herbicide tebuthiuron for brush control. Tebuthiuron gradually kills the plant over a 3 to 4 year period. Other chemicals that have historically been used on Havard shin oak are 2,4-D, benzoic acids, 2,4,5-T, and picloram. Tebuthiruron should not be used in drought years, and the treated land should not be summer grazed for 2 years. Various techniques of rotational and continuous grazing in shin oak communities have been tested with mixed results for livestock productivity. But rotational grazing is best for overall ecosystem management including maintenance of proper native grass covers, and management of the lesser prairie chicken and perhaps other wildlife. Goats have been used to control shin oak with reasonable success, although goats eating it continuously will lose weight. In addition to livestock use and direct agricultural conversion of shin oak habitat, another reason for shin oak management concerns the boll weevil (*Anthonomus grandis* Boheman). This cotton pest is known to overwinter in oak leaf litter and to reinfest cotton fields for up to a half mile away (reviewed in Peterson and Boyd 1998). Above-ground shoots may live 11 to 15 years. Shoot regeneration is rapid, 30 to 60 cm within the first year, when above ground tissues are removed mechanically or through fire. The response to fire is variable and dependent on timing of the fire. Burning reduced shin oak cover by at least 25 percent, with the greatest reduction, 50 percent, following spring burns (Boyd and Bidwell 2002). Winter and annual fires increased rhizomatous grass cover, and although oak cover was reduced, regrowth resulted in greater stem densities (e.g. increasing from 20 stems/ha to 40 stems/ha).

Benefits.—The sandy soils that Havard shin oak grows in are susceptible to wind erosion. The extensive underground rootstock system and dense above ground shoots make it an important soil stabilizer. Oak leaves can be good forage for sheep and goats, but are less utilized by cattle. Consumption of too much, especially young spring shoots, can be toxic and result in illness or even death for cattle and lambs (Gay and Dwyer 1998, Warnock 1974). As with many oak species, toxicity is due to phenolics and tannins. Later in the growing season cattle will utilize it in small and varying degrees. The crude protein content of foliage is about 9 percent. The plants are browsed by deer, pronghorn antelope, and southern plains woodrats. Phenolic content (15 to 20 percent) of catkins and buds were higher in livestock grazed plots than ungrazed plots. Crude protein and other nutritional qualities did not differ between treatments (Boyd and others 2001). The acorns are eaten by a variety of wildlife and are a staple food for lesser prairie chickens (*Tympanuchus pallidicinctus* Ridgeway) in the fall and winter seasons. Havard shin oak communities are important breeding and nesting habitats for the lesser prairie chicken. Prescribed fire in shin oak habitats can improve grass and forb cover and associated insect abundance for prairie chickens but at least a 2 to 3-year recovery period, no burning in spring, and burning in patches are necessary (Boyd and Bidwell 2001). The rare sand dune lizard (*Sceloporus arenicolus* Degenhardt and Jones), a threatened species in New Mexico, is restricted to Havard shin oak communities. Both Native Americans and early Spanish colonists would eat the acorns raw or baked. A flour can be made from the large acorns by first boiling them, then roasting, chopping into pieces, drying for 30 minutes, then passing them through a grinder a couple of times (Warnock 1974).

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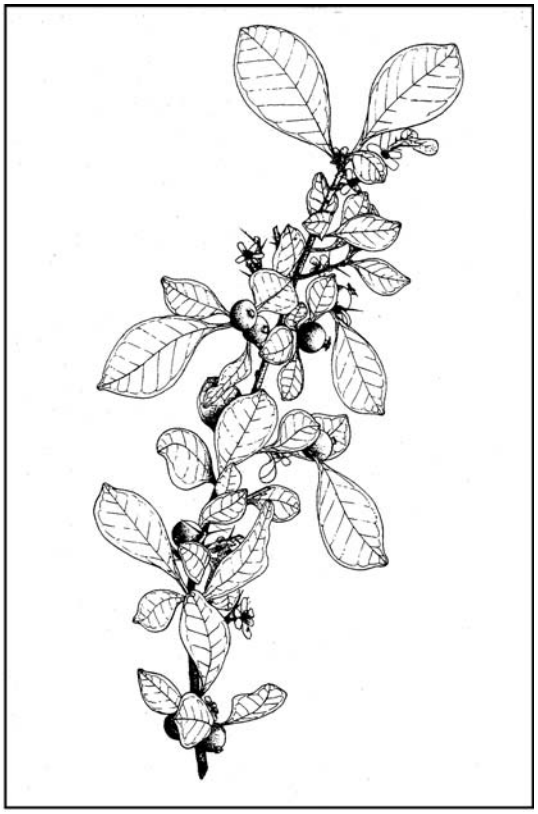
***Randia aculeata* L.** white indigo berry

RUBIACEAE

Synonyms: *Randia mitis* L.
Gardenia randia Sw.
Randia latifolia Lam.
Randia aculeata L. var. *mitis* (L.) Griseb.

John K. Francis



General Description.—White indigo berry is a shrub or small tree from 2 to 6 m in height. It is spiny and may have one to several stems. White indigo berry has smooth to slightly fissured gray bark, opposite, often horizontal, branches, a thin crown, and rough appearance. The plant is supported by an extensive tap and lateral root system. The roots have a corky, ivory colored bark and are stiff and woody. The spines are paired and the foliage is crowded on the ends of short lateral twigs. The leaves are almost stalkless and entire, ovate, obovate, or orbicular. They are 1 to 6 cm long and 0.5 to 3 cm broad, slightly thickened, shiny green above and light green below. The solitary flowers are small, white, funnel-shaped, with a five-lobed corolla, and located on very short lateral spurs. The 6- to 13-mm, globose, white fruits (or ivory with a salmon blush), with a brittle shell-like skin, have a blue or black pulp and five to 10 round, flattened seeds (Howard 1989, Liogier 1997, Little and others 1974). There are populations and transition populations with and without spines, with large leaves and small leaves, and with large and small fruits. These gave rise to variety designations that are no longer recognized (Howard 1989). White indigo berry is also known as box-brier, inkberry, prickle bush, fishing rod, five fingers, goat horn, tintillo, tintero, palo de cotorra, árbol de navidad, sota-caballo, resuelesuele, café cimmarrón, espino cruz, crucete, crucito, maíz tostado, raboe, peetsch-kitam, cabai nache, croc-à-chien, bois-lance, ti coco, and petit coco (Howard 1989, Little and others 1974).

Range.—White indigo berry is native to southern Florida, Bermuda, the Bahamas, the Caribbean Islands, and from Mexico through Central America and South America as far south as Colombia (Little and others 1974, Smithsonian Institution 2001). It is not known to have naturalized outside its native range.

Ecology.—White indigo berry grows in most types of soils including excessively drained and well drained, but not poorly drained soils. It inhabits areas that receive from about 700 to 2200 mm of annual precipitation from near sea level to over 600 m of elevation in Puerto Rico. In Florida, white indigo berry grows in unburned pinelands and along the margins of coastal hammocks (Nelson 1996). In Puerto Rico, the species grows in dry and moist forests, more commonly over limestone rocks, but also over igneous rocks and ultramafics (serpentine). Because white indigo berry is moderately intolerant of shade, it must grow in openings or under low-density forest. The species invades abandoned land, but not quickly, and because of slow growth, is not common in early secondary forest following cultivation. However, white indigo berry does hang on tenaciously after disturbance and is prominent in secondary forests arising after logging or partial clearing for pasture. Plants are usually well disbursed and seldom, if ever, form thickets.

Reproduction.—White indigo berry blooms and fruits irregularly throughout the year. Fruits (n = 73) collected in Puerto Rico weighed an average of 0.472 $\pm$ 0.014 g/fruit. Fourteen of the fruits contained from three to 14 seeds and averaged 8.2 seeds. The air dry seeds from these fruits averaged 0.0264 $\pm$ 0.0003 g/seed or 38,000 seeds/kg. Sown in commercial potting mix, 25 percent germinated between 46 and 168 days after sowing.

Growth and Management.—Weaver (1990) measured 12 plants over a 5-year period in closed low forest in St. John, U.S. Virgin Islands and found the vary slow diameter growth rate of 0.06 $\pm$ 0.02 cm/yr. A 1-m tall sapling in a moist area of Puerto Rico with a basal diameter of 2 cm had 10 growth rings (author's observation). Ornamental plants also grow slowly (Workman 1980). Seeds for nursery production should be cleaned by maceration and wet sieving before sowing. Production of seedlings in containers is recommended. Because growth is slow, a year or more in the nursery is required followed by protection from weeds in the field.

Benefits.—White indigo berry has been used as an ornamental to a limited extent in Florida and, because it is native and resists drought and hurricanes, it is currently being recommended for planting (Dade County 2001). It is available as nursery-grown plants, and plants from the wild can be successfully dug up and transplanted. The fruits are edible although of poor flavor (Workman 1980). White indigo berry provides food and nesting sites for birds (Vélez and van Overbeek 1950) and nectar for butterflies (Dade County 2001). The wood is hard and heavy and useful for fuel. The shrub is sometimes decorated for a Christmas tree, hence the Spanish name, árbol de navidad. Other names (tintillo and inkberry) arose from the former use of the berries for dye and for ink (Little and others 1974). The plant is also frequently formed into bonsai plants. The fruits are used in herbal medicine to control dysentery. An unspecified part of the plant is used to control fever, and the latex is reported to effectively stop bleeding (Liogier 1990).

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Rauvolfia viridis **Willd. ex Roemer & J.A. Schultes** bitter bush
APOCYNACEAE

Synonyms: *Rauvolfia lamarckii* A. DC. in DC.
Rauvolfia latifolia A. DC in DC.
Rauvolfia lanceolata sensu Griseb.

John K. Francis

General Description.—Bitter bush, also known as bellyache bush, balsam, sassafras, milk tree, and ti bois-lait, is a branchy shrub to 2.5 m in height (Howard 1989, Liogier 1995). The species rarely becomes a small tree to 4 m in height (Liogier 1995) and 7 cm in diameter at breast height (Weaver 1990). Usually, there are multiple stems, as suckers arising from lateral roots, especially after fire or other disturbance. The root system is dominated by lateral roots, which support sinker roots and a moderate amount of fine roots. The ovate or ovate-elliptic leaves are 5 to 15 cm long by 3 to 5 cm broad, and grow in whorls of four or rarely three leaves. The several- to many-flowered inflorescences are usually terminal. The tiny flowers are tubular and white. The fruits are spherical or slightly flattened and 5 to 8 mm in diameter. Each contains two seeds (Howard 1989, Liogier 1995).

Range.—According to Howard (1989) and Liogier (1995) bitter bush is native to Hispaniola, Puerto Rico, the Virgin Islands, the Lesser Antilles, Trinidad, Margarita, and Venezuela. There are also records for Cuba (Martínez-Pérez and others 1997), Navassa Island (New York Botanical Garden 2001), Costa Rica (Departamento de Botánica 1999), and Colombia (Missouri Botanical Garden 2001).

Ecology.—In Puerto Rico, bitter bush grows in dry and moist forests that receive from 750 to about 1700 mm of annual precipitation. Usually rocky or otherwise poor sites are colonized in areas of both igneous and sedimentary (including limestone) rocks. The species grows from near sea level to about 400 m in elevation. Bitter bush requires full or partial sunlight. It grows in open, disturbed areas and low basal area, secondary and remnant forest. It withstands competition from herbs and shrubs well but eventually succumbs to competition from tall grass swards and closed forests. Although never abundant, the species becomes more common in overgrazed areas.

Reproduction.—A sample of bitter bush fruits collected in Puerto Rico weighed an average of 0.124 ± 0.005 g/fruit. Air-dried seeds separated from these fruits averaged 0.0247 ± 0.0004 g/seed or 40,500 seeds/kg. Sown in commercial potting mix without any pretreatment, 5 percent germinated after 11 months. Birds that eat the fruits disburse the seeds.

Growth and Management.—Growth of bitter bush is slow. The author estimated height growth of young shrubs from sprouts at 0.5 m/year. Weaver (1990) measured the diameter growth rate of two old small trees and found an average of only 0.01 cm/yr. No planting or management experience has been reported.

Benefits.—The roots of bitter bush were analyzed for alkaloids. Ajmalidine, a-yohimina, reserpinine, quebrachidine, and yohimbina were isolated. Reserpine, a sedative present in other *Rauvolfia*s, was not found (Martínez Pérez and others 1997). Bitter bush furnishes minor food and cover for birds and other wildlife. With other dry forest vegetation, it protects the soil from erosion.

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***Rhododendron macrophyllum* D. Don ex G. Don** Pacific rhododendron
ERICACEAE

Synonyms: *Hymenanthyes macrophyllum* (D. Don ex G. Don) H.F. Copel
Rhododendron californicum Hook.

Christopher Ross

General Description.—Pacific rhododendron, also known as coast rhododendron and California rosebay, is a coarse-branched evergreen shrub to 4 m tall. The alternate leathery ovate to obovate leaves are 7 to 15 cm long and 3 to 6 cm wide. Flowers are showy and bell shaped, about 4 cm long, with rose pink to purple corolla, five petals, five sepals, and 10 stamens (Wallace 1993).

Range.—Pacific rhododendron occurs near the Pacific coast from British Columbia south to Monterey, California, and in the coastal and Cascade mountain ranges of Oregon, Washington, and California (Hitchcock and others 1959, Wallace 1993). It occurs in redwood, Douglas fir, yellow pine, and mixed evergreen forests fron sea level to over 1,000 m elevation (CalFlora 2000).

Ecology.—Pacific rhododendron grows in acidic (pH 5.5) to neutral fine textured soils (USDA 2002). Pacific rhododendron, like many others of the genus, is highly toxic to humans and animals. The poison is a neurotoxin, andromedotoxin, or grayanotoxin, which has occasionally caused large livestock losses (Kingsbury 1964). About 30 diterpine, polyhydroxylated cyclic hydrocarbons are found in rhododendrons and related species (Harborne and Baxter 1993). Sucking nectar from flowers has caused illness in humans, as has consumption of rhododendron honey (Alberta Government 2002). The species has recently been identified as a host of the algae *Phytophthora ramorum* responsible for sudden oak death in California, but the effects are not yet known (University of California Cooperative Extension 2002). A variety of insect and fungi may attack rhododendrons, including several caterpillars such as cutworms, loopers, and leafrollers (Foss and Antonelli 1999).

Reproduction.—Pacific rhododendron flowers are insect pollinated. Fruits are oblong capsules that split along the sides to release minute seeds (4400 to 12,500/g) after ripening. Germination occurs with no pretreatment, but requires light (Young and Young 1992). Vegetative reproduction by crown sprouting is common after fire, logging, and other disturbance. Propagation is by seeds or cuttings.

Fire Effects.—Rhododendron has been classed as a residual shrub (rather than a colonizer) after fire (Dyrness 1973). It recovers well but slowly after fire, primarily from vegetative sprouting from root crowns and stem bases. Fire dramatically reduces it initially, and peak abundance is not reached until late in the fire recovery process (Halpern 1989). It is scarce after severe burns (Dyrness 1973).

Growth and Management.—Pacific rhododendron typically occupies drier sites within its range (Dyrness 1973). Like some other rhododendrons, it may have a mycorrhizal relationship that enables it to thrive on low-nutrient soils (USDA USFS 2002). The tendency to resprout from stem crowns has caused difficulty for conifer reforestation (Halverson and others 1986), so that spring spraying with triclopyr has been used for control in some areas (Burrill and others 1989). At California's Kruse Rhododendron

State Reserve, Pacific rhododendron is considered to be an early seral stage after fire or logging, and before tanoak, which is being thinned in order to set back the succession process and maintain the rhododendrons (California State Parks 2002).

Benefits.—Pacific rhododendron is widely available from commercial nurseries and is valued for native landscaping purposes. It has served as a source of genetic material for many ornamental cultural selections. It is also used in erosion control (Olson 1974). It has no other common uses (USDA 2002).

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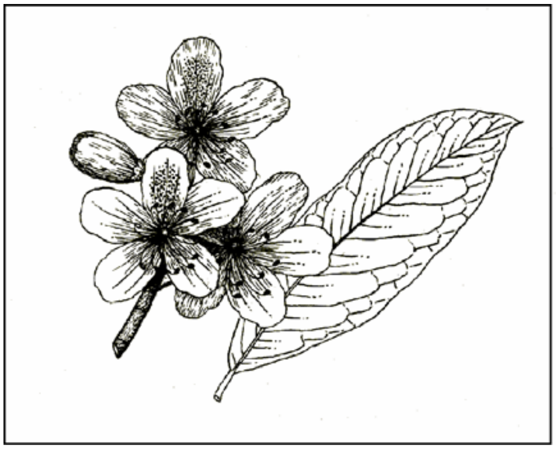
***Rhododendron maximum* L.** rosebay rhododendron
ERICACEAE

Synonyms: none

Barton D. Clinton



General Description.—Rosebay rhododendron, sometimes known as 'great laurel', is an understory evergreen shrub. It ranges in height from 2 to 8 m, and can occasionally reach diameters of 20 to 25 cm. Leaves are schlerophyllous, simple, alternate, and oblong (10 to 30 cm long, 5 to 8 cm wide). It retains its waxy, deep-green leaves for up to 8 years, but once shed are slow to decompose. It produces large, showy, white to purple flowers each June.

Range.—Worldwide, there are over 800 species in the genus *Rhododendron*. Most of the 26 North American species occur in the East along the mountain chain stretching from Nova Scotia in the north to Georgia and Alabama in the south, but are concentrated in the southern Appalachians (Dobbs 1998). Rosebay rhododendron is the most frequently occurring and dominant species of this genus in the southern Appalachian region (Swanson 1994), and occurs occasionally on mesic hill-slopes throughout the upper Piedmont Crescent of the Southeastern United States.

Ecology.—Approximately 1.2 million ha in the southern Appalachians are occupied by this species (Dobbs 1995) where it dominates the understory. This species has historically been confined to riparian areas and other mesic sites but takes advantage of disturbed areas where it is present to advance onto sub-mesic sites. It prefers deep well-drained acid soils high in organic matter where it produces a thick, peat-like humus. It prefers low to medium light conditions for optimum carbon gain, and has a tremendous capacity for avoiding cavitation during freeze-thaw cycles (Lipp and Nilsen 1997). Where extensive overstory mortality has eliminated most of the overstory, this species forms a thick and continuous subcanopy known locally as 'laurel slicks' or 'laurel hells'. Rosebay rhododendron is an important structural and functional component of southern Appalachian forest ecosystems. What isn't clear is whether or not we are in a period of advancement or retreat for this species. For example, on poorly drained sites on ridge or upper slope positions, large areas of rosebay rhododendron, particularly at the high elevations, have recently died out presumably due to the *phytophthora* fungus, or due to recent prolonged periods of below-average precipitation. Yet, rosebay rhododendron now occupies sites that historically were free of evergreen understory. There are still important questions to be answered regarding this species to completely understand its role in forest understories.

Reproduction.—Rosebay rhododendron is clonal. It is capable, however, of reproducing both vegetatively and sexually. It reproduces vegetatively through a process called 'layering' where it produces roots from aboveground woody parts when in contact with the forest floor. The fruit is produced from showy flowers from March to August. The fruit is an oblong capsule that ripens in the fall, and splits along the sides soon after ripening to release large numbers of minute seed (approx. 400 per capsule) (Schopmeyer 1974). Microsite requirements for seed germination are relatively specific (e.g., high in organic matter such as rotting logs); hence, the majority of reproduction is vegetative resulting in a clonal distribution.

Growth and Management.—Seeds from rosebay rhododendron are minute and it is estimated that approximately 11 million are contained in 1 kg. Commercial seed production is generally from cultivated hybrids. Seeds from wild sources are not commonly sold commercially. Rosebay rhododendron is a slow-growing shrub and has a very high sprout potential. If mechanical removal is attempted in the case of forest management, extremely high densities are attained by this species in a manner of a few years. Prescribed fire has also been used to control this species but with limited success (Clinton and Vose 2000).

Benefits.—Rosebay rhododendron is a striking and aesthetically pleasing feature of mesic southern Appalachian forests. It is one of the largest and hardiest rhododendrons grown commercially. Several cultivars with white to purple flowers have been selected for the horticultural trade (Brown and Kirkman 1990). Where it occurs naturally, it produces a showy, white, pink, or light purple flower primarily in June, but occurs from March into August. Rosebay rhododendron maintains deep-green foliage year round. This species affords protection to steep watersheds and shelter for wildlife. The wood is very hard and is occasionally used for specialty wood products.

Detrimental Effects.—For all its prized qualities as a naturally occurring component of the landscape or as plantings in residential and commercial landscaping, rosebay rhododendron can have an inhibitory effect on regeneration of other plant species. There is some evidence to suggest that due to fire suppression and the absence of other cultural activities (i.e., mountain-land grazing), this species has advanced beyond the mesic forest sites into sub-mesic understories (Dobbs 1998). The significance of this movement onto previously unoccupied sites centers around the impacts of rosebay rhododendron on plant succession (Clinton and Vose 1996) and resource availability (Nilsen and others 2001). Rosebay rhododendron is associated with reduced woody and herbaceous seedling abundance throughout its range, and hence poses a serious impediment to the production of wood products. The mechanism(s) by which rosebay rhododendron reduces seedling survival has been the subject of much debate. Possible sources of inhibition include allelopathy, competition for resources including light, physical and chemical attributes of the forest floor and soil, and interactions between some or all sources (Nilsen and others 1999, Nilsen and others 2001).

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***Rhus copallinum* L.** shining sumac

ANACARDIACEAE

Synonyms: None

Kristina Connor

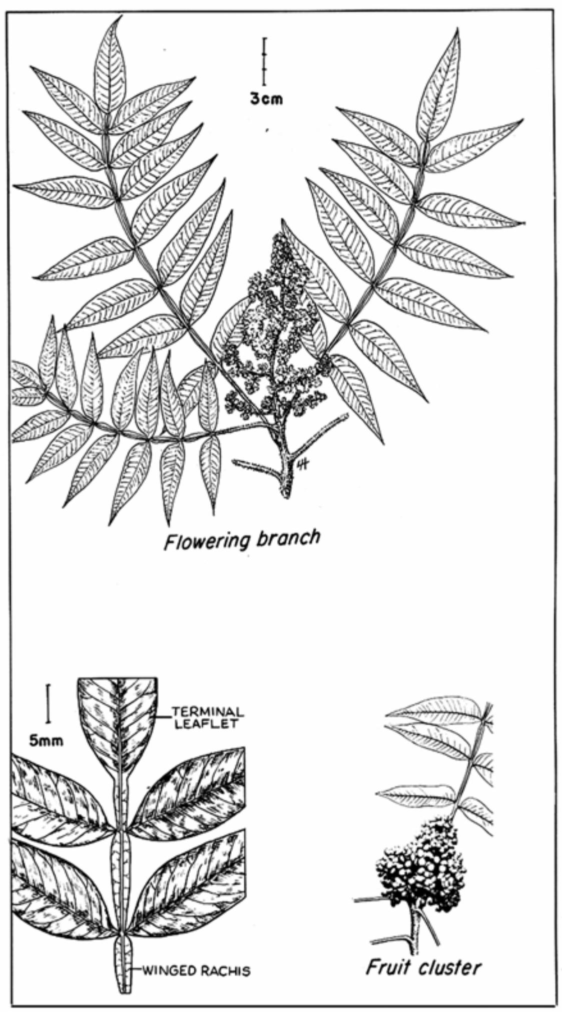

Illustration source: Grelen and Duvall 1966

General Description.—Shining sumac, also known as black sumac, dwarf sumac, flameleaf sumac, mountain sumac, shiny sumac, and winged sumac, is an upright, deciduous shrub or (rarely) small tree from 3 to 6 m tall (Bailey and Bailey 1976, Odenwald and others 1996). Bark ranges in color from light brown to gray to reddish-brown. Shoots and twigs are hairy and reddish in color. Twigs have conspicuous lenticels. The sparsely branched, flat crown is composed of alternate, pinnately compound leaves approximately 15 to 30 cm long, with wings between each of the 7 to 27 glossy, dark green leaflets (Brickell and Zuk 1996, Odenwald and others

1996, Seiler and Peterson 2001). Leaflets are paired, olbong-lanceolate in shape, and from 3 to 10 cm long (Bailey and Bailey 1976, Krussmann 1976, Johnson and Hoagland 1999). Buds are glabrous, and terminal buds are absent (Synor and Cowen [no date]). Sap is sticky and yellow (Johnson and Hoagland 1999).

Range.—Shining sumac grows from southern Ontario south along the Coastal Plain to Florida. It extends westward into eastern Texas, and inland from central Michigan and Wisconsin to Kansas and Oklahoma (USDA-ARS [no date], Coladonato 1992). It is also found in Cuba. Recognized varieties are *R. copallinum* var. *latifolia* Engl., *R. copallinum* var. *lanceolata* Gray, and *R. copallinum* var. *leucantha* (Jacq.) DC (USDA-ARS [no date], USDA-NRCS 2001).

Ecology.—Shining sumac is a deciduous, clonal shrub. It is an early pioneer species and grows best on well drained soils in full sunlight (Coladonato 1992, Odenwald and others 1996, Seiler and Peterson 2001). It can form thickets in abandoned fields, along roadsides, in glades and open woods, and in waste areas (Tenaglia 2002, Oplin 2001, Arborquest 2001). It is difficult to get rid of, once established, due to its ability to spread from rhizomes (Arborquest 2001). This characteristic also makes it well adapted to fire (Coladonato 1992). Shining sumac will tolerate compacted soil, drought, pollution, heavy pruning, and transplanting, but the shallow roots make it susceptible to uprooting and the stems can break in strong wind storms (Arborquest 2001). It can be a serious competitor with young pines and hardwoods (Coladonato 1992).

Reproduction.—Shining sumac is a clonal species which sprouts from roots and the root crown. It also regenerates sexually (Coladonato 1992). From May to August, plants produce panicles of small yellow-green dioecious flowers that have five petals and five sepals (Tenaglia 2002). The panicles are pubescent, about 12 to 15 cm long, and can be either terminal or axillary (Brickell and Zuk 1996, Johnson and Hoagland 1999, Krussmann 1976). Brown and Kirkman (1990) report the presence of polygamous flowers but state that shining sumac is functionally dioecious since the pistils of the polygamous flowers abort. Thus, both male and female plants are needed for good fruit set to occur (Arborquest 2001) The 3- to 5- mm pubescent fruits are small drupes that contain a single nutlet (Coladonato 1992). Fruits ripen from August to October. They turn dark red when ripe and often remain on the plant throughout the winter. The hard-coated seeds germinate poorly without pretreatment, but a 1 hr soak in sulfuric acid at room temperature can result in a 75 percent germinative capacity (Brinkman 1974).

Growth and Management.—Shining sumac is a fast growing but short lived clonal shrub, first cultivated in 1688 (Brinkman 1974). It is planted as an ornamental and used in mass plantings because of its brilliant red fall foliage but it can spread well beyond desired borders because of its ability to sprout from the roots.

Benefits.—Shining sumac is nonpoisonous to humans (USDA-ARS [no date], Seiler and Peterson 2001, Synor and Cowen [no date]), and the fresh fruits can be used to make a lemon-tasting beverage. It was also used by Native Americans to treat dysentery and mouth sores (Tenaglia 2002). Dense thickets of shining sumac serve as cover for birds and mammals. The seeds are eaten by a variety of birds, while the flowers attract butterflies. Deer and rabbits commonly browse the twigs in winter; rabbits also eat the bark (Grelen and Duvall 1966, Oplin 2001, Arborquest 2001, Coladonato 1992). It is not, however, a preferred food and is considered a poor to moderately important browse (Coladonato 1992). However, the seeds, bark and leaves, while low in nutritive value, have a high tannin content and have been used by the leather industry (Bailey and Bailey 1976, Brown and Kirkman 1990, Coladonato 1992). Its ability to sprout from the roots, coupled with its rapid growth rate, make shining sumac a good species to plant for erosion control (Arborquest 2001).

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***Rhus glabra* L.** smooth sumac
ANACARDIACEAE

Synonyms: *Rhus borealis* Greene
Rhus calophylla Greene
Rhus canadensis Mill.
Rhus carolineana Mill.
Rhus cismontana Greene
Rhus occidentalis (Torr.) Blank. (additional synonyms: Institute of Systematic Botany 2003).

John K. Francis

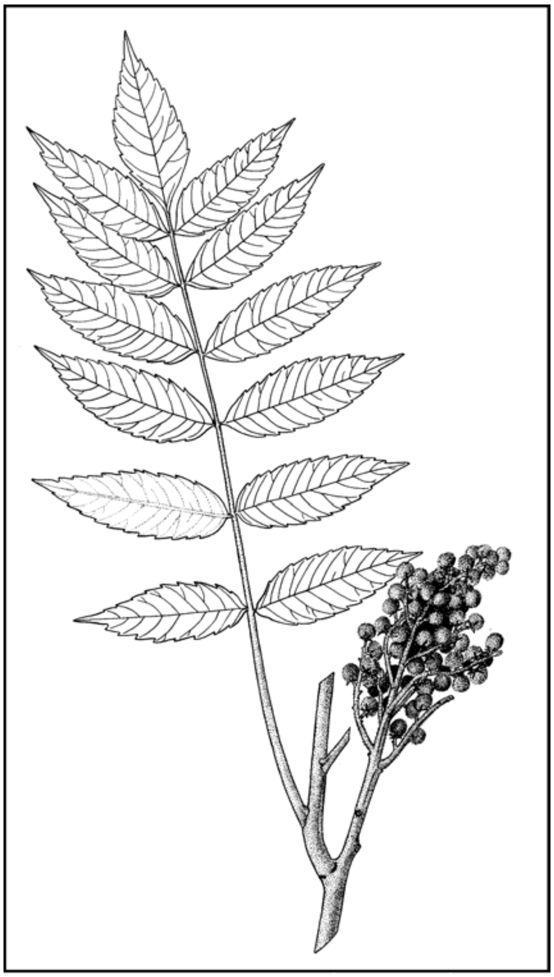

Illustration source: USDA-Forest Service collection, Hunt Institute

General Description.—Smooth sumac, also known as common sumac, Rocky Mountain sumac, red sumac, scarlet sumac, lemonade sumac, western sumac, and white sumac, is a deciduous shrub or a small tree from 0.5 to 6 m in height and 1 to 18 cm in stem diameter. It usually has a single gray-brown stem but often occurs in clonal thickets formed by suckers from horizontal roots. The relatively few branches and twigs are thick, have a soft pith, and large, horseshoe-shaped leaf scars. Stems and branches ooze a milky-resinous sap when cut. The alternate leaves are uneven, pinnately compound, up to 46 cm long, and support seven to 29 leaflets. Leaflets are almost stalkless and have serrate edges. (Clark 1973). The foliage turns a brilliant red or scarlet during the fall. Small, greenish-yellow flowers are grouped in tight, 15- to 25-cm terminal panicles. The fruits are dry, hairy, red to scarlet drupes that contain one hard ovoid, dark-gray nutlet. The fruits have a tangy, sour taste (Johnson 1995). Smooth sumac is dioecious (male and female plants) (Wyman 1969). Total above-ground dry biomass may be predicted by the equation: dry weight = 1.5130 + 0.6292 D^2H, where D = diameter at 1 cm above groundline, H = total height and r^2 = 0.974 (Reeves and Lenhart 1988).

Range.—Smooth sumac is native to every state of the United States (except Alaska and Hawaii) and from Nova Scotia to British Colombia and south into northern Mexico (Abrams 1951, Fire Sciences Laboratory 2003, Natural Resources Conservation Service 2003). However, it is most common in the eastern half of United States north of Florida (Hutchison 2003). It has been planted widely as an ornamental but has not been reported to have naturalized outside its native range.

Ecology.—Smooth sumac prefers rich, well-drained soil but will grow on excessively drained, sandy soils and eroded sites without topsoil. In much of the Eastern range, it grows as a seral species on disturbed sites such as logged areas, abandoned fields, neglected pastures, old construction sites, strip mines, stream overflow areas, roadsides, and fence rows (Hutchison 2003).

In Western areas it grows in stable communities on mountains, hillsides, and canyons. The species is used as a climax indicator in a number of shrub-grassland communities (Fire Sciences Laboratory 2003). Smooth sumac usually grows with full sun but tolerates partial shade. It grows from low elevations in many areas and up to 2,100 m in Arizona (Kearney and Peebles 1951).

Reproduction.—Smooth sumac flowers from May to late July, depending on location. Fruits ripen in September and October and persist through the fall and winter (Fire Sciences Laboratory 2003). The flowers are pollinated by bees (Rowe and Blazich 2003). Smooth sumac produces at least some fruits and seeds nearly every year (Fire Sciences Laboratory 2003). There are about 2,000 seeds per well-formed panicle (Browse-Shrub and Forb Committee 1985), much less in some areas and during dry years. Rowe and Blazich (2003) report 50,600 to 105,600 fruits/kg and 52,800 to 277,200 seeds/kg. Plummer and others (1968) found 137,700 seeds/kg in samples from Utah. Air-dried fruits collected by the author in Utah averaged 0.0202 $\pm$ 0.0004 g/fruit. Seeds separated from them averaged 0.0103 $\pm$ 0.0002 g/seed or 97,000 seeds/kg. The seeds are dispersed principally by birds and form a soil seed bank (Fire Sciences Laboratory 2003). Once individual plants are established, horizontal roots sucker to form clonal thickets.

Nursery plants are usually produced from seed, although production from cuttings is also done to preserve favorable traits of select strains (such as assuring only female plants). Rootstalks pulled up from wild stands in the early spring when the ground is wet will survive almost 100 percent if planted properly (Plummer and others 1968). Seed can be collected in quantity by hand in fall or early winter. Seeds may be separated from the fruits by rubbing or beating followed by screening (Rowe and Blazich 2003) and can be stored for as long as 5 years without loss of viability (Fire Sciences Laboratory 2003). Scarification to break physical (endocarp) dormancy may be done by a 3 to 4 hr soak in concentrated sulfuric acid (Rowe and Blazich 2003) or emersion for less than 1 min. in boiling water (Li and others 1999).

Growth and Management.—Smooth sumac has a moderate growth rate of 30 to 46 cm in height per year (Michigan State University Extension 1999). Although clones may last much longer, individual stems are not long-lived, perhaps 2 to 10 years. It requires more than ordinary maintenance to keep smooth sumac from spreading vegetatively. One method of keeping plants in check is to establish them in soil space limited by rock or concrete barriers (Clark 1973). The tops are killed by fires, but underground rhizomes (7.5 to 30 cm deep) are not damaged and sprout vigorously, increasing the density and extent of smooth sumac stands. Seeds from the soil seed bank are also stimulated to germinate. Spring fires are more beneficial than late summer fires (Fire Sciences Laboratory 2003). When it is necessary to control the plant, it is recommended that they be lopped during or shortly after flowering and the sprouts spot-sprayed with glyphosate (Hutchison 2003).

Benefits and Detriments.—Smooth sumac helps protect the soil in disturbed areas, adds to the aesthetics of wildlands, and furnishes food and cover for wildlife. The fruits are eaten by a wide variety of birds (Johnson 1995). Smooth sumac foriage is rated poor in both energy and protein value (Fire Sciences Laboratory 2003). White tail deer (*Odocoileus virginianus*) browse it during fall and winter but do not weaken the plants (Strauss 1991). It is also browsed by mule deer (*Odocoileus hemionus*) (Fire Sciences Laboratory 2003). Smooth sumac is valued as an ornamental for its brilliant red and scarlet fall colors and because it can be planted almost anywhere in the Continental United States. It is particularly useful for vegetating sandy banks and for low screens (Clark 1973) and has been recommended for establishing “living snow fences.” The species has been planted to revegetate roadsides and cuts, landfills, and strip mines (Fire Sciences Laboratory 2003, Plummer and others 1968). In addition to using dried leaves as an adulterant for tobacco and making drinks from the fruits, Native Americans employed smooth sumac to treat a large number of ailments, particularly mouth and throat sores, burns, to control diarrhea, and to promote urination (Fire Sciences Laboratory 2003, Giese 1996, Moerman 1986). Basis for medicinal uses may be found in the fact that methanol extracts of ground branches were effective (although not as effective as commercial antibiotics) against total of 11 species of bacteria. The antibacterial compounds were identified as methyl gallic acid, gallic acid, and the methyl ester of 3,4,5-trihydroxybenzoic acid (Saxena and others 1994). Some people develop allergic dermatitis after contacting the sap, but the species is not as dangerous as many other *Rhus* species (Clark 1973). Thickets of smooth sumac can prevent the development of tree seedlings through shade and root competition and arrest succession (Putz and Canham 1992).

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Rhus microphylla Engelm. ex Gray little-leaf sumac
ANACARDIACEAE

Synonym: *Rhoeidium microphyllum* (Engelm.) Greene

James E. Nellessen

General Description.—Little-leaf sumac is sometimes referred to as desert sumac because of its occurrence in habitats that are drier than the habitats of other sumacs. Another name is correosa. This highly branched shrub may reach heights of up to 4 to 5 m and is frequently as broad as it is tall. Some twigs may be somewhat spiny-tipped. Leaves are odd-pinnately compound, alternate, with five to nine elliptic to oblong leaflets, which are sessile, 8 to 18 mm long, 2 to 6 mm wide, and generally not leathery or shiny. Leaflet margins are entire and may be somewhat revolute, and the rachis is winged (Carter 1997, Correll and Johnston 1970, Epple 1995, Great Plains Flora Association 1986, Kearney and others 1951, Martin and Hutchins 1980-81). Leaves persist on the plant until the first hard frost.

Range.—Little-leaf sumac occurs from western Texas, southwestern Oklahoma, through the southern half of New Mexico into southeastern Arizona, and south into Mexico. It occurs at elevations from about 1,060 m to 1,830 m.

Ecology.—This species is a common member of Chihuahuan Desert grassland vegetation although its distribution is not uniform. It may occur in canyons, along river banks, arroyos, rocky hillsides, even alkali flats. It grows on both limestone and sandy soils and can be a dominant in some sandy-dune soils forming extensive coppice conditions. Littleleaf sumac will often grow adjacent to arroyos but is considered a facultative or semiriparian species (Dick-Peddie 1993, Whitford 2002). It demonstrated a 46 percent nitrogen and phosphorus resorption efficiency from leaves prior to leaf drop in the autumn (Whitford 2002). This was lower than the obligate riparian shrubs, desert willow [*Chilopsis linearis* (Cavanilles) Sweet] and cutleaf brickellia (*Brickellia laciniata* A. Gray), but higher than the nitrogen fixing mesquite (*Prosopis glandulosa* Torrey). Hence, the greater resorption efficiencies of these shrubs may be due to their biology and ecology as it relates to plant nitrogen demand and nitrogen availability within their local habitats (Killingbeck and Whitford 2001). Littleleaf sumac as well as Torrey yucca (*Yucca torreyi* Shafer) and javelina bush (*Condalia warnockii* MC Johnston) were the most frequently used species for nesting birds in a Chihuahuan Desert location in south-central New Mexico (Kozma and Mathews 1997). This observation was made despite the fact that little-leaf sumac was lower in density (209 stems/ha in arroyo sites and six stems/ha in upland sites) than other shrub species. Twenty-seven bird species were monitored from 1993-1995. Large junipers may function as nurse plants, aiding the establishment of certain shrub species, including little-leaf sumac, in western Texas (McPherson and others 1988).

Reproduction.—Flowers are small, greenish white with five petals and five stamens. Flowers appear before the leaves in both axillary and terminal clusters. Blooming may occur from March through May depending on local environmental conditions and availability of moisture. Fruits are red to orange drupes, from 4.5 to 6 mm in diameter, with a covering of glandular hairs, and maturing in July to August.

Seed Dormancy.—Seed dormancy appears to be caused by a water impermeable endocarp (Li and others 1999). After incubation on moist substrate for 4 weeks, 29 to 34 percent of all seeds had imbibed water, and after 1 year imbibition had climbed to 93 to 100 percent among all of the seeds. This type of physical dormancy occurs in other members of the genus *Rhus* (Young and Young 1992), and some members of the genus also have physiological dormancy (Baskin and Baskin 2001). There is a high proportion of species with physical dormancy in savannas, hot deserts, and similar climates with distinct dry and wet seasons, the wet season being the season favorable for germination. The impermeable endocarp in the genus *Rhus* may have evolved as long ago as the Middle Eocene epoch (Baskin and Baskin 2001).

Growth and Management.—Little-leaf sumac is not one of the faster growing shrubs. It produces numerous stems and resprouts readily. Tebuthiuron, an herbicide often used for brush control on rangelands, proved effective in little-leaf sumac control (Emmerich and others 1984). Tebuthiuron was applied at 0.84 kg/ha to rangeland in both pelleted and dissolved forms. After 21 months there was a 100 percent kill of little-leaf sumac, tarbush (*Flourensia cernua* DC.), and four-wing saltbush [*Atriplex canescens* (Pursh) Nutt.], all dominant species on the test site. Tebuthiuron moved to a soil depth of 15 cm within 8 months, and after 21 months 38 percent of the application was remaining, while only 0.47 percent was detected in runoff water.

Benefits.—The fruits are readily eaten by many birds. Little-leaf sumacs are also important nesting sites for birds. The fruits may be steeped in warm or cold water to make soothing tea-like drinks that can sooth sore throats (Bowers and Wignall 1993, Warnock 1974).

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Rhus trilobata Nutt. oakleaf sumac
ANACARDIACEAE

Synonyms: _Rhus aromatica_ Ait. var. _trilobata_ (Nutt.) Gray
Toxicodendron trilobatum Kuntze
Schmaltzia oxyacanthoides Greene
Schmaltzia pubescens Osterh.

Nancy L. Shaw and Ann M. DeBolt

Illustration credit: E.G. Hurd

General Description.—Also known as skunkbush sumac or lemonade sumac, oakleaf sumac is a morphologically variable deciduous species with a spreading, mound-like, or erect growth form. It frequently forms clumps or thickets 0.6 to 2.1 m in height (Hitchcock and others 1961, Thornburg 1982, Welch and others 1987). Young branches are brownish and puberulent, turning gray with age. The alternate, trifoliate leaves are glossy, dark green, and 3 to 7 cm long. Leaflet lobes are shallowly to deeply incised and puberulent below. The terminal leaflet is fan-shaped; the lower two are about half as large and shallowly crenate-lobed (Hitchcock and others 1961). Plants are polygamo-dioecious (nearly dioecious, but with some male/female flowers). Inflorescences consist of clusters of spikes located near branch tips (Goodrich and Neese 1986). Flowers are inconspicuous, pale-yellow and mostly imperfect, developing before the leaves. Fruits are sticky, subglobose, orange-red drupes 6 to 8 mm in diameter with a lemony flavor when fresh. This species closely resembles _R. aromatica_ Ait. and is often treated as a variety of that more eastern species.

Range.—Oakleaf sumac is a widespread and highly variable taxon, ranging from Alberta to Iowa and south to California, Mexico, and Texas (Harrington 1964). It grows at elevations from 1,050 to 2,400 m on sites that receive 250 to 500 mm of precipitation (Hitchcock and others 1961, USDA Forest Service 1937, Wasser 1982).

Ecology.—In the Intermountain Region, oakleaf sumac is common in mountain brush and pinyon-juniper communities (Hitchcock and others 1961, Welch and others 1987) and also grows in openings in communities of oakbrush, ponderosa pine, and other conifers (Vories 1981). At lower elevations it may be found in the blackbrush, basin big sagebrush, or Wyoming big sagebrush zones. In these areas it occurs on streambanks and terraces, floodplains, seep, and spring margins, mesic slopes, talus slopes, swales, drainageways, and on other sites receiving extra moisture (Welsh and others 1987). It is frequently associated with riparian communities, growing intermixed with other shrubs or as scattered thickets in communities dominated by herbaceous species. Adapted to a wide range of soil conditions, oakleaf sumac grows on basic to acidic soils with textures ranging from clayey to sandy.

Reproduction.—Flowers appear in early spring, usually March or April (Brinkman 1974). Fruits ripen from June to September (Plummer and others 1968, Shaw 1984, van Dersal 1938) but many remain on the shrub well into winter. Seeds are dispersed primarily by birds but also by rodents and other animals (Brinkman 1974). There are approximately 44,000 cleaned seeds/kg (Brinkman 1974, Plummer and others 1968). Germination is restricted by the presence of a hard seedcoat and embryo dormancy, with the degree of dormancy varying considerably among populations. Seedcoat permeability of most populations is improved by a 0.3 to 2 hour sulphuric acid scarification (Babb 1959, Brinkman 1974, Glazebrook 1941, Heit 1968), while 30 to 120 days of moist prechilling is required to release embryo dormancy (Babb 1959, Swingle 1939). Mechanically rupturing the seedcoat improves germination (McKeever 1938), but techniques have not been developed for treating large seed lots. Following fire, oakleaf sumac generally sprouts vigorously from the root crown and rhizomes (Wasser 1982).

Growth and Management.—Local seed sources should be selected for range seedings or transplanting projects as the range of adaptability for most populations is not known (Swenson 1957). Scarified seed may be fall planted to provide overwinter moist prechilling. Seed should be planted approximately 1.3 cm deep or slightly deeper in dry, coarse textured soils. Seedlings are considered to be drought and cold hardy but may succumb to competition from herbaceous species when young (Clark and Depuit 1981, Monsen 1987). Range or wildland seedings normally require 2 to 5 years for establishment (Plummer and others 1968).

Benefits.—Oakleaf sumac can be used to stabilize disturbed riparian areas. It provides excellent ground cover, and the spreading root system reduces soil erosion. It is particularly useful for restoration of meadows and other riparian sites where extensive erosion and gully cutting has lowered water tables. Oakleaf sumac thickets provide excellent cover for many small birds and mammals, and winter browse where shrubs are limited. It is increasingly being used by homeowners seeking drought-tolerant native species since it is commercially available, easy to grow, long-lived, responds well to pruning, and has attractive red, orange to yellow fall color. Native Americans have used oakleaf sumac for food, tobacco substitute, basketry, and as a mordant in dyeing (LHBH 1976).

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***Ribes aureum* Pursh** golden currant

GROSSULARIACEAE

Synonyms: *Chrysobotrya aurea* (Pursh.) Rydb.

Juanita A.R. Ladyman

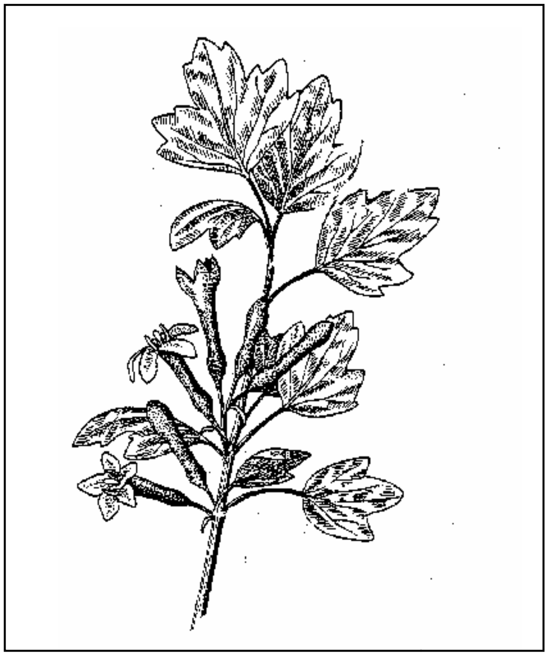

Illustration credit: J. Shoemaker in Wasser 1982

General Description.—*Ribes aureum* Pursh. is commonly known as golden currant, but local names also include buffalo, flowering, fragrant, and clove currant (Elmore 1976). The species name "*aureum*" is derived from the Latin word for "golden-yellow" and refers to the rich-yellow colored flowers. In some areas flowers may also be a cream or reddish color (Derig and Fuller 2001). The derivation of "*Ribes*" is apparently debatable. Gledhill (1992) suggests it is derived from the Persian word for "acid-tasting" whereas Vines (1986) indicates "*Ribes*" may be derived from an ancient Danish name. Another likely derivation is a link to historical cultural use. In the Middle East, a popular syrup was made from an Oriental species of rhubarb (*Rheum ribes*) called "*Ribas*" (USDA FS 1988, ISTA 1968). In Western Europe, currants were substituted for the rhubarb in this prized juice, and apparently this use influenced Linnaeus to adopt "*Ribes*" as the generic name for currants (USDA FS 1988). Golden currant is a deciduous, unarmed (spineless) shrub. It is usually from 60 cm to 3 m tall but may grow to a little over 4 m. The light green, semiglossy leaves are usually three-lobed. The flowers are large (up to 9 mm long) and each has five petals. They are solitary or in erect clusters, or racemes, of up to 15 flowers. The smooth, hairless, spherical fruit is a juicy several-seeded berry approximately 0.5 to 1.5 cm across and variously colored from yellow, red, brown to black. This description is after Carter 1997, Cronquist and others 1997, Hitchcock and Cronquist 1973, and Vines 1986. Kartesz (1994) and the U.S. Department of Agriculture (2003) database PLANTS recognize three varieties: the type variety *aureum*, variety *gracillimum* (Coville and Britt.) Jepson that is synonymous with *Ribes gracillimum*, and variety *villosum* DC that is synonymous with *Ribes odoratum* H. Wendl. Despite some confusing references to the contrary, *Ribes aureum* var. *aureum* is not a synonym of *Ribes odoratum*. The likely source of the taxonomic confusion is that *Ribes odoratum* H. Wendl is synonymous with *Ribes aureum* Gray, as opposed to the more familiar and taxonomically accepted, *Ribes aureum* Pursh.

Range.—Golden currant, *Ribes aureum* var. *aureum,* is a wide-ranging species across Western North America (Cronquist and others 1997). It is common from Alberta, Canada, to western Texas (Kershaw and others 1998, Powell 1998). *Ribes aureum* var, *odoratum* is native to mid-America, west of the Great Lakes (Cronquist and others 1997). Both varieties have become naturalized in Europe and possibly in other parts of the world (Stace 1997, Cronquist and others 1997, Komarov 1939).

Ecology.—Golden currant grows along water courses and in moist meadows in a variety of vegetation communities from grasslands, shrub lands, piñon juniper woodland, western hardwood, pine, and fir-spruce forests (Marshall 1995, Dick-Peddie 1992, Welsh and others 1993). Common associates include rabbitbrush (*Chrysothamnus* species), maples (*Acer* species), serviceberry (*Amelanchier* species), chokecherry (*Prunus virginiana* L.), juniper (*Juniperus* species), ponderosa pine (*Pinus ponderosa* P. & C. Lawson), willows (*Salix* species), and cottonwoods (*Populus* species). The elevation at which it occurs tends to depend somewhat upon latitude, but generally plants are found between approximately 400 to 2,800 m (Cronquist and others 1997, Carter 1997, Powell 1998). Golden currant grows in full sunlight but also does well in partial shade (Tykač 1990). It is tolerant to a range of weakly acid (pH 6) to weakly basic soils (Wasser 1982). Bacterial diseases have been noted to infect canes of some genotypes, but resistant varieties are available (Wasser 1982). *Ribes* species are intermittent hosts of the white pine blister rust (*Cronartium ribicola*), a fungal pathogen that can be ruinous to most native white pine species. Because of this, *Ribes* species have been subject to specific eradication programs in many white pine (*Pinus monticola* Dougl. *ex* D. Don) regions (Martin and others 1951, Van Arsdel and others 1998). However, the significance of specifically golden currant in the life cycle and pathology of this rust is uncertain. Throughout the Sacramento Mountains of New Mexico, *R. pinetorum* Greene was a major contributor to the spread of rust to nearby pines, but blister rust was not found on golden currant that generally grew below the elevation of the pines (Van Arsdel and others 1998).

Reproduction.—Golden currant generally flowers in June through August, although flowers may be found from March until the first frost (Epple 1995, McGregor and others 1986, USDA FS 1988, Vines 1986). The fragrant flowers are insect pollinated. Some insects have adapted to the long narrow flower tube by boring a hole at its base to “steal” the nectar (Derig and Fuller 2001). Golden currant readily crosses with other *Ribes* species (Wasser 1982). The fruits mature in summer and fall. The seed is a densely hairy achene. The cleaned seed averages approximately 478,398 to 513,672 individuals per kg with a germination rate of 60 to 98 percent (Vines 1986, Wasser 1982). The seeds undergo a physiological dormancy that is broken by 60 days of cold stratification (Baskin and Baskin 2001). Germination is epigeal. The plant also spreads by growing shoots from rhizomes (Wasser 1982).

Growth and Management.—Golden currant is easily propagated from hardwood cuttings in June or September and bare rooted plants are best planted when leafless in the spring or fall (Tykač 1990). When starting plants from seed, fall seeding is preferred, but stratified seed can be planted in the spring (Wasser 1982). Golden currant is used as a rootstock for grafting on other species of currant that root poorly (Tykač 1990). Cutting back old shoots stimulates new growth, and plants can sprout after fire (Tykač 1990, Marshal 1995). Tolerance to fire in the dormant state is good (Wasser 1982). However, the severity, or heat, of the fire is likely to be important to survival, and very hot fires can kill shrubs completely (Marshall 1995).

Benefits.—Golden currant rates from “poor” and “fair” to “medium” palatability for cattle (Dayton 1931, USDA FS 1988). It has good palatability for sheep (Dayton 1931). In Montana, twigs and foliage can make up to 2 to 5 percent of a sheep’s diet (Martin and others 1951). The fruits are an important food source for a variety of wildlife such as songbirds, chipmunks, mice, and ground squirrels (Martin and others 1951, Marshall 1995, Tykač 1990). The fruits may contribute up to 10 percent of a chipmunk and ground squirrels’ diet (Martin and others 1951). Both fruit and foliage are used by a range of species that include grouse, coyote, and beaver (Martin and others 1951). Elk have been reported to eat the foliage in Colorado, and one report indicated that mule deer browsed it infrequently, but cattle not at all, during a 1-year study in Montana (Dusek 1975). Golden currant has been planted for erosion control and in restoration projects (Vines 1986, Wasser 1982). It is particularly used for restoration of game habitat (Wasser 1982). When golden currant is used in vegetation restoration projects it is usually a small component of the seed mix and used at approximately 461 to 922 grams per hectare (Wasser 1982). The berries, both fresh, dried, and made into jams and cakes, have been used for food by many Native American tribes as well as by European settlers (Elmore 1976, Moerman 1998, Welsh and others 1993). It has also been used as a pharmaceutical by some of the tribes of the Great Plains. The dried, pulverized inner bark was sprinkled on sores, used with other ingredients in a poultice, and a decoction was taken for leg swelling (Moerman 1998). The flowers are edible, apparently flavorful, and eaten by gourmets (Elmore 1976). Golden currant is a popular ornamental plant in North America, Europe, and parts of the former Soviet Union (Bailey and others 1976, Komarov 1939, Tykač 1990).

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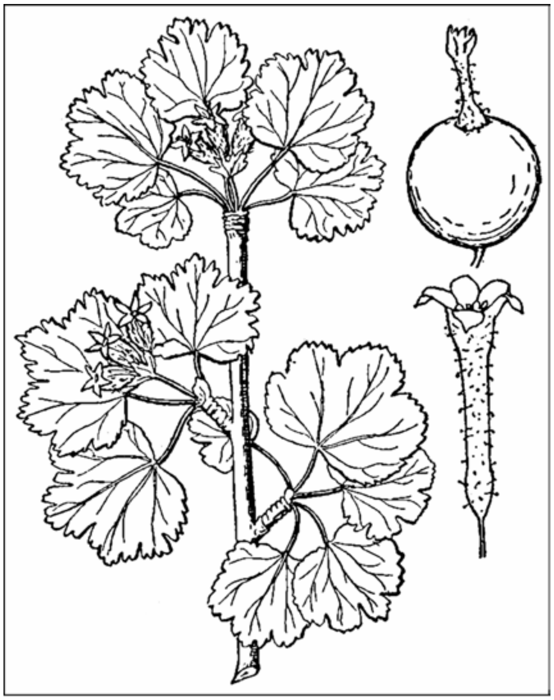
***Ribes cereum* Dougl.** wax current
GROSSULARIACEAE

Synonyms: *Ribes inebrians* Lindl.
Ribes cereum Dougl. var. *inebrians* (Lindl.) C.L. Hitchc.

John K. Francis



Drawing source: Britton and Brown 1913

General Description.—Wax current, also known as squaw current, is a deciduous shrub 0.5 to 1.5 m in height. Plants support one to several stems and are unarmed, dark gray to brown, sticky, and hairy when young, becoming glabrous with age. The yellow-green to grayish-green, simple leaves are circular to kidney-shaped with three to seven shallow lobes and a fine toothed or rounded-toothed margin. Petioles are 0.4 to 2.2 cm long and blades are 0.5 to 2.5 long and 0.7 to 3.0 cm broad. Inflorescences are two- to four-flowered racemes that are shorter than the leaves. The 4- to 7-mm long, glandular, tubular, greenish-white to pale pink flowers have five tiny petals. Fruits (berries) are red, shiny, and 6 to 8 mm in diameter. Each fruit contains several rough-surfaced, elliptical seeds about 2.5 mm long. There are 2n = 16 chromosomes (Abrams 1944, Brayshaw 1996, Mesler and Sawyer 2003, Pfister 1974, Welsh and others 1987).

Range.—Wax current is native to the states of Washington, Oregon, California, Nevada, Utah, Arizona, New Mexico, Oklahoma, Idaho, Montana, Wyoming, North Dakota, South Dakota, and Nebraska, as well as the provinces of British Columbia and Alberta. There are three recognized varieties. Variety *cerium* is apparently found in all the range except Oklahoma. Variety *colubrinum* C.L. Hitchc. occurs in Washington, Oregon, Idaho, (and probably British Columbia). Variety *pedicellare* Brewer & S. Wats., known as whisky current, occupies the range east and south of Washington and Oregon (Natural Resources Conservation Service 2003).

Ecology.—Wax current is most common and grows best in the open but it can grow under open conifer forest canopies. It therefore classifies as intolerant of shade. New seedlings appear after fires (that may scarify seeds) and when the soil is disturbed and opened to sunlight (Marshall 1995). The species grows on well-drained soils of the full range of textures that have developed from a wide variety of parent materials. These soils are often rocky or gravelly. Wax current grows at elevations of 1,500 to 4,000 m (Marshall 1995) in areas with warm, dry to moist summers and cool to cold winters. Minimum annual precipitation is around 330 mm/year. Wax current occurs in many vegetation types including open and broken coniferous forests, exposed subalpine slopes and ridges, and sagebrush (*Artemisia* spp.) steps (author's observation).

Reproduction.—Wax current flowers between April and June and ripens fruit in August (Pfister 1974). Flowers are pollinated by insects (Plants For a Future 2003). There was an average of 553,000 seeds/kg from fruits collected in California (Pfister 1974). Seeds are dispersed by birds and small mammals, as well as by gravity (Marshall 1995). At 21 °C, air-dried seeds retained some viability for 27 years (Pfister 1974). Reproduction is mainly by seed; the species has only a "weak" ability to sprout from the root crown (Marshall 1995).

Growth and Management.—Fruits must generally be picked by hand. Seeds are cleaned of fruit by maceration, and air dried. They can be stored in sealed containers at ambient temperatures or refrigerated (Pfister 1974). Seeds require 4 to 5 months of cold stratification (at temperatures near freezing) after which they can be planted in the spring (Marshall 1995). Alternately, they can be sown in the fall and allowed to stratify naturally. Plants can also be started from cuttings of semi-hardened wood (Plants For a Future 2003). Adult plants can be eliminated from stands by fire, grubbing, and probably herbicides. However, in at least one study, because many new seedlings appeared, the number of plants increased in sites disturbed by treatments (Marshall 1995). Because wax current does poorly in shade, tree planting is suggested as a long-term solution.

Benefits.—Wax current contributes to the beauty of forest lands where it grows and helps protect the soil from erosion. Shade from their crowns shelters conifer seedlings and thus aids forest succession (Marshall 1995). The species is used to a limited extent as a foundation plant in formal landscaping (Wildland Nursery 2003). Wax current is fair to poor browse for domestic livestock and wild ungulates and is mainly eaten when little else is available. New annual growth contains about 5.6 percent protein. Several species of birds and rodents consume the fruits (Marshall 1995). The larva of the Rocky Mountain *Agepema* moth (*Agapema homogena* Dyar) feed on the foliage (Oehlke 2003). Wax current berries are edible but have little flavor. They are picked for making jams, jellies, and pies and were formerly used by Native Americans for making pemmican (Marshall 1995). People of the Secwepemc tribe of British Columbia ate them to relieve diarrhea (Secwepemc Nation 2003). An infusion of inner bark was used as a wash for sore eyes (Plants For a Future 2003). Wax current and other *Ribes* species are alternate hosts for white pine blister rust (*Cronartium ribicola*), which can be lethal to five-needle pines. Efforts to eradicate Ribes from several forest areas failed and did not decrease the incidence of blister rust (Marshall 1995).

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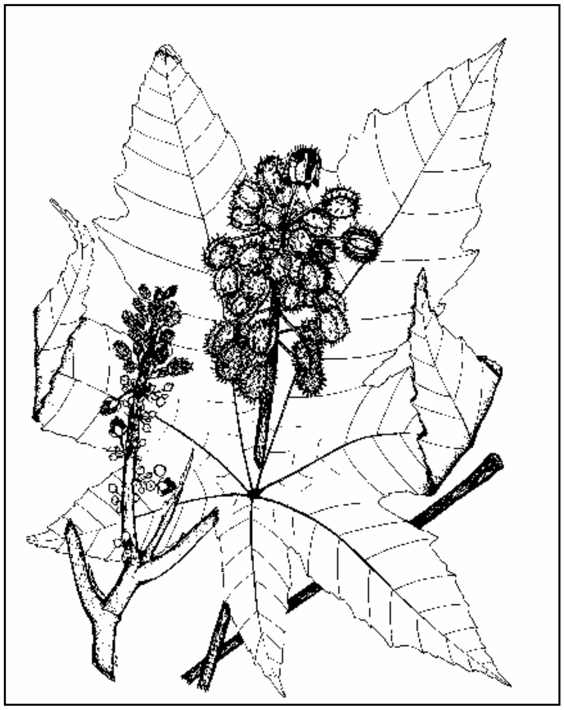
***Ricinus communis* L.** castor bean
EUPHORBIACEAE

Synonyms: none

John K. Francis



General Description.—The castor bean, also known as the castor-oil plant, higüerito, higüerillo, palma Christi, carrapateira, ricin commún, and many other common names, is grown as an annual herb in temperate countries but grows to treelike proportions on fertile ground in tropical climates. The plant usually has only one stem arising from the soil but develops a number of low robust branches when open grown. Castor bean is herbaceous when young but becomes woody with age. The wood is soft and light with a thick central pith. Occasionally, irregular brown heartwood develops (Kadambi and Dabral 1955). The bark is light brown, smooth, and exhibits rings at the nodes and raised lenticels. There are a moderate number of large, star-shaped leaves with 7 to 9 long pointed lobes (Little and others 1974). Castor bean has been cultivated in Africa and Asia from ancient times and used medicinally (CISR 1972).

Range.—Castor bean is a native of tropical Africa but has naturalized in moist tropical and subtropical regions throughout the world. It may be found growing naturally and in cultivation as an ornamental throughout the tropical and subtropical areas of the United States and its territories.

Ecology.—Disturbance is required for successful natural stands of castor bean. The species is an intolerant pioneer. If disturbance is not repeated, it will be succeeded in a few years by grass, vines, or trees. Castor bean is competitive and most frequently seen in flood zones, on neglected farmland, and roadsides. In Puerto Rico, wild stands rarely succeed on exposed subsoils and highly weathered soils such as Ultisols. In cultivation, where excessive vegetative growth is a detriment, castor beans are often grown on marginal agricultural soils (CSIR 1972). Castor bean is not frost hardy. Many pests and diseases are known worldwide, but they rarely present a serious threat to cultivated or wild stands.

Reproduction.—Castor bean flower clusters grow erect at the ends of twigs. Male flowers form on the lower part and female flowers on the upper part of each raceme. The seed capsules are covered with weak spines (spineless types exist). The capsules split into three parts, each containing one seed. The seeds are shiny brown with darker streaks or spots and resemble a bloated tick (Little and others 1974). Two seed sizes are reported in India: 1,164 seeds/kg and 2,610 seeds/kg (Kadambi and Dabral 1955). Stored seeds should be kept cool. Seeds stored at ambient temperature lose 75 percent of their viability within 3 months (CISR 1972). Soaking the seeds for 12 hours prior to sowing is reported to improve germination (CISR 1972). Germination starts in 7 to 10 days and is complete in 25 to 45 days (Kadambi and Dabral 1955). There are hundreds of natural forms and cultivated varieties of the species, including annual and perennial types.

Growth and Management.—Castor beans are planted in rows spaced from 1 to 2 m apart with spacing within the rows of about 0.5 m. When grown as an annual crop, it takes 5 to 9 months from planting to harvest (CSIR 1972). Castor beans are reported to survive for 8 to 10 years in India and may reach 6 m in height (Kadambi and Dabral 1955). Annual varieties reach 1 to 2 m in height. Seed yields under cultivation vary from 200 to 1,700 kg/ha, depending on variety and site quality (CISR 1972).

Benefits.—Castor beans contain from 31 to 61 percent oil (CISR 1972). After decorticating, they are subject to a series of hot or cold presses followed by solvent extraction, each step yielding a different grade of oil (Kirschenbauer 1960). The largest producers are Brazil and India. The principal consumer is the United States (Encyclopedia Brittanica 2000), but an annual demand for 100,000 tons of castor oil is reported for Europe (NF-2000 Database 2000). The seed cake remaining after extracting the oil is used as fertilizer or cooked to destroy the toxin and incorporated into animal feeds. Not as popular as it once was, castor oil is still widely used in traditional and herbal medicine, especially in less developed countries. Its principal use in medicine is as a purgative and laxative. Castor oil is also used as a lubricant, lamp fuel, a component of cosmetics, and in the manufacture of soaps, printer's ink, plastics, fibers, hydraulic fluid, break fluid, varnishes, paints, embalming fluid, textile dyes, leather finishes, adhesives, waxes, and fungicides (Encyclopedia Brittanica 2000, CISR 1972). It is gradually being replaced as a raw material for some of the uses by petroleum-based products. In India, the leaves are used as food for eri silk worms (Kadambi and Dabral 1955). The stalks from fields are burned for fuel in India and have been shown to be suitable for short-fiber pulp (Kadambi and Dabral 1955). The species has been planted for dune stabilization (CISR 1972). Castor bean is widely planted as an ornamental. Its large, star-shaped leaves make it a bold foliage plant. Some varieties have red- or purplish-colored leaves and stems.

Detrimental Effects.—Castor bean may become a weed in neglected cropland and pasture. It is not difficult to control through cultivation and mowing. Of greater concern than its weedy potential is the high toxicity of its seeds, which contain ricin, a water-soluble protein. Even a small amount of masticated seed is likely to cause death. Humans and horses are especially vulnerable. Fatal doses are from 2.5 to 6 seeds for humans and about 6 seeds for horses (CISR 1972). Symptoms are stomach irritation, diarrhea, abdominal pain, increased heart rate, profuse sweating, collapse, and convulsions. Broken seeds can cause skin irritation. The foliage is only slightly toxic (Anonymous 2000). It is advisable to completely eliminate castor bean from pastures, especially horse pastures, and pinch off flowers of ornamental plants to prevent possible poisoning of children.

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***Rondeletia inermis* (Spreng.) Krug & Urban** cordobancillo
RUBIACEAE

Synonyms: *Catesbaea inermis* Spreng.
Rondeletia inermis angustifolia Krug & Urban
Rondeletia inermis oblongifolia Krug & Urban
Rondeletia inermis intermedia Krug & Urban
Rondeletia inermis latifolia Krug & Urban

John K. Francis

General Description.—Cordobancillo is an upright evergreen shrub or occasionally a small tree sometimes reaching 4.5 m in height and 7.5 cm in stem diameter. The plant occasionally takes a vine-like form. Older plants usually have multiple stems arising at or near ground level. Stems and branches are slender, mostly straight. The bark is gray or dark brown and nearly smooth. Inner bark is green. The wood is hard or moderately hard and stiff; sapwood is yellowish and heartwood is light brown. Cordobancillo plants are supported by a tap and lateral root system of stiff, brown roots. Foliage is mostly grouped at the ends of twigs. The opposite leaves are variable: with or without hairs, cartaceous to coriaceous, linear to elliptic, and 1 to 10 cm long. There are deltoid stipules about 2 mm long and petioles 3 to 6 mm long. Groups of one to five small, yellow (or white to purple or brown) flowers with four corolla lobes are borne on peduncles 0.5 to 3.0 cm long. The fruit is a two-celled, 3- to 4-mm, globose capsule containing tiny, wrinkled, brown seeds (author's observations, Liogier 1997, Little and others 1974).

Range.—Cordobancillo is endemic to Puerto Rico and its offshore island, Muertos (Little and others 1974). There are several races differing in size and shape of leaves and amount of pubescence (Liogier 1997). The species is not known to have been planted or naturalized elsewhere.

Ecology.—The species is intermediate in tolerance to shade. It usually grows in the understory of open to moderately dense forests, or in small openings or edges. Cordobancillo may be found in both primary remnants and secondary forests. It invades disturbed areas but takes many years to do so. Cordobancillo grows in a wide range of well-drained, neutral to mildly acidic soils derived from sedimentary (including limestone), igneous, and metamorphic (including ultramafic) rocks. It grows from a few meters above sea level to elevations of 1,000 m (Little and others 1974) in areas that receive from about 750 to 2500 mm of mean annual precipitation.

Reproduction.—Cordobancillo flowers and fruits throughout the year. A collection of air-dried seeds from the moist limestone hills near Bayamon, Puerto Rico averaged 1,863,000 seeds/kg. Seed dispersal is probably by gravity and wind. Collecting seeds is difficult because the capsules ripen, dry, and open a few at a time and immediately release their tiny seeds.

Growth and Management.—Cordobancillo appears to have a slow to moderate growth rate and be relatively long-lived. By sprouting from the base and root crown, plants live longer than individual stems. There is no published experience on plantation establishment or management of natural stands.

Benefits.—Cordobancillo helps protect the soil, furnishes cover for wildlife, and adds to the aesthetics of Puerto Rican forests. Too small for lumber or poles, the wood is occasionally used for fuel.

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***Rondeletia pilosa* Sw.** cordobancillo peludo
RUBIACEAE

Synonyms: *Rondeletia triflora* Vahl
Oldenlandia longiflora Lam.
Hedyotis longiflora (Lam.) Spreng.

John K. Francis

General Description.—Cordobancillo peludo, also known as cachimbo peludo and lechecillo, is an evergreen shrub or small tree commonly 1.5 to 2 m in height and 2 cm in basal diameter but sometimes reaching 5 m in height. It may have several stems from the base. The form is usually upright but occasionally vine-like. Stem bark is gray and smooth. The plants examined by the author had a tan colored, robust, shallow lateral root system with sparse secondary and tertiary roots. The twigs are long, slender, forking, and ringed at the nodes. Soft hairs cover the twigs and lower surfaces of the leaves. The leaves are opposite, with entire, elliptic blades 4 to 10 cm long and 2 to 3.5 cm broad, and pointed at both ends, and have a petiole 3 to 6 mm long. Inflorescences are axillary and usually have three flowers with peduncles up to 7 cm long. The flowers have four-lobbed hairy calyxes and corollas. The corollas are white with red-tipped lobes. The two-celled capsules are rounded, 3 mm in diameter, with calyx lobes persistent. The capsules produce many minute brown seeds (Liogier 1997, Little and others 1974).

Range.—Cordobancillo peludo is native to Puerto Rico, the Virgin Islands, and Monsarrat (Liogier 1997). It is not known to have been planted or naturalized elsewhere.

Ecology.—Cordobancillo peludo occurs in areas that receive from about 750 to about 1000 mm of mean annual precipitation from near sea level to about 450 m in elevation. Soil texture does not appear to be a limiting factor. All are well- to excessively-well drained. Soil pH's range from about 5.5 to 8.0. Parent materials may be sedimentary (including limestone), igneous, and metamorphic (including ultramaphic) rocks. It is moderately intolerant and grows in open areas as well as under low basal-area low forest. Because the species is not highly competitive, cordobancillo peludo is more likely to survive where growth otherwise is limited—such as very rocky terrain. It is scattered to rare in coastal thickets, and remnant and middle to late secondary forests in upland areas.

Reproduction.—Cordobancillo peludo appears to flower and fruit throughout the year. In terms of numbers, production of seeds is huge. The seeds are dispersed by the wind. However, seedlings are uncommon. The seeds number a few million/kg. Of a group of seeds sown on moist filter paper, 69 percent germinated between 15 and 70 days after sowing. Germination is epigeal.

Growth and Management.—Growth of cordobancillo peludo is slow. Basal sprouts in one stand grew about 30 cm/year. One plant with a 2.5-cm basal diameter had 10 growth rings. Individual stems probably last 10 to 20 years, and plants can prolong their lives by coppicing. No planting or management experience is known to the author. Probably the best management strategy is to protect remnant stands and late-secondary forests containing the species.

Benefits.—Cordobancillo peludo contributes to the aesthetics of the forest, it helps protect the soil, and furnishes cover for wildlife. The wood is useful for small-diameter fuel.

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Rosa woodsii Lindl. Wood's rose

ROSACEAE

Synonyms: *Rosa fendleri* Crep
Rosa californica Watson.
Rosa macounii Greene
Rosa chrysocarpa Rydb.

Bruce L. Welch

General Description.—Wood's rose is a prostrate to upright shrub from 0.5 to 3.0 m tall (Blauer and others 1975). It is a strongly armed to nearly unarmed shrub with well-developed, straight, or less often, somewhat curved infrastipular prickles, and often with other stout or weak prickles (Cronquist and others 1997). The opposite compound leaves are composed of five to 11 leaflets, which are oval, elliptic, or obovate in shape, with serrate margins (Blauer and others 1975). Leaflets are 2 to 5 cm long and 1 to 2.5 cm wide; the teeth are not gland-tipped except in var. *woodsii*. Flowers are light-pink to deep-rose color and are borne on lateral shoots from old wood, which are usually over 10 cm long (Blauer and others 1975). Flowers are solitary or two to several in small corymbiform cymes that terminate the lateral branches of the season and are relatively small (Cronquist and others 1997). The hypanthium is glabrous and 3 to 5 mm thick at anthesis (Cronquist and others 1997). Pedicels are glabrous (Cronquist and others 1997). The five persistent sepals are from 1 to 2 cm long and 2 to 3.5 mm wide at the base. The tip of each sepal is usually a little expanded above the median constriction (Cronquist and others 1997). The sepals are erect or spreading in the fruit (Blauer and others 1975). Petals, five in all, are 1 to 2.5 cm long (Cronquist and others 1997, Welsh and others 1987). Hips (fruits) are red to purple or nearly black in color and ellipsoid to subglobose in shape (Cronquist and others 1997, Welsh and others 1987). Hip size varies from 6 to 15 mm wide and up to 2.0 cm in length and contains from 15 to 30 achenes (Blauer and others 1975). Each achene is 3 to 4 mm long with stiff hairs along one side. Achenes weigh from 0.007 to 0.013 g (Gill and Pogge 1974). The diploid chromosome number of Wood's rose is 14 (Blauer and others 1975).

Taxonomy.—Two varieties of Wood's rose are recognized: var. *ultramontana* and var. *woodsii* (Blauer and others 1975, Cronquist and other 1997, Welsh and others 1987). Variety *ultramontana* is the most prevalent in the Intermountain area of Western United States. *Woodsii* is found on the prairies and plains of central North America and is smaller and stiffer than var. *utlramontana* with smaller leaflets that often have gland-tipped teeth (Blauer and others 1975, Cronquist and others 1997, Welsh and others 1987).

Range.—Wood's rose occurs from Minnesota west and northwest to Alaska and British Columbia, south to Arizona, northern Mexico and western Texas and north to western Kansas and North Dakota. It is the most widespread native rose in Alberta (Blauer and others 1975, Cronquist and others 1997, Pacific Southwest Experiment Station 2002). It grows in 24 ecosystems and occurs in 51 of Kuchler's plant associations (Pacific Southwest Experiment Station. 2002). The Society of American Foresters list Wood's rose as occurring in 55 of its cover types (Pacific Southwest Experiment Station 2002).

Ecology.—Wood's rose can grow at elevations reaching 3,549 m (Pacific Southwest Experiment Station 2002). It occurs on bluffs, dry grassy slopes, and on sandhills throughout the prairies and on riverbanks and clearings in boreal and subalpine forests. It can be found on the eastern slopes of the Rocky Mountains and throughout the Great Basin. It is found along roadsides and south-facing cutbanks (Pacific Southwest Experiment Station. 2002). In the Great Basin, Wood's rose prefers moist sites along streams, in seepage areas along fences, irrigation canals, marsh lands, lake shores, and hillsides in palustrine and lacustrine habitats (Welsh and others 1987). When conditions are favorable, nearly impenetrable thickets of Wood's rose are formed along some mountain streams (Pacific Southwest Experiment Station 2002). It flourishes in moderate shade to full sunlight and so makes good growth on all aspects (Blauer and other 1975). Wood's rose is adapted to a wide range of soil types and textures (Pacific Southwest Experiment Station 2002). Growth is generally best on moderately fertile, well-drained clay loam, sandy loam, or sandy soils. It is tolerant of moderately acid to weakly basic soils. (Pacific Southwest Experiment Station 2002). It is seldom found where the average annual precipitation is less than 260 mm (Blauer and others 1975).

Reproduction.—Seeds are produced on 2 to 5 year old plants. Seeds of Wood's rose are ingested with the hip and dispersed in the dropping of birds and mammals. The seeds have a seed coat dormancy and require warm or cold stratification. Seed viability ranged from 44 to 64 percent for seed collected in northern Alberta. The seeds remain viable for 2 to 5 years. Seeds will germinate within 30 to 40 days (Blauer and others 1975, Gill and Pogge 1974, Pacific Southwest Experiment Station 2002). Wood's rose spreads vegetatively through underground rhizomes, sprouting from the root crown, and by layering (Blauer and other 1975, Pacific Southwest Experiment Station 2002).

Management.—Wood's rose has a fairly high tolerance to browsing (Pacific Southwest Experiment Station 2002). It is susceptible to various leaf spots, as well as to leaf rusts, gray mold, powdery mildew, common gall, and stem cankers (Pacific Southwest Experiment Station 2002). The principal forest insect pests are tent caterpillar, rose leaf hopper, and a subspecies of western tussock moth (Pacific Southwest Experiment Station 2002).

Benefits.—Wood's rose adds to the biodiversity of a multitude of ecosystems. It provides habitat and food for a number of wildlife species, and watershed protection. Fruits, leaves, or twigs are eaten by a number of birds and mammals. These include pronghorn, elk, mule deer, white-tailed deer, porcupines, beavers, squirrels, coyotes, bear, small nongame birds and upland game birds (Pacific Southwest Experiment Station 2002). Livestock also eat Wood's rose. Crude protein content of Wood's rose leaves vary from 5.7 (fall) to 16.4 (spring) percent of dry matter and stems from 5.4 (winter) to 12.0 (spring) percent (Dietz 1972). Phosphorus content of leaves varied from 0.29 (fall) to 0.48 (spring) percent of dry matter with stems varying from 0.12 (winter) to 0.32 (spring) percent (Dietz 1972). In vitro digestible for Wood's rose was 65.9 percent of dry matter digested for spring tissues and 54.5 percent for winter tissues (Dietz 1972). These in vitro digestible values would rank Wood's rose as a highly digestible spring and winter forage (Welch 1989, Welch and Andrus 1977). The dense thickets formed by Wood's rose are used for nesting and escape cover by many birds and small mammals (Pacific Southwest Experiment Station 2002). The extensive rhizomes and good survivability and revegetation characteristics makes this species an effective tool in erosion control (Pacific Southwest Experiment Station 2002). Good results have been obtained with rooting of hardwood cuttings, direct seeding, and transplanting trials (Pacific Southwest Experiment Station 2002). Native Americans made extensive use of Wood's rose roots, stems, leaves, flowers, and hips for foods and therapeutic purposes. The hips are a source of vitamin C and are dried for use in flavoring teas, jellies, fruitcakes, and puddings. Wood's rose is used as an ornamental near homes to attract birds and other wildlife (Pacific Southwest Experiment Station 2002).

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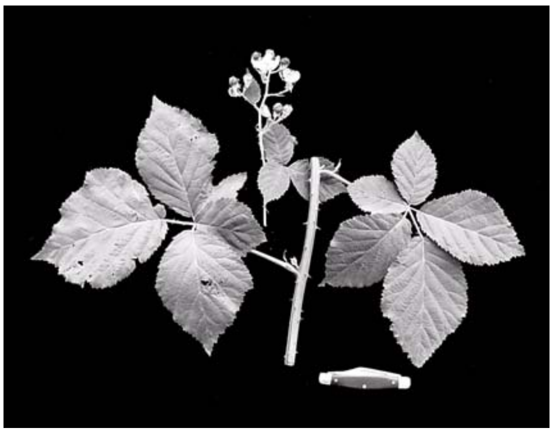
***Rubus discolor* Weihe & Nees** Himalayan blackberry
ROSACEAE

Synonyms: *Rubus procerus* auct. non P. Muell. ex Genev
Rubus fruticosus L.
Rubus macrostemon (Focke) Sampaio
Rubus thyrsanthus (Focke) Foerster.
Rubus praecox Bertol.
Rubus grabowskii Weihe ex Gunther et al.

John K. Francis



General Description.—Himalayan blackberry, also known as Armenian blackberry or just blackberry, is a deciduous to evergreen, spiny, arching woody shrub that may reach heights of 4 m with stem (cane) lengths up to 10 m. The multiple stems are fluted with stout, red, straight or recurved prickles along ridges. The canes grow straight upward at first but arch as they become long. The root crown may reach 20 cm in diameter; the root may penetrate up to 1.5 m into the soil, and lateral roots extend 30 to 60 cm. The bark is green to purplish-red. The 7- to 20-cm-long leaves are usually penta-foliate except on fruiting branches where they can be trifoliate or unifoliate. The petioles, rachises, and lower surfaces of the midveins are also armed. The blades are 3 to 12 cm long, ovate to orbicular, dark green, and have biserrate margins. The white to pink, five-peteled flowers 2- to 2.5-cm broad are borne three to 20 in terminal panicles. Fruits are aggregates 12 to 20 mm in diameter of black, juicy, sweet druplets on a torus (central core). Each drupe contains one hard, flattened seed that is covered with a fine network of pits and ridges (Brayshaw 1996, Bruzzese 1998, Starr and others 2003, Welsh and others 1987). Luther Burbank introduced the fruit cultivar he called Himalayan blackberry in 1885. After its release to gardeners, it quickly spread to wildlands on the West Coast and later to other parts of the United States (Jacobson 2001). Taxonomists disagree on its identity. Some maintain that it is in fact *Rubus armeniacus* Focke (Ceska 1999). Himalayan blackberry hybridizes with *R. thyrsiger* Banning & Focke, *R. calvatus* Lees ex Bloxam, and *R. schlechtendalii* Weihe ex Link (Tirmenstein 1989).

Range.—Himalayan blackberry originated in the Old World, probably Europe. It has been under semicultivation for a long time and has escaped into the wild in Western and East-Central United States, Hawaii, parts of Europe, Australia, New Zealand, South Africa, and probably southern South America (Ceska 1999, Natural Resources Conservation Service 2003, Starr and others 2003). In many populations, it is not always clear from the literature whether it is Himalayan blackberry or other closely related taxa.

Ecology.—Himalayan blackberry grows in vacant lots, logging sites, burned areas, along rivers, roads, fences, and railroad tracks. It grows best in full sunlight but does well under a light forest cover. However, it will not grow under a dense canopy. Himalayan blackberry colonizes most soil types in moist areas but is confined to riparian areas and the edges of irrigated fields in interior dry climates. It grows at elevations from near sea level on the West Coast to 1,500 m in the inland West (Welsh and others 1987). Himalayan blackberry is confined at the northern extent of its range to mild coastal areas and low-elevation, sheltered inland sites. It tolerates periodic flooding of fresh or even brackish water. The species vigorously sprouts from root systems after fires (Tirmenstein 1989).

Reproduction.—Himalayan blackberry commonly flowers from June to August. The flowers are intensely visited by honey bees, but insect pollination is not necessary for seed production. In fact, sexual reproduction may be rare; 17 samples from Himalayan blackberry plants collected throughout Australia proved to have no genetic variation (Evans and others 1998). Good seed crops are produced nearly every year (Tirmenstein 1989). There are 324,000 cleaned seeks/kg. The seeds are dispersed by birds and mammals as well as by gravity. Passing through birds and mammals is reported to increase germination by 30 percent in the first year (Bruzzese 1998). Seeds in the soil seed bank remain viable for several years (Brinkman 1974). Stands in Victoria, Australia have been estimated to produce 7,000 to 13,000 seeds/m^2/year (Bruzzese 1998). Himalayan blackberry seedlings commonly appear after fires or disturbance that exposes the soil and allows sunlight to reach the surface. Once seedlings become established, most subsequent reproduction is vegetative. Plants reproduce by sprouts from rhizomes and by layering (rooting) at the nodes when stems come in contact with the ground.

Growth and Management.—Canes do not bloom during their first year in which they make most of their growth (2 to 8 m of elongation). Canes bloom and fruit in their second and sometimes third years and die at the end of their second or third years. Individual root crowns live a maximum of 7.5 years in Australia (Bruzzese 1998). By suckering from rhizomes and layering, plants (clones) can endure almost indefinitely. Live biomass of a stand in Victoria, Australia totaled 3.1 tons/ha (59 percent above-ground and 41 percent below-ground) and 27 tons of dead canes and litter (Bruzzese 1998). Scarification is required for prompt germination. Although several methods will work, soaking in concentrated H_2SO_4 for 50 to 60 minutes followed by 90 days of cold stratification is recommended. About 33 percent germination in about 70 days can be expected. Sowing in late summer for spring germination can substitute for artificial cold stratification. Sowing depth is 3 to 9 mm. (Brinkman 1974). The species can be propagated by digging up and replanting suckers. However, many more plants can be started by using root cuttings. Root pieces between 3 and 13 mm in thickness and 10 to 18 cm long are recommended. They are grown for 1 year in the nursery bed before outplanting (Shoemaker 1978). Himalayan blackberry can be troublesome in many habitats and is a potential threat to native ecosystems in places such as Hawaii (Starr and others 2003). Plants can be eliminated by grubbing with follow-up treatment a year later, repeated mowing, and by pasturing with goats (Cox 2003). Several herbicides are effective using foliar spray, stem injection, treatment of cut stumps, and basal spray methods (Starr and others 2003, Tirmenstein 1989). Dead canes accumulate in older stands and are as much a nuisance to remove as the plants themselves. Because of dormant seeds in the soil, checking and retreatment for many years may be required to completely eliminate the species.

Benefits.—Himalayan blackberry provides food and cover for many mammals and birds. It is little used by domestic livestock except for goats. However, deer, elk, rabbits, porcupines, beavers, and mountain beavers consume leaves, buds, twigs, and cambium, especially during the winter months. A large number of species consume the fruits and a number rely on the thickets of stems for escape and reproductive cover (Tirmenstein 1989). Himalayan blackberry fruits are among the most delicious of wild fruits but are difficult to pick because of the spines. They are eaten fresh, canned, used to flavor ice cream, and made into pies, jams, jellies, juices, and wines. Some people object to the seeds getting caught in one's teeth when eaten whole, but it is a minor inconvenience that can be avoided by juicing the fruit. In spring, the succulent canes can be pealed and eaten, fresh or cooked (Jacobson 2001). The brambles are allowed to grow over fences and trellises to create barriers almost impenetrable to people and livestock. While the species does protect the soil from erosion and helps revegetate disturbed sites, the thickets and mounds of brambles restrict movement of hikers and woods workers, and suppress other vegetation and slows succession.

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***Rubus parviflorus* Nutt.** thimbleberry
ROSACEAE

Synonyms: *Rubus nutkanus* Moc. ex Ser.
Rubus lacer Kuntze
Rubacer parviflorum Rydb.
Bossekia parviflora Greene
Rubus nutkanus var. *parviflorus* Focke

John K. Francis

Illustration source: USDA-Forest Service collection, Hunt Institute

General Description.—Thimbleberry, also known as western thimbleberry, salmonberry, mountain sorrel, and western thimble raspberry, is a spineless, deciduous shrub 0.5 to 2.5 m in height. Twigs and new stems are green and glandular; old stems are covered with tan, papery, shredding bark. Stems support relatively few branches. Clonal groups of plants are usually represented by several to many somewhat dispersed stems that have arisen from rhizomes (underground stems). Leaves, which have a maple-leaf appearance, are simple, alternate, and palmately veined with three to seven lobes and have entire to serrate margins. The yellow-green to dark-green blades are 4.5 to 15 cm long and 5.5 to 20 cm broad and are supported by long petioles. Perfect, white flowers 2 to 4 cm broad are grouped in terminal corymbs of 2 to 7 flowers. The fruits, which are aggregates of tiny drupes, are hemispherical, thin, somewhat dry, fragile, and dark pink to bright red, and detach easily from the central core (torus), which has five sepals at its base. The hard seeds are 1.5 to 2.5 mm long (Abrams 1944, Rook 1998, Welsh 1974)

Range.—Thimbleberry occurs from Alaska to western Ontario, from Michigan westward, and south through California, Arizona, New Mexico, and northern Mexico (Natural Resources Conservation Service 2003, Welsh 1974, Welsh and others 1987). It is also reported in Massachusetts, probably as a naturalized population. There are two recognized varieties of thimbleburry, var. *parviflorus*, accounting for virtually all of the range, and var. *velutinus* (Hook. & Arn.) Greene, which is densely hairy on the underside of leaves, found in California (Abrams 1944, Natural Resources Conservation Service 2003).

Ecology.—Thimbleberry grows on most types of moist soils, including skeletal soils. The species is most common in cool, moist sites, particularly on north slopes. Thimbleberry also occurs on dry, exposed ridges in high-elevation areas. It grows from near sea level to 2,900 m in elevation in

Wyoming (Tirmenstein 1989). Thimbleberry is moderately shade tolerant. Although it is most abundant and grows and fruits best in 60 to 100 percent sunlight, the species persists in the understory of closed stands (Tirmenstein 1989). It occurs both as scattered individual plants and as large continuous stands. Habitat includes burned sites, logged areas, avalanche tracks, roadsides, natural shrublands, hardwood forest understories, understories of low to moderate basal area conifer forests, and river overflow terraces and shorelines. It is a part of a large number of different plant communities. Thimbleberry is resistant to fire, readily resprouting from rhizomes. In fact, the species generally benefits from all kinds of disturbance. It usually appears during the first year after disturbance and often dominates the understories of logged areas within 5 years. Moderate to light thimbleberry stands can serve as a good protective cover for conifer seedlings. In recreational sites, the species showed relatively low resistance to trampling (Tirmenstein 1989).

Reproduction.—Thimbleberry generally blooms in June and July. Its fruits mature in July and August (Borialforest.org 2003). However, at the extremes of its range, it may bloom anywhere from May to September and fruit between late June through September (Tirmenstein 1989). The flowers are insect pollinated. Good fruit and seed crops are usually produced every year except in high-elevation areas where production may be unreliable (Tirmenstein 1989). The seeds are dispersed by birds and mammals that eat the fruits, and by gravity. The seeds accumulate in the soil and duff to form a seed bank and germinate in great numbers following fire and other disturbances that remove the forest canopy (Rook 1998). After establishment by seeds, stands thicken through sprouts from rhizomes (Rook 1998).

Growth and Management.—The stems (or canes) live for 2 or 3 years. In the first year, canes grow in height and develop only leaves. During the second and third years height growth continues and flowers and fruits are produced. The canes then die and are replaced by others that sprout from rhizomes. Maximum height of current canes is reached within 10 years after establishment (Tirmenstein 1989). Seeds must be collected by hand and should be cleaned of adhering fruit. Seeds may be sown in the fall for spring germination or may be warm (20 to 30 °C for 90 days) and cold stratified (2 to 5 °C for 90 days) for spring sowing. Also, scarifying with H_2SO_4 prior to the cold stratification may enhance germination. Tests have given maximum germination estimates of 62 percent (Tirmenstein 1989). Hardwood cuttings can be easily rooted. New plants can also be started from rhizome cuttings and plant divisions. Wildlings survive well but are slow to become established (Washington State University Cooperative Extension 2003). Occasionally, it is desirable to release conifer seedlings in and under thimbleberry thickets or to make way for other, more palatable forage species. The species is moderately susceptible to herbicides. Picloram, 2,4-D, and glyphosate have been effective in appropriate applications (Tirmenstein 1989).

Benefits.—Thimbleberry is an important shrub of the understory and forest openings. It helps protect the soil and adds to the beauty of the forest. The species is occasionally planted as an ornamental for its fragrant flowers and brilliant orange to maroon fall foliage (Borialforest.org 2003, Rook 1998). It is also occasionally planted in conservation plantings in disturbed areas. Thimbleberry is relatively low in energy and protein (4 to 8 percent), and is little used by cattle and horses and is only fair forage for sheep. It is sometimes important for deer, elk, and other wild ungulates during the summer while the leaves are still present. Rodents consume bark, buds, and foliage to a limited extent. On the other hand, the fruits are an important food item for numerous wild mammals and birds. Thickets of thimbleberry are also important escape, resting, and reproductive cover for many species of wildlife (Tirmenstein 1989). Fruits are certainly edible to humans but reports vary greatly on their palatability (Clark 1976, Welsh 1974). The author has eaten them for years and finds them inferior to cultivated raspberries (*Rubus idaeus* L.) but well worth the trouble of picking while hiking in the forest. The fruits are made into an excellent jelly and were once dried for later use by Native Americans. The tender young shoots are juicy and sweet and can be boiled or eaten fresh. The leaves are sometimes made into herb teas (Borialforest.org 2003, Washington State Department of Transportation 2003). Native Americans applied poultices of leaves to burns and wounds and took decoctions of roots as a tonic, for vomiting, and certain internal disorders (Moerman 1986).

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Rubus rosifolius Sm. roseleaf raspberry
ROSACEAE

Synonyms: *Rubus coronaries* (Sims) Sweet

John K. Francis

General Description.—Roseleaf raspberry, also known as wild raspberry, Mauritius raspberry, Queensland raspberry, fresa de montaña, framboisier, and akalakala, is an evergreen scrambling shrub, freestanding to 0.75 m, taller when supported on other vegetation, and extending laterally 2 m or more. Individual plants usually have several arching stems (canes) with basal diameters of 0.5 to 1 cm and have a 3-mm pith. Stems are green with reddish coloration at the nodes and lower portions. Wood of the lower stems is moderately hard and brittle. The stems, twigs, and leaf petioles and rachises are armed with short, straight or curved prickles. Adult plants have a fibrous lateral root system. Leaves are odd-pennate with mostly seven ovate to linear, doubly serrate leaflets. The terminal or axile inflorescences contain one to four, 1.5 to 3 cm diameter flowers with five white petals. The globose to narrowly oblong aggregate fruit is bright red and juicy when ripe. The pitted (foveolate), yellow seeds (pyrenes) are about 1.5 mm long (author's observation, Howard 1988, Liogier 1985, Lu and Boufford 2002).

Range.—Roseleaf raspberry is apparently native from China and Taiwan south through Indochina and Indonesia along the eastern coast of Australia, Mauritius, New Caledonia, the Solomon Islands, and Vanuatu, and eastward as far as northeastern India. However, it is difficult to tell the native from naturalized range that extends from Japan to Africa and through the Caribbean (including Puerto Rico) and Brazil and to many of the islands of the Pacific (including Hawaii) (Liogier 1985, Lu and Boufford 2002, Pacific Island Ecosystems at Risk 2002, Peixoto 2002).

Ecology.—Although roseleaf raspberry invades forest understories in some habitats (Pacific Island Ecosystems at Risk 2002), it is moderately shade intolerant, requiring partial sun to flower and fruit; it does best in full sun. Preferred habitats include natural and artificial openings in primary and secondary forest, such as tree-fall gaps, landslides, abandoned fields, neglected pastures, and roadsides. Roseleaf raspberry has a high moisture requirement, which usually means more than 1800 mm of mean annual precipitation and no severe annual droughts. The species usually grows at moderate to high elevations. It is reported at 2,200 m in Tahiti and 1,730 m in Hawaii (Pacific Island Ecosystems at Risk 2002). A variety of well-drained to poorly-drained soils are colonized.

Reproduction.—In China, roseleaf raspberry flowers in March through May and fruits in June and July (Lu and Boufford 2002). The species blooms and fruits throughout the year in continually moist areas of Puerto Rico and Equatorial Africa (Burkill 1997). *Rubus* species are pollinated by insects, particularly honey bees (*Apis mellifera* L.) (Dalaplane and Mayer 2000). Fresh fruits collected in Puerto Rico averaged 1.516 $\pm$ 0.102 g/fruit. Air-dried seeds separated from them averaged 0.00045 g/seed or 2.2 million seeds/kg. The seeds are dispersed by birds and rodents (Pacific Island Ecosystems at Risk 2002). Stems root (layer) whenever they come in contact with the soil, which helps it fill in newly colonized habitat.

Growth and Management.—Stems (canes) of roseleaf raspberry originating from sprouts grow 1 m or more per year and live about 1.5 years. New sprouts then arise to replace them and the plant lives on (potentially) for several years. In Puerto Rico, clumps and thickets of roseleaf raspberry usually disappear in 2 or 3 years due to mounting competition and encroaching shade from trees, shrubs, and herbs. The species is occasionally planted from wildlings and rooted layers for personal use in gardens. It is controlled along with other vegetation by slashing or mowing, and by tillage to prepare ground for crops.

Benefits.—Roseleaf raspberry helps return disturbed areas to forest vegetation, protects the soil, and furnishes food and cover for wildlife. Leaves and tender shoot are browsed by livestock. The berries are eaten out of hand and made into drinks and preserves throughout its range. Fresh fruits are sold nearly year-round in Ugandan markets (Burkill 1997). The fruits contain relatively high (1.58 and 12.93 mg/100g fresh weight respectively) of vitamins E and C (Wei and Payne 2002). Roseleaf raspberry has been grown as a ground cover in Cameroon plantations (Burkill 1997). A double petaled variety (*R. rosifolius* var. *coronaries* (Sims) Focke) is grown as an ornamental (Garden Plant Conservation 2002). Infusions of flower petals are used to control diarrhea, vomiting, and other flu symptoms, and as a tonic (Liogier 1990). An infusion of the leaves was brewed in former times to relieve menstrual cramps, morning sickness, and labor pains (Nortan 2002).

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***Salix arctica* Pallas** arctic willow
SALICACEAE

Synonyms: *Salix anglorum* Cham.
Salix brownie (Anderss.) Bebb
Salix caespitosa Kennedy
Salix pallasii Anderss.
Salix petrophila Rydb.

Juanita A.R. Ladyman

Illustration source: USDA-Forest Service collection, Hunt Institute

General Description.—*Salix arctica* is commonly known as arctic willow. This deciduous, prostrate, trailing shrub is usually less than 10 cm tall and commonly forms mats. However, its growth habitat is variable, and in the Pacific Northwest it grows up to 50 cm tall (Pojar and MacKinnon 1994). The broadly oval, alternate leaves are 2 to 6 cm long and sparsely hairy when mature. They are a glossy green on the upper side and pale green-grey below (Kershaw and others 1998, Fertig and Markow 2001). Plants are dioecious, possessing male and female flowers on separate, "unisexual" plants. The flowers of both sexes are arranged in dense, erect clusters or catkins. The female catkins are densely hairy, 1 to 8 cm (usually 2 to 4 cm) long and are borne on lateral, sometimes appearing terminal, branchlets (Kershaw and others 1998, Fertig and Markow 2001). The male, staminate, catkins are up to 4 cm long. Flowers appear with the leaves. There are several more synonyms than those listed above and may be referred to in Kartesz (1994), Argus and others (1999), and Dallwitz (1980). Identification may be difficult. Environment can affect the morphology to such an extent it appears a unique species is present (Argus and others 1999). Although many subspecies have been described, they have generally been discarded in favor of the type species. In addition, hybrids are reported, and introgression with other species, such as *S. cascadensis* in Utah and *Salix reticulata* in Russia, is well documented (Hultén 1968, Komarov 1936, Pojar and MacKinnon 1994, Welsh and others 1993).

Range.—Arctic willow is a circumpolar species occurring in North America, Europe, and Asia (Britton 1901, Fertig and Markow 2001, Hultén 1968, Komarov 1936). In North America it grows in the sub-alpine and alpine tundra zones from Quebec to Alaska and south, through the Rocky Mountains, into New Mexico (Kershaw and others 1998). Occurrences are also reported from Utah (Welsh and others 1993) and the Ruby Mountains of Nevada (Charlet 1994). It has disjunct occurrences on the west coast of the U.S.A., occurring in California and in the northern Cascade Mountains in Washington and in the Wallowa Mountains in Oregon (Hitchcock and Cronquist 1973).

Ecology.—Arctic willow grows in dry meadows, rocky tundra, fellfields, and in relatively moist sites in fen lands and at the edge of snowfields. Habitat tends to be related to latitude. In the mountains of New Mexico it is an obligate wetland species, whereas at higher latitudes it grows in both dry and moist habitats (Cooper and others 1997, Dick-Peddie 1993, Fertig and Markow 2001, Hultén 1968). It may be locally dominant in some cushion plant communities and co-occur with other species of dwarf willow such as *Salix reticulata* L. (snow willow). In New Mexico tundra, arctic willow and snow willow are often found associated with lichens and other vascular plants in snowbank and rivulet communities (Dick-Peddie 1993). Similarly in Montana and elsewhere in the Rocky Mountains, a common *S. arctica*/*Polygonum bistortoides* Pursh community was identified in "water-receiving positions" (Cooper and others 1997). However, the latter sites were also reported to have a good probability of experiencing wind scouring, and some of the associated vegetation suggested the area could be relatively dry (Cooper and others 1997). The elevation at which it occurs is also associated with latitude. Plants are only found above 3,350 m in New Mexico, whereas they occur at sea level and up to 700 m in northern parts of its range, such as Greenland (Carter 1997, Argus and others 1999). It grows in a range of soils, from acidic to calcareous (Argus and others 1999, Cooper and others 1997, Pojar and MacKinnon 1994). A mutualistic association exists between arctic willow and ectomycorrhizal fungi that are primarily agarics, or gilled mushrooms (Cripps and Horak 2002).

Reproduction.—Arctic willow reproduces by seed and also vegetatively by rooting at the nodes of stems (Fertig and Markow 2001). Flowering is from June into August. On calm, sunny days the female catkins can be up to 8.5 ^{o}C warmer and the male catkins up to 7 ^{o}C warmer than the surrounding air temperature (Kershaw and others 1998). The warmer temperatures speed pollen and seed development and also attract insects (Kershaw and others 1998).

Growth and Management.—Seeds have a physiological dormancy and require a 30-day stratification period for germination (Baskin and Baskin 2001). Seeds germinate at 25 ^{o}C although minimum temperatures for germination are not defined (Densmore and Zasada 1983). Thompson (1992) reported that seeds of *Salix* species are "normally absent" from the seed bank in alpine and arctic communities. Individual shrubs live for 60 to 85 years although one specimen was reported to be 180 and another 236 years old (Savile 1979, Raup 1959). Habitat appears to influence the sex that is most abundant. Dawson (1987) reported female plants were significantly more numerous than male plants in mesic-wet, more fertile, low soil-temperature sites, whereas male plants were most prevalent in drier, less fertile sites. In addition, both habitat and sex may influence a plant's response to environmental conditions such as temperature. In a 3-year gas exchange field study, male and female willows from dry and wet habitats were subjected to passively enhanced summer temperature using small open-top chambers (Jones and others 1999). Overall net assimilation was higher in the dry habitat than in the wet habitat, and higher in females than in males, although there appeared to also be some habitat-sex interactions (Jones and others 1999). Elevated temperature enhanced development and growth of both male and female catkins, but the response of the leaves to elevated temperatures was more variable particularly among male individuals (Jones and others 1999). These findings indicate the importance of defining both sex and habitat conditions when making observations on this dioecious species, and they may also have significance in predicting the response of Arctic willow to global climate change.

Benefits.—The majority of *Salix* species provide important browse for wildlife and livestock within their range (Dayton 1931). Arctic willow, particularly the young leaves stems and buds, provide valuable browse for ptarmigan and other arctic animals including muskox and reindeer (Kershaw and others 1998, Komarov 1936, Tolven and others 2001). Arctic willow is tolerant of varied conditions, and cuttings have been rooted and used in restoration projects (Bittman 1997). Willow leaves and bark are commonly used for medicinal purposes and the roots, twigs, and bark are used for a multitude of fiber work, such as basketry and clothing by Native American peoples (Moerman 1998). Arctic willow has been used for similar purposes by peoples native to Asian Arctic regions (Moerman 1998). The Yakuts have used an infusion as a substitute for tea called "chai-talak" (Komarov 1936). It is used as fuel in some regions where it is the only source of wood (Kershaw and others 1998). Arctic willow is cultivated, and it is especially popular for rock gardens (Bailey and others 1976, Pojar and MacKinnon 1994).

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***Salix exigua* Nutt.** coyote willow

SALICACEAE

Synonyms: *Salix interior* Rowlee

James E. Nellessen

General Description.—Coyote willow is also known as sandbar willow, basket willow, narrowleaf willow, slender willow, riverbank willow, acequia willow, long-leaved willow, and gray willow (Elmore 1976). It generally ranges in height from 0.5 to 3 m, is occasionally a small tree to 6 m and trunk diameter to 13 cm, with one author (Dorn 1998) reporting up to 17 m in height. Coyote willow is a clonal species that spreads by creeping rootstocks that generate new shoots forming multistemmed dense thickets. Coyote willow is one of few willow species that reproduce this way. As with other willows the species is dioecious. The bark is greenish to reddish on young twigs and ashy gray to grayish brown on older stems. Lenticels are elliptic and raised. The buds are reddish brown. The leaves are alternate, simple, long and narrow, linear to lanceolate in shape, tapering at both ends, generally six or more times longer than wide, 2 to 16 cm long, 4 to 15 mm wide, the margins are smooth or irregularly toothed, with one to five teeth per cm, and the petioles are short, 2 to 7 mm long (Argus 1986, Britton and Brown 1913, Carter 1997, Gleason and Cronquist 1963, Great Plains Flora Association 1986, Martin and Hutchins 1980-81, Newsholme 1992). Upon emergence the young twigs and leaves are densely silvery hairy, but with time and aging, the upper leaf surface reduces to a moderately gray hairy or smooth surface, sometimes slightly shiny. Plants in moist sites at higher elevations in the mountains may be noticeably less hairy (Mozingo 1987). The lower leaf surface generally remains whitish and much hairier. Coyote willow is one of few willow species with stomata on both leaf surfaces (Argus 1986). Stipules are small and sometimes absent. The chromosome number is 2n = 38 (Dorn 1998).

Taxonomy.—Coyote willow has a complicated taxonomy. It is a member of *Salix* section *Longifoliae*. Several botanists now consider *S. interior* as a much less hairier to smooth form of *S. exigua* that occurs in the Great Plains and Eastern United States, while variety *exigua* is the hairier Western form (Argus 1986, Carter 1988, Dorn 1998, Gleason and Cronquist 1963, Great Plains Flora Association 1986, Weber and Wittman 2001a, b). The Eastern *interior* is more distinctly toothed, leaf veins are more prominent, and the fruits (capsules) slightly longer. But characteristics are highly variable across the entire range of this plant. Under this taxonomic organization and using the Dorn (1998) treatment, there would be two subspecies: *S. exigua* subsp. *exigua* (coyote willow) and *S. exigua* subsp. *interior* (Rowlee) Cronq. (sandbar willow). The Western subspecies is divided into four varieties: var. *exigua*, var. *hindsiana* (Benth.) Dorn, var. *sessilifolia* (Nutt.) Dorn, and var. *columbiana* Dorn. The Eastern subspecies, *interior*, contains no varieties under Dorn's treatment. There are various synonyms (Argus 1986, Britton and Brown 1913, Dorn 1998, Gleason and Cronquist 1963, Great Plains Flora Association 1986, Kearney and others 1951, Newsholme 1992). A close to complete list of 34 synonyms can be found in Kartesz (1994). Hybridization is likely an important factor complicating the taxonomy for this species, the entire section, likely a syngameon undergoing geographic speciation (Brunsfield and others 1992).

Range.—This is a widely distributed species of plains and lower elevations to lower montane habitats in the Western United States, as well as throughout Eastern deciduous forests if *S. interior* is considered a subspecies. The Western form (*exigua*) occurs from Saskatchewan to Eastern British Columbia in Canada, south through the United States to Eastern and Southern California, Arizona, New Mexico, and into Northern Mexico and the Western Great Plains. The Eastern form or subspecies (*interior*) occurs from New Brunswick in Eastern Canada, westward throughout the Great Plains, as far west as Idaho, north to Alaska, south to Eastern New Mexico, and extends into the Southeast along a line from Northern Virginia to Tennessee and Louisiana. The two subspecies overlap in the Western Great Plains. In the Western mountains, coyote willow can be found as high as 2,900 m in elevation.

Ecology.—Coyote willow commonly forms thickets along streams and rivers and is an important riparian species stabilizing streambanks. It will commonly colonize sand bars along rivers, hence the frequently used alternate common name sandbar willow. It also occurs in ditches, and on the edges of swamps, lakeshores, and other wetland habitats. This species will grow anywhere groundwater is close to the surface. This includes sites where human activities result in surface water availability on a reasonably regular and reliable basis (exclusive of saline conditions). Coyote willow is also one of the few willow species that can be found in lower elevation, hot desert areas in the Western United States. But because if its wide elevational range it is both a floodplain-plains and montane riparian species (Dick-Peddie 1993). Due to the extensive rootstock and clonal nature of the species, cut stands of coyote willow will regenerate relatively quickly. The presence of an aerenchyma-containing wetland plant, *Typha latifolia* L., may facilitate a nonaerenchyma bearing species like coyote willow to survive in low oxygen wetland soils (Callaway and King 1996). Leaf water potentials as low as -2.7 MPa have been measured for high elevation populations in Wyoming (Foster and Smith 1991). Coyote willow leaves within the Colorado River (Arizona) decomposed substantially more slowly than those of *Populus fremontii* S. Watson and salt cedar (*Tamarix ramosissima* Ledebour), with 52 percent of the leaf mass remaining after 142 days (Pomeroy and others 2000). A number of insects attack coyote willow, including leaf mining beetles, lepidopterans, sawflies (*Euura* spp.), and galling insects. A bud galling midge (*Rabdophaga* sp.) affects both terminal and lateral shoots, arresting growth of the immediate shoot (Declerck and Price 1994). Coyote willow responds by producing new lateral buds and shoots, but many do not survive.

Reproduction.—The male flowers are in densely flowered catkins from 1 to 6 cm in length, each flower with two stamens, the filaments hairy. The female catkins are loosely flowered, from 2 to 10 cm long, the ovaries are smooth to slightly silky with a short or almost nonexistent style. Each ovary bears nine to 15 ovules (Argus 1986). Catkin scales are yellow and deciduous. The catkins appear with the leaves or shortly after the leaves in spring (March to May) on short leafy stalks. The flowers are bee pollinated. There may even be a second blooming period from June to August (Argus 1986). The fruits are smooth capsules from 4 to 8 mm long, green, turning yellow to reddish brown upon ripening. The fruits open by two valves releasing tiny seeds (22,000/g [Brinkman 1974]) with long hairs that aid in wind dispersal. The seeds are short-lived, do not require stratification, must fall on a moist substrate, and can germinate within 12 to 24 hours under proper conditions (Young and Young 1992). Successful germination is reported at 22 °C for the Western subspecies *exigua* (Brinkman 1974) and 5 to 25 °C for the Eastern subspecies *interior* (Densmore and Zasada 1983, Baskin and Baskin 2001). Flower-and-fruit-bearing shoots have been observed to sprout new leafy shoots and become new side branches (Argus 1986).

Growth and Management.—Along the Rio Grande in New Mexico, clearing riparian areas of the invasive, nonnative salt cedar prior to peak river flows in the spring can facilitate the reestablishment of natives such as coyote willow (Taylor and others 1999). In Alberta, Canada, successful seedling establishment of several riparian species, including coyote willow, occurred best on deposits 80 to 120 cm above the late summer stream flow (Rood and Mahoney 2000). In Manitoba, Canada, average annual height increases were 30 cm, stem diameter increases were 2.6 mm, flowering began in 2 to 3 year old stems, stem mortality was greatest in 3 to 6 year old clones, entire plant senescence first occurred at 12 years, and the oldest plant recorded was 31 years on a point bar in the Assiniboine River (Ottenbreit and Staniforth 1992).

Benefits.—Because coyote willow forms dense thickets and spreads clonally, it is an important stabilizer of streambanks. It is frequently and successfully used in riparian and wetland revegetation and restoration. It is an important food for wildlife such as deer and beaver. It is considered good browse for sheep and fair for cattle, but cattle generally find it more palatable later in the growing season (Mozingo 1987, Stubbendieck and others 1997, USDA 1937). Coyote willow is used in intensive culture coppice plantations (Aravanopoulos and others 1999), was one of 32 woody plants tested for biomass gasification, and was one of three species that exceeded 0.30 liter methane per gram of volatile solids (Turick and others 1991). Coyote willow has been successfully grown in tissue culture with roots developing from shoots longer than 1 cm (Stoehr and others 1989). Native Americans have used the slender stems in making baskets and have made a tea from the bark to treat fever and headache. Willow bark, as with most willows, is bitter and acts as an astringent for diarrhea, has been used for fevers, pain, arthritis, rheumatism, and a poultice for cuts, ulcers, and rashes. Salicylic acid, commonly used in asperin as acetylsalicylic acid, was originally derived from salicin contained in the bark of willows (Foster and Duke 1990). Salicin is a member of the chemical class of phenols and affords some protection against browsing mammals such as rabbits. It tends to attain a greater concentration in low growing willows but becomes lost in larger, taller willows (Harborne 1988). Oestriol (an oestrogen), a human sex hormone, has also been found in willow flowers.

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***Salix scouleriana* Barratt ex Hook.** Scouler's willow
SALICACEAE

Synonyms: *Salix brachystachys* Benth.
Salix capreoides Anderss.
Salix flavescens Nutt.
Salix nuttallii Sarg.
Salix stagnalis Nutt.

John K. Francis

Illustration source: USDA-Forest Service Collection, Hunt Institute

General Description.—Scouler's willow, also known as fire willow, Nuttall willow, mountain willow, and black willow, is a deciduous shrub or small tree, depending on the environment. It usually has multiple stems that reach 2 to 7 m in height in dry, cold, high elevation, and other difficult environments, and 10 to 20 m in favorable sites. The stems are straight and support few branches generally resulting in narrow crowns. The root system is fibrous, deep, and widespread. The thick sapwood is nearly white, and heartwood is light brown tinged with red. Stem bark is thin, gray or dark brown with broad, flat ridges. Twigs are stout and whitish green. Leaves are oblanceolate to elliptic, 5 to 12.5 cm long, mostly short-pointed at the apex and tapered toward the base with entire to sparsely wavy-toothed margins. The leaves are dark-green and nearly hairless above and white- or grayish-hairy below. Scouler's willow is dioecious, having male and female flowers on different trees. Tiny flowers are grouped in "pussy willow"-like catkins. The anthers, two per flower, are yellow, sometimes tipped with red; pistols are red. Fruits are light reddish-brown, long-pointed capsules about 0.75 cm long. At maturity, they open to release a white fluff with imbedded tiny seeds. The species has 2n = 76 or 114 chromosomes (Anonymous 2003, Department of Ecology 2003, Harrington 1964, Peattie 1953, Sargent 1923, Viereck and Little 1972).

Range.—Scouler's willow occurs from south central Alaska to central Manitoba, in the Black Hills of South Dakota, in the Rocky Mountains south to New Mexico and Arizona, and along the coast through British Colombia, Washington, Oregon, and California (Natural Resources Conservation Service 2003, Peattie 1953, Treeguide.com 2003).

Ecology.—Scouler's willow is the most common upland willow through most of its range. It invades quickly and abundantly after fires and logging (Viereck and Little 1972). Mineral soil seedbeds are required for seedling establishment (Forest Practices Branch 1997). In northern areas, Scouler's willow occurs in muskegs, willow thickets, disturbed areas, and forests (Welsh 1974). At lower latitudes, the species grows in former clearcuts, burned areas, thinned forests, and areas of natural disturbance such as avalanche areas and river flood zones. These are all moist, well-drained to poorly drained sites. Although this willow tolerates drier conditions than most other willows, it does not tolerate xeric conditions. Scouler's willow is a component in a large number of vegetation types throughout its range (Anderson 2001). With few exceptions, it is the only willow found growing with other trees in upland Western forests (Johnson 1995). Soils of all textures, including skeletal soils and soils derived from most parent materials are colonized. Sites may vary from near sea level to about 3,000 m in elevation (Peattie 1953). Scouler's willow is top-killed by all but gentle fires, but usually greater than 65 percent of the plants sprout quickly afterwards (Anderson 2001). The species is intolerant of shade, and when overtopped by conifers and other hardwoods, it begins to decline.

Reproduction.—Scouler's willow flowers from April through June, flowers appearing before leaves, often while snow is still on the ground, and fruiting occurs from May through July, depending on area. The flowers are insect pollinated. There are about 14,300 cleaned seeds/g. Germination, which is epigeal, begins to occur in 12 to 24 hours after seeds alight on wet ground. Germination usually reaches 95 percent in 1 or 2 days (Brinkman 1974). The seeds are dispersed by the wind. Plants sprout from the root collar when cut or top-killed. Pieces of stem and root will root and grow if partially buried in moist soil (Forest Practices Branch 1997).

Growth and Management.—Annual height growth of sprouts from cut stems varies from 1 to 3 m/year. Up to 60 sprouts are produced per stem (Forest Practices Branch 1997). Maximum height at 20 years is about 9 m. At higher elevations, shrubs reach 4 to 5 m in 15 years after which growth slows until a maximum height of 10 m is reached (Natural Resources Conservation Service 2003). Fruits should be collected by hand or with pruning poles as soon as they turn from green to yellow. The capsules are air-dried until opening. Generally, the seeds should be sown as soon as possible because they remain viable for only a few days. Seed can be stored in sealed containers under refrigeration for 4 to 6 weeks, but germination begins to drop rapidly after 10 days. Seeds are broadcast on well-prepared beds that are kept continually moist until germination and seedling emergence. Light is required for successful germination (Brinkman 1974). Recommended spacing using rooted cuttings for erosion control is 1.8 m by 1.8 m; for unrooted whips or shorter cuttings, 0.6 m. Rooted cuttings can be grown to 3 m tall in containers. Cuttings should be 45 to 60 cm long, and whips (not recommended) should be 1.2 m long (Department of Ecology 2003).

Benefits.—Scouler's willow protects the soil and helps return sites to forest cover following disturbance. When growing along streams, it helps protect the stream banks from erosion and shade the watercourse, thus maintaining cooler water temperatures. It is an important browse species for domestic livestock and wild animals. Cattle, sheep, and goats all like it as browse. It is sometimes the most preferred food species for white tailed, black tailed and mule deer, elk, moose, and bighorn sheep. Small mammals, bears, upland game birds, and waterfowl feed to a lesser extent on leaves, buds, and seeds. Fresh browse (twigs and leaves) contain 41 percent dry matter, 4 percent protein, 2 percent fat, 20.8 percent nitrogen-free extract, 11.2 percent crude fiber, and good quantities of mineral nutrients (Anderson 2001). The cover provided by Scouler's willow is important for mammals and birds. The flowers provide pollen and nectar to honey bees in early spring (Anderson 2001). The wood, which is soft and close-grained, is not sawn into lumber but is used to a limited extent for firewood and wood carving (Viereck and Little 1972). The Secwepemc people of British Colombia used Scouler's willow wood for smoking fish, drying meat, and constructing fishing weirs, the inner bark for lashing, sowing, cordage, and headbands, and decoctions of twigs for treating pimples, body odor, and diaper rash (Secwepemc Cultural and Education Society 2003).

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***Salvia apiana* Jepson** white sage

LAMIACEAE

Synonyms: *Audibertia polystachya* Benth.
Ramona polystachya Briq.
Audibertiella polystachya Briq.
Salvia californica Jepson not Bdg.

Arlee M. Montalvo

General Description.—White sage is a rounded, 1 to 2.5 m tall shrub of low elevations that has highly aromatic, 3 to 9 cm long, whitish to pale gray-green leaves that persist throughout the year. The thick, petioled, lance-oblong leaves have crenulate margins and are covered with short appressed hairs and oil glands that give the leaves a silvery sheen. The attractive white to pale lavender flowers with short greenish calyx are clustered in compact cymose branches of a tall graceful, often pink-tinged inflorescence (thyrsoid panicle) that extends from 0.5 to 1.5 m above the foliage (Munz and Keck 1968). The lower lip of the two-lipped corolla is long and ruffled and obstructs the corolla tube, whereas the upper lip is reduced to a small lobe. Anthers release most pollen prior to maturity of stigmas. The two stamens are exerted to about 15 mm, diverging up and outward from their insertion on the lower lip. The exerted stigma protrudes forward about 15 mm beyond the floral tube. There is a north to south and east to west geographic gradient in floral morphology (Meyn and Emboden 1987). For example, longer lips occur toward the coast. On the desert edge, there is a form with more compact inflorescences called *S. apiana* var. *compacta* Munz (Munz and Keck 1968). Plants have n = 15 chromosomes (Epling and others 1962). The four nutlets are about 2 to 3 mm long, somewhat rectangular, narrow in cross-section, keeled on one side, convex on the other side, and often grey-brown to light brown.

Range.—White sage ranges from Santa Barbara County, California south to the middle of Baja California and east to the western edge of the Colorado desert and is an important component of inland and coastal sage scrub vegetation, with peak abundance in Riverside, Orange, and San Diego Counties, California. It is found on dry slopes and benches in many plant communities below 1500 m (occasionally higher), including chaparral, coastal sage scrub, yellow-pine forest, and the upper edges of desert scrub (Munz and Keck 1968).

Ecology.—Plants often thrive in droughty soils and in habitats with high summer temperatures. Westman (1981a) reports occurrence on coarse to loamy soils derived from sandstone, conglomerate and sandstone, shale, granitic/dioritic rocks, and volcanic rocks. In western Riverside County, plants also occur on serpentine outcrops (author's observation). White sage tends to occur with *Artemisia californica* Less. and *Eriogonum fasciculatum* Benth. Plants are notably drought tolerant even though roots are thought to be less than 1.5 m deep (Hellmers and others 1955). The crowded, whitish leaves are often held vertically and become folded during drought, likely adaptations for keeping leaves cool. In addition many leaves dehisce late in the dry season. In a desert wash in Baja California during summer drought, leaf conductance, transpiration rates, and turgor potentials were high, and plants did not show signs of drought stress (Schmitt and others 1993). In chaparral, white sage had higher water potentials throughout the day well into the summer drought than did most of the evergreen shrubs measured (Poole and Miller 1975). Water potentials decreased late in the dry season and recovered after November at the end of the seasonal drought. The roots of white sage form associations with arbuscular mycorrhizal fungi that may also assist plants in low nutrient and droughty habitats (personal communication, James Beaver, Indiana University, Bloomington).

Fire is a normal disturbance factor of most plant communities within which white sage occurs. Following fire, this shrub frequently sprouts from distinct basal burls (Keeley 1998), but year-old seedlings are killed by fire, and repeated burning kills mature plants (Zedler and others 1983). Seedlings can emerge from the seedbank in the first season after fire, but reported densities are low (Zedler and others 1983, Keeley 1998), and high intensity fires can kill seeds (Keeley and Fotheringham 1998).

Reproduction.—Inflorescences arise from the upper nodes in spring and produce flowers from late May to July. Based on the floral morphology, only some of the larger bees are capable of transferring pollen to the highly exerted stigmas. Grant and Grant (1964) report three species of *Xylocopa* and a species of *Bombus* as effective pollinators. Hummingbirds, honeybees, bombyliid flies, and small species of native bees (primarily *Anthophora*, *Diadasia, and Osmia*) sometimes visit flowers (Grant and Grant 1964) but are thought to be ineffective as pollinators. The protandrous flowers and presence of interspecific hybrids are consistent with an outcrossing breeding system. Inflorescences are large and many-flowered, making some self-pollination likely. The small nutlets fall from the dried calyx during mid to late summer but are secondarily dispersed by harvester ants and seed caching rodents. Seed traps revealed that seeds dispersed up to 3 m away and that there was a higher secondary removal rate of seeds in coastal sage scrub (80 percent) than in grassland (0 percent) or the ecotone of the two habitats (about 40 percent) (DeSimone and Zedler 2001).

Establishment and Growth.—Seedlings emerge in the cool wet season in late winter to early spring and can take 2 years or more to reach maturity, depending on rain patterns and growing conditions. Seedling establishment in shrublands is associated with gaps in mature vegetation and within grasslands in areas where herbs have been removed by gophers (DeSimone and Zedler 1999, 2001). Seedlings show a relatively high growth rate, little herbivore damage and they fold their leaves in response to drought (DeSimone and Zedler 2001). In plots that were hand weeded and seeded in a twice-normal rainfall year, about a quarter of the seedlings survived to the second year (Storms 1999). Seedling survival is expected to be much lower in dry years and weedy areas. Most growth occurs after winter rains begin and continues until the soil becomes dry in summer. Leaf growth over the season results in a seasonal dimorphism in leaf size (Westman 1981b). Smaller leaves are produced on short shoots that develop from leaf axils along the main elongated stems and are often retained when the older, longer leaves dehisce during drought. With the return of seasonal rains, the short shoots elongate into long shoots, and the retained short leaves continue to expand and subtend the next generation of short shoots and leaves.

Hybridization.—Epling (1938) reports that white sage hybridizes with other *Salvias* with the same chromosome number, including *S. mellifera* Greene, *S. munzii* Epl., *S. leucophylla* Greene, *S. clevelandii* (Gray) Greene, *S. eremostachya* Jeps., *S. pachyphylla* Epl. Ex Munz., *and S. vaseyi* (Porter) Parish. Hybrid zones between *S. mellifera* (black sage) and white sage are especially common. Their hybrids are fully viable but, on average, suffer reduced fertility relative to parental species (Epling 1947a, Meyn and Emboden 1987), and there are fewer seeds/flower in F1 backcrosses to both parental species (Grant and Grant 1964). Hybrids exhibit a range of intermediate floral and leaf traits (Epling 1947a, b, Anderson and Anderson 1954) and differ in leaf anatomy (Webb and Carlquist 1964). Most hybrids are thought to be F1 crosses or backcrosses to black sage and they tend to grow close to the parental types.

Although black and white sage overlap in range, they have different habitat affinities. Their ranges overlap in most of coastal southern California, but white sage is not found north of Santa Barbara County and it ranges farther south into Baja California and eastward into the edge of the desert than does black sage. Both species can occur intermingled, but black sage tends to be found in flatter and wetter areas, while white sage is usually on drier slopes (Epling 1947a, Anderson and Anderson 1954, Grant and Grant 1964, Gill and Hanlon 1998). As such, most sites contain a single species, but hybrids are present at most sites where the species co-occur (Meyn and Emboden 1987).

Authors have speculated about factors that may limit the success of hybrids and maintain black and white sage as distinct species. Epling (1947a) first suggested that hybrids were less adapted to wet sites than black sage and less adapted to dry sites than white sage, but that they may be better adapted to recently disturbed conditions. Hybrids usually occur on recently disturbed areas, suggesting that hybrids are better adapted to intermediate habitats (Anderson and Anderson 1954, Meyn and Emboden 1987). Within a natural hybrid zone, Gill and Hanlon (1998) found that xylem pressure potential was significantly higher in white than in black sage, that hybrids were intermediate to the two parental species, and that white sage drops fewer leaves during drought. These data support that white sage is more drought adapted than black sage. It is possible that selection will maintain the integrity of the hybrid zones if the intermediate hybrids do better in intermediate habitats relative to their performance in the main habitats of the parental species.

The potential for reproductive isolation of the species within areas of overlap has been examined most thoroughly by Grant and Grant (1964), augmenting earlier observations (Epling 1947a, Anderson and Anderson 1954). Black sage generally flowers earlier than white sage and the short overlap in flowering time of one to several weeks limits hybridization. In addition, white sage has large, highly modified flowers that are pollinated almost exclusively by large carpenter and bumblebees (*Xylocopa* and *Bombus*), while black sage has smaller, unmodified flowers that are pollinated primarily by honeybees and small native solitary bees.

Seed germination.—Keeley (1987) showed that exposure to 70 °C for 1 hour followed by incubation in light substantially increased germination over controls, that heat shock for 5 minutes at 100 °C had no effect, and that exposure for 5 min at 120 °C killed seeds. Leachate from charred wood did not increase germination (Keeley 1987), but cool smoke treatment increased germination (Keeley and Fotheringham 1998). Liquid smoke can also be used to significantly increase germination (author's observation).

Horticulture.—The generally rounded form with attractive whitish leaves and long graceful, pink-tinged inflorescence stalks make this an attractive shrub for background areas of dry landscape gardens (Perry 1992, Keator 1994, Clebsch 1997). Plants require full sun, well-drained soil, do not tolerate constantly damp conditions, and are sensitive to conditions below –7 °C (Keator 1994, Clebsch 1997), although populations in desert scrub are likely to be more cold tolerant than those from coastal locations. Plants should be kept dry all summer long. Clebsch (1997) recommends trimming back the dried inflorescence stalks to encourage compact growth. Plants can be easily started from seeds in the fall or planted from containers.

Growth and Management.—Because of its historical abundance, fast growth, attractive nature, and importance to the biodiversity of sensitive sage scrub habitat, white sage is used in many restoration and roadside revegetation projects, especially in endangered sage scrub vegetation. Both container plants and seeds are used successfully in dry-land restoration in southern California. Seeds are collected from the dry, fruiting inflorescences, usually in July and August, depending on site, and processed to remove chaff and insects. S&S Seeds (Carpenteria, CA) and Mirov and Krabel (1939) report 715,000 to 750,200 bulk seeds/kg, with often 70 percent purity and 50 percent germination. Seeds should be planted before the onset of the cool rainy season. If seed germination tests show low germination but high seed viability, seeds can be treated with dry or liquid smoke before sowing. If liquid smoke is used, seeds must be air-dried prior to dry broadcasting. Dormant seeds can result in a beneficial seed bank and establishment over several years. Hydroseeding can be successful on steep slopes and road cuts. Shallow planting methods such as hydroseeding and imprinting are likely to produce higher germination than drilling because seed germination is improved with exposure to light. Based on seedling survival data (Storms 1999, DeSimone and Zedler 2001), even under well-weeded and rainy conditions, fewer than 25 percent of seedlings should be expected to survive through their first year. This species has decreased dramatically in percent cover in western Riverside County since the early 1930's (Minnich and Dezzani 1998). Successful restoration will depend on controlling the factors associated with its decrease, especially invasive plants and fire frequency, so that shrubs can establish, mature, and buildup a seed bank.

Benefits.—White sage leaves are an important browse of mountain sheep in the winter and spring (Perry and others 1987). Leaves contain essential oils and a variety of diterpines and triterpenes, including carnosic acid, oleaolic acid, and ursolic acid, some of which have been linked to the medicinal use of white sage by native Tribes. Some may also deter many herbivores (Dentali and Hoffman 1992). A tincture of the leaves has been used internally as a diaphoretic and diuretic, and externally to wash skin. The tincture may have antimicrobial properties. Antibacterial and antifungal activity of several compounds have been verified in vitro (Dentali and Hoffman 1992). In addition to medicinal use, the dried leaves have been used as a smudge and crushed as a soapless shampoo (Bean and Saubel 1972, Moore 1989). Seeds have been used as food and leaves for flavoring.

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Salvia mellifera Greene black sage
LAMIACEAE

Synonyms: _Audibertia stachyoides_ Benth.
Ramona stachyoides Briq.
Audibertiella stachyoides Briq.

Arlee M. Montalvo. and Paul A. McMillan

General Description.—Black sage has a dark appearance, especially during drought. _Salvi_a is derived from the Latin word for safe and refers to the medicinal properties of sages. The specific epithet _"mellifera"_ means "honey producing" and refers to its use by nectar foraging bees. Shrubs are open, 1 to 2 m tall with twisted, furrowed woody stems at the base, and herbaceous greenish branch tips that are square in cross section. Twigs and leaves are glandular, highly aromatic, and opposite. The oblong-elliptical blades are 2 to 6 cm long, dark green and rugulose above (convex between obvious veins) with crenulate (finely scalloped) margins, and taper to a few to 12 mm long petiole (Munz and Keck 1968). Many small, 6- to 12-mm long, two-lipped flowers occur in compact clusters subtended by green bracts and are spaced 2 to 6 cm apart along the often branched inflorescence. Corollas vary from pure white to pale blue or lavender. The style and stamens extend just beyond the corolla tube. Flowers bear four oblong nutlets (single–seeded fruits) within a persistent calyx. Nutlets vary from mottled gray to dark brown and are about 1 mm wide and 2 mm long.

Range.—Black sage occurs on dry slopes and alluvial fans within interior and coastal sage scrub and lower montane chaparral from sea level to 1,200 m, ranging from Contra Costa County, CA (near San Francisco) south to northern Baja California (Munz and Keck 1968, Hickman 1993). On leeward slopes of the Coast Ranges it extends into desert scrub (Keeley 1986). It is one of the dominant shrubs of sage scrub (Westman 1983), and can form dense, nearly monospecific stands on steep slopes.

Ecology.—Black sage occurs on a variety of soils derived from sandstone, shale, granite, and especially serpentinite, and gabbro basalt (Westman 1981). Plants produce numerous volatile compounds, including camphor, cineole, terpenes, and sesquiterpenes (Neisess and others 1987, Gonzalez and others 1992, Arey and others 1995), which may be important in herbivore or pathogen defense.

Black sage is semideciduous, depending on site and severity of drought, and shallow rooted. Plants are drought tolerant by leaf curling rather than drought avoiding through leaf drop (Gill and Hanlon 1998). Leaf drop is drought induced possibly due to embolisms that occur in xylem tissues (Kolb and Davis 1994). At Stanford, CA, leaves began to senesce and drop in October in both irrigated and unirrigated treatments, leaf stomata did not control transpiration when xylem water potentials were low, and rates of photosynthesis did not decline until after leaf drop (Gigon 1979). In Santa Barbara County, CA, most leaves senesced between May and July, 32 percent persisted into the following growing season, leaf curling and uncurling was related to water stress, and leaf drop was more related to photoperiod than to low xylem potentials (Gill and Mahal 1986).

Reproduction.—The timing of growth and flowering is closely adapted to the Mediterranean climate of southern California, with cool wet winters and hot dry summers (Grant and Grant 1964, Gill and Mahall 1986). Common garden studies with 12 populations revealed that date of first flowering varies with source population and ranged from early February to early May (Montalvo, unpublished data). Also, shifts in flowering time occur in years with contrasting rainfall patterns (Meyn and Emboden 1987).

The self-compatible flowers are hermaphroditic with stamens dispersing pollen before stigmas are receptive. Flowers are pollinated by small to meduim-sized solitary bees in families Andrenidae, Anthophoridae, Halictidae, Megachilidae, and Xylocopinae as well as introduced honey bees (Grant and Grant 1964). Rarer visitors include large-bodied *Bombus* and *Xylocopa* bees, syrphid and bombyliid flies, and Anna's hummingbirds. Each flower produces up to four seeds that are gravity dispersed in June and July from the dry, persistent calyces, and can be secondarily dispersed by ants. Seeds accumulate in a dormant seed bank (Keeley 1986).

Establishment and Growth.—Black sage occurs in plant communities adapted to fire and drought. Seedlings emerge in clearings between adult shrubs, but most emerge in the first 2 years following fire, primarily from February to April (Keeley 1986, Westman and O'Leary 1986). Plants take two or more growing seasons to reach maturity. After fire, plants sometimes resprout from the base (Went and others 1952, Keeley 1986, 1998). However, where fire intensity is high, shrubs tend to be killed, and recruitment is primarily by seed. Across a range of conditions, resprouting success averaged 15.8 percent, and shrubs that resprouted had significantly smaller basal diameters, suggesting resprouting decreases with age (Keeley 1998). The seasonal pattern of growth and dormancy varies both geographically and between years. Generally, seasonal growth begins after the start of fall rains, most new leaves are produced by mid March, and flowering occurs from late winter to late spring.

Roots are colonized by arbuscular mycorrhizal (AM) fungi. After 4 months of growth in a greenhouse, root and shoot mass was higher in seedlings inoculated with AM fungi than in controls, but in younger plants the opposite occurred (E. Allen, L. Egerton-Warburton, A. Montalvo, unpublished report).

Seed germination.—Seeds of black sage often have low germination rates unless exposed to light or components of fire such as charred wood, smoke, or KNO_3 (Keeley 1986, Thanos and Rundel 1995, Keeley and Fotheringham 1998). Exposure to dry cool smoke for 5 min (Keeley and Fotheringham 1998) yields higher germination than charred wood. A 12 to 15 hour soak in a 1:25 dilution of Regen 2000 Smokemaster, a liquid smoke product, also breaks dormancy (author's observation). Heat of fire may reduce germination of seeds from sage scrub populations (Keeley and Fotheringham 1998). Oddly, seeds from desert populations, where fires are less frequent, were stimulated to germinate by heat and charred wood, but not by light (Keeley 1986).

Genetics, Geographic Variation, and Fitness.—Black sage is genetically variable over its geographic range. In a survey of 12 populations (Montalvo, Clegg, and Ellstrand unpublished, 14 allozyme loci), expected heterozygosity was high (He = 0.23) and alleles averaged 2.81 per locus. Within sites, a low inbreeding coefficient (f = 0.072) suggests the protandrous flowers and pollinators combine to promote outcrossing. There is significant but low structure both among and within populations, and results are consistent with a relatively high level of historical gene flow (Theta-p ($\sim F_{ST}$, sites relative to total population) = 0.041; Theta-s (plots relative to sites) = 0.057; and F (F_{IT}) = 0.125).

Populations cluster by genetic similarity, and geographic floristic associations and this is somewhat mirrored by distribution patterns of morphological variation and timing of flowering. Flowers from populations in the Santa Monica Mountains and Simi Hills can be strikingly bluish. In the drier, more interior hills and valleys of Riverside Co., flowers tend to be white to pale blue or lavender, and plants flower earlier. These differences are retained in common gardens. Differences in timing of flowering could affect seed production of translocated populations if pollinator activity, seed predation, or important physical environmental factors differ from home sites. Plants from contrasting populations also smell different, likely due to differences in composition of volatile chemicals. Such differences among populations may be adaptive and contribute to their success under particular environments. Montalvo and Ellstrand (unpublished) evaluated seedling survival, growth and reproduction of 12 populations in a common garden. A combination of climatic data and soil traits was used to calculate environmental similarity among garden and source sites. After three growing seasons, populations from sources most similar to the garden site were the most successful (measured as survival x flower production). This effect was small ($r^2 = 0.18$) but is consistent with the presence of weak adaptive differences among source populations.

Hybridization.—Black sage hybridizes with the shrubs *S. apiana* Jeps. (n = 15), *S. leucophylla* Greene (2n = 30), and *S. clevelandii* (Gray) Greene (2n = 30), and rarely with annuals *S. columbariae* Benth (n = 13) and *S. carduacea* Benth (n = 16) (Epling 1938, 1947a, Epling and others 1962, Munz and Keck 1968). Most hybridization is with *S. apiana*. These hybrids are fully viable but suffer reduced pollen fertility (Epling 1947a, Meyn and Emboden 1987) and numbers of seeds/flower in F1 back crosses to parental species (Grant and Grant 1964). Hybrids differ from both parental species by a range of intermediate floral, leaf, and anatomical traits (Epling 1947a, b, Anderson and Anderson 1954, Webb and Carlquist 1964). Most are thought to be F1s or backcrosses to *S. mellifera* and tend to grow near parental types. Hybrid zones can be stable in position but may shift in morphology (Meyn and Emboden 1985). This suggests differences in the relative success of hybrids and backcrossed progeny over time. The influence of gene exchange on floral form of black sage does not appear to extend beyond hybrid zones (Epling 1947a, b).

Several authors have speculated on the factors promoting hybridization while also maintaining black and white sage as distinct species. While ranges overlap in most of southern California, *S. apiana* is not found north of Santa Barbara County and it ranges farther south into Baja California and eastward. In areas of contact, *S. mellifera* tends to occur in flatter and wetter microsites, while *S. apiana* occurs on drier slopes (Epling 1947a, Anderson and Anderson 1954, Grant and Grant 1964, Meyn and Emboden 1987, Gill and Hanlon 1998). Hybrids also occur in recently disturbed areas, suggesting that hybrids are adapted to intermediate habitats (Anderson and Anderson 1954, Meyn and Emboden 1987). Within a hybrid zone, Gill and Hanlon (1998) found that xylem pressure potential was significantly higher in white than in black sage and that putative hybrids were intermediate to the two parental species. These data support that *S. apiana* is more drought adapted than *S. mellifera*, and that the hybrids are intermediate. In addition, reproductive isolation is favored by flowering differences. *S. apiana* flowers later than black sage, limiting opportunities to hybridize (Grant and Grant 1964). In addition, white sage has larger, highly modified flowers that are pollinated almost exclusively by large bees in *Xylocopa* and *Bombus*. Black sage has smaller, two-lipped flowers that are rarely visited by these large-bodied bees.

Growth and Management.—Seeds are collected from June-August and should be cleaned to remove seed predators. Air separation can be used to remove lighter unfilled seeds that are sometimes abundant. There are about 1,375,000 seeds/bulk kg (personal communication with Victor Schaff, S&S Seeds, Carpenteria, CA). Treatment of seeds with dry or liquid smoke increases germination substantially. Seeds should be air-dried before handling. Plants can be sown in flats for subsequent transplanting or directly sown into the ground in the fall. Plants can be started from cuttings, but this should be avoided for restoration because it reduces genetic variation. Prostrate cultivars (e.g., Clebsch 1997) should not be used in restoration. Black sage grows in well-drained soil and can tolerate some summer water in a garden.

Benefits.—Black sage is important for restoration, erosion control, and native landscape gardening in California. Plants provide cover and seeds for wildlife, and in western Riverside Co. the listed California gnatcather frequently nests in vegetation containing black sage (Weaver 1998). The seeds were eaten and the leaves used for flavoring by native California tribes (Bean and Saubel 1972). In addition, the leaves have a long history of medicinal use by native tribes (Bocek 1984). Their diterpene compounds have antimicrobial activity against gram (+) bacteria (Moujir and others 1996).

Decreasing Populations.—Black sage populations are declining. Increased ignition sources and invasion of shrublands by annual grasses have increased fire frequency, jeopardizing recovery of seed banks (Westman and O'Leary 1986, Haidinger and Keeley 1993, Minnich and Dezzani 1998). Black sage is also inhibited by exotic annual grasses, black mustard (Went and others 1952, Storms 1999), and air pollution (Westman 1985, Preston 1988).

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Sassafras albidum (Nutt.) Nees sassafras

LAURACEAE

Synonyms: _Sassafras sassafras_ (L.) Karst.
Laurus albidus Nutt.
Laurus sassafras L.
Sassafras officinale Nees & Eberm.
Sassafras variifolium (Salsb.) Kuntze
Sassafras albidum (Nutt.) Nees var. _molle_ (Raf.) Fern.

John K. Francis

General Description.—Sassafras is also known as white sassafras, common sassafras, ague tree, cinnamon wood, saloop, smelling stick, gumbo file, and mitten tree. It is a shrub or small tree up to 15 m in height and 35 cm in diameter. The species grows as a medium to large shrub in Florida, in the northern part of its range, and on sand or poor, rocky sites. It may have single or multiple stems. Older stems have deeply furrowed, red-brown bark. Slender, brittle, twigs with thick, white, mucilaginous pith are covered by green bark. The species depends primarily on a shallow, lateral root system. Long lateral roots develop suckers that in turn develop their own root system. The alternate dark green leaves occur in three forms: ovate or elliptical leaves, leaves with one side lobe ("mitten"), and trilobate leaves with the center lobe being symmetrical and somewhat larger than the side lobes. Leaves are 8 to 15 cm long. Small yellowish-green flowers grow in axillary racemes. The fruit is a fleshy, oblong, dark blue or black drupe partially set in a red or orange thickened base (pedicel and calyx). The seeds are oblong, pointed, and brown (Griggs 1990, Sargent 1923, Vines 1982).

Range.—Sassafras is native to all of the States east of a line running between Lake Superior and western Texas, and in extreme southern Ontario (Natural Resources Conservation Service 2003, Sullivan 1993). It is planted as an ornamental in at least the United Kingdom, Germany, and Spain (Oberle 2003, Plants for a Future 2003, Sanchez de Lorenzo 2003). There are no reports of it naturalizing outside its native range. The genus contains two other species, natives of China and Taiwan (Center for Wood Anatomy Research 2003)

Ecology.—Sassafras is intolerant of shade, and reproduction from seed is rare under closed-canopy forest. However, it is a pioneer in old fields and an invader of disturbed and early secondary forests. It grows as scattered individual plants or as dense thickets, often of sucker origin. Removal of the forest overstory by almost any means (i.e. gypsy moth, logging, fire) results in increased density of the species. On the other hand, as competition increases and forest canopies close, sassafras decreases in importance. Although uncommon, it persists in old-growth stands. The species grows from a few meters above sea level to 1,220 m (Sullivan 1993). Mean annual precipitation ranges from 760 to 1400 mm/year and the average frost-free period ranges from 160 to 300 days. Average January temperatures range from -7 to 13 °C and average July temperatures range from 21 to 27 °C. (Griggs 1990). Sassafras grows in a wide variety of soil types and grows best on well-drained sandy loams with a pH between 6.0 and 7.0 (Griggs 1990). Seedlings and saplings are easily top-killed by fire but readily sprout. Thick-barked trees are injured by fire (Sullivan 1993). Sassafras is sometimes attacked by leaf blight caused by *Actinopelte dryina*, by leaf spots caused by *Mycosphaerella sassafras*, and by a *Nectria* canker. A number of insects also attack the species (Griggs 1990).

Reproduction.—Flowers open in early spring with the first leaves. Male and female flowers usually occur on different plants (Sargent 1923). Fruits mature in August or September. Seed production begins when plants are about 10 years old (Griggs 1990). There are about 12,800 seeds/kg (Bonner and Maisenhelder 1974) or according to Griggs (1990), 8,800 to 13,200 seeds/kg. About 35 percent of the seeds are sound. Birds are the principal dispersers of seeds, with gravity, water, and mammals playing minor roles. Germination, which occurs in the spring, is hypogeal. Seeds may remain viable in the soil seed bank for up to 6 years (Griggs 1990). Sassafras sprouts prolifically from stumps and suckers from lateral roots.

Growth and Management.—Growth of sassafras is moderately fast. Sprouts can reach 1.2 m in the first year and 4.5 m in 4 years (Floridata 2003). Rare individual trees reaching the forest canopy may live as long as 300 years (TreeGuide 2003). Fruits are ripe and can be harvested when they turn from green to dark blue and can be picked by hand or by flailing them from the trees or shrubs onto a tarp. The seeds can be cleaned of fruit tissue by rubbing against hardware cloth and washing away the pulp. One kg of fruits will yield about 310 g of seeds. Seeds should be placed in sealed containers and stored at 2 to 5 °C. Before planting, seeds should be moistened and held at the above temperatures for 120 days. Drilling in nursery beds in 20- to 30-cm-wide rows and covering with 6 to 12 mm of soil is recommended (Bonner and Maisenhelder 1974). Sassafras can also be reproduced from root cuttings but not from stem cuttings (Griggs 1990). Wildlings are difficult to transplant. Sassafras shrubs and trees can be killed by injecting 2,4-D, picloram, or glyphosate (Sullivan 1993).

Benefits.—Sassafras adds beauty in both summer and winter to forest lands where it grows. It has been used to help restore depleted soils of old fields and is considered superior to black locust (*Robinia pseudoacacia* L.) and pines in this application (Grigg 1990). Sassafras is browsed year-round by white tailed deer. The plants are also utilized to some extent by woodchucks, rabbits, beavers, and bears. Many species of birds and some small mammals consume the fruits. Crude protein ranges from 21.0 percent (leaves in April) to 6.1 percent (twigs in January). The fruits have a high lipid and energy value (Sullivan 1993). Sassafras makes an attractive ornamental small tree and is widely, although not heavily used. The fall foliage colors of yellow, orange, and red are particularly beautiful. Sassafras heartwood is pale brown to orange brown; sapwood is yellowish-white. The wood is ring-porous, coarse- but straight-grained, brittle, soft, and has a spicy aromatic odor. It is resistant to decay making it useful for fence posts and other items exposed to moisture. It is also useful for lumber, millwork, furniture, and small boats. Technical details of the wood have been published (Center for Wood Anatomy Research 2003). The use of sassafras in herbal medicine has a long history beginning with Native Americans who used it to treat colds, high blood pressure, heart troubles, swelling, as a tonic, to treat for worms, and to control fever (Moerman 1986). Sassafras tea is still widely drunk both for pleasure and as a tonic. Extracts and infusions of the plant are used to treat a wide range of physical complaints. Dry, powdered leaves, called file, are used to thicken gumbo and other Cajun dishes (Katzer 1999). Oil of sassafras, extracted from the root bark, was the original flavoring for root beer and was used to flavor candy, chewing gum, and medicines. Because it contains safrole, a carcinogen, it is no longer permitted in food, but may be used to add scent to cosmetics and soap (TreeGuide 2003).

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***Schaefferia frutescens* Jacq.** Florida-boxwood

CELASTRACEAE

Synonyms: *Schaefferia completa* Sw.
Schaefferia frutescens Jacq. var. *buxifolia* DC.
Schaefferia buxifolia (DC.) Nutt.

John K. Francis

General Description.—Florida-boxwood is a shrub or occasionally a small tree. Florida-boxwood is also known as yellowwood, jiga, cafeíllo, cabra cimarrona, amansa, guapo, jasmín, limoncillo, fruta de paloma, petit bois blanc, bois capable, petit garcon, and merisier (Little and others 1974). It has multiple stems, branching near the base, or a single stem, and usually reaches heights of 4 to 5 m. However, the Florida record tree measures 8 m in height and 18 cm diameter at breast height (Champion Tree Project 2001). The bark is light gray and nearly smooth, becoming increasingly furrowed in older shrubs and trees. The inner bark is light yellow. The roots are bright orange. There is a weak taproot supporting robust and stiff lateral roots and fine 3rd and 4th order roots. Twigs of Florida-boxwood are slender, slightly angled, hairless and pale yellow-green when young, turning light gray with age. The branch habit is upright to partially drooping. The leaves are yellow-green, alternate, simple, leathery, and elliptic to oval shaped with pointed ends. They measure 4 to 7 cm in length and 1.2 to 2.5 cm in width. The flowers are small, pale green or greenish-yellow or greenish-white, and borne in small clusters at the leaf axiles. The fruits that arise from them are spherical to ovoid, 4 to 8 mm long, and red or orange-red. Each fruit contains two light-brown seeds (Howard 1989, Little and others 1974, Liogier 1994, Nelson 1996).

Range.—Florida-boxwood is native to southern Florida, the Bahamas, the West Indies, Mexico through Central America, Colombia, Venezuela, and Ecuador (Liogier 1994). It is not known to have naturalized outside its native range.

Ecology.—Florida-boxwood grows in soils ranging from sandy to clayey and from mildly alkaline to moderately acid derived from both sedimentary and igneous rocks. In Puerto Rico, the species inhabits areas receiving from 750 to about 1700 mm of mean annual precipitation and from near sea level to 600 m in elevation. In the upper range of rainfall, it grows only on excessively drained sites. Florida-boxwood is moderately shade tolerant. It is usually found in the understory of low-density forest where it grows well and reproduces. After the forest overstory is removed, Florida-boxwood grows well in full sun. In Puerto Rico, the species grows in remnant dry and moist forests and middle and late secondary forests. In Florida, it grows in tidewater areas and hammocks. The species is drought tolerant and somewhat resistant to soil salinity (Gilman 1999). Although the species is common in Puerto Rico and in much of its range, it is considered endangered in natural environments in Florida (Institute of Systematic Botany 2001).

Reproduction.—Florida-boxwood flowers in March through May in Florida (Nelson 1996). Fruits collected in Puerto Rico averaged 0.142 $\pm$ 0.002 g/fruit. Seeds separated from them averaged 0.011 $\pm$ 0.000 g/seed or 98,000 seeds/kg. Twenty-one percent of these seeds germinated between 62 and 93 days of sowing in moist peat. Germination is epigeal. The fruits are apparently eaten and the seeds dispersed by birds.

Growth and Management.—Florida-boxwood is reported to have a high growth rate, withstands heavy pruning, and can be formed into hedges and shaped into small trees (Gilman 1999).

Benefits.—Florida-boxwood makes superior quality hedges, screens, and accent plantings. It is also used for reclamation plantings (Gilman 1999). The wood is light brown to yellow, hard and moderately heavy. It has been used in the past for wood engraving (Little and others 1974). It is also used, when available, for carving, for boxes (Gilman 1999), and, to a limited extent, for fuel. The leaves have been used in the past as emergency soap for the body and cloths (Liogier 1990). Almost nothing is known about its forage value except that Key deer (*Odocolleus virginanus clavium*) will not eat it (Schaus and others 2001). Decoctions are used in herbal medicine for colds, flu, and chronic cough, and crushed leaves are used as a soothing bath for skin irritations (Liogier 1990).

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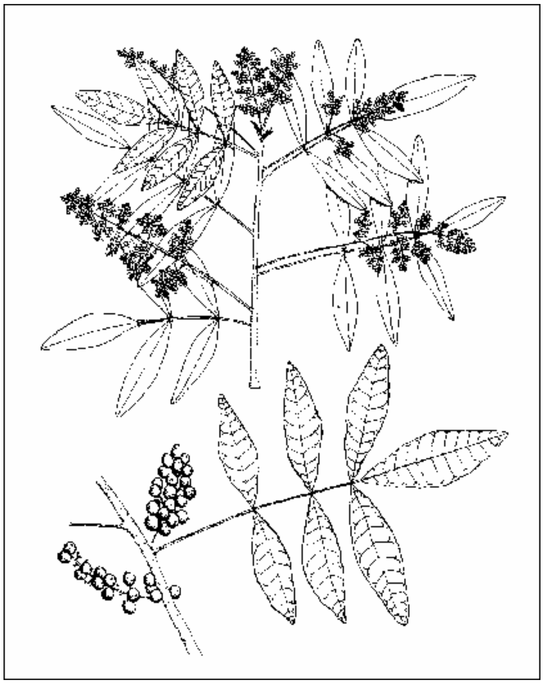
***Schinus terebinthifolius* Raddi** Brazilian pepper tree
ANACARDIACEAE

Synonyms: *Sarcotheca bahiensis* Turcz.
Schinus antiarthriticus Mart. ex Marchand
Schinus mellisii Engl.
Schinus mucronulatus Mart.
Rhus terebinthifolia Schlecht. & Cham.

John K. Francis



General Description.—Brazilian pepper tree, also known as Christmas berry, Florida holly, pimienta de Brazil, copal, chichita, and aroeira pimenteira, is a multiple-stemmed evergreen shrub or small tree, usually 2 to 6 m in height and 3 to 12 cm in stem diameter. A few individuals of the species develop large central stems and a dense growth of low limbs and basal sprouts. The bark is smooth and gray. Wounds in the stem and twigs exude a resinous sap that turns black on exposure to air. The alternate, compound leaves have a rachis 3 to 14 cm long, often winged, with five to nine leaflets. The leaflets are 1.5 to 7.5 cm long, lanceolate to elliptic, pointed at each end, with entire to serrate edges. The midribs, rachis, and petiole are often reddish, especially when young. Crushed foliage smells like turpentine. The inflorescences (panicles) are mostly born in the leaf axils near the twig ends and contain many small white flowers. Male and female flowers are borne on different plants (dioecious). The fruits are bright-red, fleshy drupes 4 to 6.5 mm in diameter with an aromatic brown pulp and an elliptic light-brown stone (Liogier 1988, Long and Lakela 1976, National Parks Service 2002).

Range.—Brazilian pepper tree is a native of Brazil, Argentina, and Paraguay (Liogier 1988). It was introduced into Florida in 1898 and has since been distributed widely. The species has escaped cultivation and occupies huge areas in natural stands (Nelson 1996). It has also naturalized in Arizona, California, Hawaii, Puerto Rico, the U.S. Virgin Islands, and many tropical and subtropical countries (Little and others 1974, National Parks Service 2002).

Ecology.—Brazilian pepper tree is an aggressive pioneer species that quickly colonizes disturbed areas. The species has an intermediate tolerance of shade and can survive and grow slowly under forest canopies until disturbance releases it. Although seedlings are quickly killed by inundation, large plants can withstand up to 6 months of flooding. It is very drought resistant. Brazilian pepper tree also survives fire well and can withstand high winds without significant damage. It is apparently at home in tropical, Mediterranean, and desert climates (National Parks Service 2002). In Puerto Rico, the species is most common in low-elevation, moist limestone areas and nearby coastal plains. In Florida, it grows in mangrove associations, hammocks, pinelands, old fields, and disturbed areas (Long and Lakela 1976).

Reproduction.—Brazilian pepper tree flowers most prolifically in the spring in Florida (Nelson 1996). It flowers and fruits intermittently throughout the year in Puerto Rico (Little and others 1974). In Florida, the flowers are pollinated by a native syrphid fly (Fire Sciences Laboratory

2002). Seeds from Brazil were reported to average 80,600 seeds/kg (Instituto de Pesquisas e Estudos Florestais 2002). Germination of intact fruits (without the exocarp digested or manually removed) is minimal, and seeds do not remain viable in the soil bank more than 9 months (Panetta and Mckee 1997). Birds, particularly robins, mockingbirds, and cedar waxwings, are the chief dispersers of seeds in Florida (Fire Sciences Laboratory 2002). Brazilian pepper tree is propagated from both seeds and cuttings (Little and others 1974). It readily sprouts when cut.

Growth and Management.—Brazilian pepper tree is fast growing and in certain circumstances is capable of growing to large diameters. The U.S. Champion tree in Florida measures 134 cm in diameter at breast height and 10.7 m in height (American Forests 2002). Brazilian pepper tree has shown large growth responses to inoculation with mycorrhizal fungi and superphosphate (Carneiro and others 1996). Hand pulling, bulldozing, prescribed fire, and spraying with herbicides have all been used with varying degrees of success to control Brazilian pepper tree. So far, biological control methods have failed (National Parks Service 2002).

Benefits and Detriments.—Widely introduced as an ornamental, Brazilian pepper tree was popular for its red berries and bright green foliage. It is still used for Christmas decorations. Because it and the species growing in its understory do not burn readily (Fire Sciences Laboratory 2002), Brazilian pepper tree has been recommended for planting as fire resistant barriers (Castronovo 1997). Goats browse on the foliage with no ill effects (National Parks Service 2002). The species is a honey plant (Little and others 1974) and the wood has been used for fuel, lumber, stakes, posts, and railway sleepers (Fire Sciences Laboratory 2002). The dried fruits are marketed in Brazil as a substitute for black pepper (*Piper nigrum*) (personal communication with J.A. Parrotta, USDA Forest service, Washington, DC). A decoction of bark is used in baths to relieve rhumatisum and back pain (Liogier 1990). The essential oils from leaves and flowers are made up of a mixture of a large number of chemicals, the most important of which are alpha-pinene (24 percent), limonene (12 percent), and p-cymene (14 percent) (Singh and others 1998). Extracts of Brazilian pepper tree were shown to be the most effective of a number aromatic and medicinal plant species in suppressing several important pathogenic bacteria (Martínez and others 1996, Siddiqui and others 1995). Despite these benefits, Brazilian pepper tree is often undesirable outside its native range. It is so well adapted and aggressive in Florida and Hawaii that it suppresses and replaces native vegetation, including endangered species. For this reason it is banned from cultivation there (Fire Sciences Laboratory 2002, Nelson 1996). Brazilian pepper tree is reported to have an allelopathic effect on competing plants (National Parks Service 2002). The plant causes skin irritation similar to poison ivy (*Toxicodendron radicans* Linn.) and respiratory difficulties in some people when it is in bloom (Nelson 1996). It is a host of the black twig borer of coffee, *Xylosandrus compactus* (Eichoff) (College of Tropical Agriculture and Human Resources 2002). The fruits are eaten by mammals and birds, but excessive feeding has been blamed for massive bird kills in Florida (National Parks Service 2002), and the unripe fruits can be fatal to horses (Fire Sciences Laboratory 2002).

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Securidaca virgata **Sw.** bejuco de sopla
POLYGALACEAE

Synonyms: *Elsota virgata* (Sw.) Kuntze

John K. Francis

General Description.—Bejuco de sopla, also known as jaboncillo and maravedí, is a woody vine-like shrub that ascends trees and other vegetation and can reach 9 m in length and 3 cm in basal stem diameter. The plants have a tap and lateral root system of tough and flexible roots with a moderate amount of fine roots. The stems give rise to few branches until they reach full or nearly full light after which there are abundant secondary and tertiary branches. The greenish, cylindrical woody stems have pronounced annual rings. The fine branches are green and produce relatively few leaves, which they lose during dry seasons. Foliage is found only on the current year's growth. The alternate leaves are oval, have a 1 mm petiole, and are 10 to 20 mm long by 8 to 15 mm broad. Small, 8 mm-long, pink to violate, fragrant flowers are borne near the ends of the branches in paniculate racemes. The fruit, a reticulate-veined samara 2 to 4 cm long and about 1 cm broad, turns from green to yellow to light tan as it ripens, and contains a single seed (Acevedo-Rodrígiez 1985, author's observations, Grisebach 1963, Liogier 1988).

Range.—Bejuco de sopla is native to Puerto Rico, its offshore island, Vieques, as well as Jamaica, and Cuba (Acevedo-Rodrígiez 1985, Grisebach 1963, Liogier 1988).

Ecology.—Bejuco de sopla grows on a wide variety of soils over both sedimentary and igneous rocks at lower and middle elevations. Annual rainfall in its native areas ranges from about 900 to 2500 mm/year. It sustains itself on other vegetation by twining around stems and branches (Vélez and van Overbeek 1950). Although it depends on trees and shrubs for support, it does not smother them, tending to hang down from side branches. Bejuco de sopla is intolerant of shade and does not grow under closed, shady forest canopies. It grows in brushy pastures, old fields, fencerows, roadsides, canyons, gallery creek bottoms, secondary forest, and low-density remnant forests. The species does not form pure stands or dense thickets, although is may grow in mixture with other vines and shrubs in thickets.

Reproduction.—Bejuco de sopla flowers and fruits sporadically throughout the year (Acevedo-Rodrígiez 1985, Vélez and van Overbeek 1950). A collection of fruits from Puerto Rico weighed an average (air-dried) of 0.0728 $\pm$ 0.0011 g/fruit. The acorn-like seeds separated from the wing weighed an average of 0.0455 $\pm$ 0.0012 g/seed or 22,000 seeds/kg. Sown in moist potting mix, 22 percent of these seeds germinated in 32 days by which time some of the seedlings began to die from "damping-off" (fungal species unknown). The survivors were 10 cm tall 2 months after sowing and ready to prick out. Fruits of bejuco de sopla are mature and ready to harvest when they are dry on the tips or have a yellow color. They should then be air-dried before storage or planting. If the seeds are separated, it must be done by hand, a laborious process that probably is not necessary. Bejuco de sopla vines layer (root) whenever they come in contact with the ground. Although untested, this probably indicates that the species can be propagated by air layering and from cuttings. The seeds are dispersed as they spiral sideways in the wind or still air. Seedlings are usually well scattered.

Growth and Management.—Bejuco de sopla has a moderate growth rate. Height growth of established plants is 1 m or more per year and diameter growth is about 3 mm/year. Individual stems live 5 to 10 years or more; plants may last longer by resprouting. Bejuco de sopla is not abundant, aggressive, or weedy. Should it be necessary to eliminate individual plants, grubbing them out will probably be effective.

Benefits.—Bejuco de sopla contributes to biodiversity, helps protect the soil, and furnishes wildlife cover. It is a honey plant (Marcano-F. 1973). The roots, principally, are used to treat flu, laryngitis, edema, urinary infections, and as an expectorant and a diuretic (Liogier 1990). The plant is prescribed by traditional Latin healers in New York City to treat uterine fibroids (Balick and others 2000).

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***Senecio flaccidus* Less.** threadleaf groundsel
ASTERACEAE

Synonyms: *Senecio douglasii* DC.

James E. Nellessen

General Description.—Threadleaf groundsel is also known as threadleaf butterweed, Douglas groundsel or ragwort, felty groundsel, sand wash groundsel, comb butterweed, old man, yerba cana, squawweed, creek senecio, and cenicillo (Elmore 1976, Epple 1995, Stubbendieck and others 1997). This species commonly reaches heights of 80 to 130 cm and under ideal conditions may reach 2 m. It is probably best classified as a subshrub. It forms woody stems to a meter or so but often dies back to less than 50 cm from the ground-line. It tends to become somewhat straggly as branches may lean over in different directions, some becoming almost decumbent. The leaves are alternate, pinnately compound (sometimes not divided), narrow and thread-like, up to 12 cm in length, and usually covered with whitish hairs giving the plant an obvious grayish color (Carter 1997, Ivey 1995, Kearney and others 1951, Martin and Hutchins 1980-81). It may have some tendencies to be evergreen in the southern portion of its range.

Taxonomy.—There has been a profusion of taxonomic names and varietal subclassifications attached to this species, making for a complicated taxonomy. The oldest specific name applied to this species complex is now known to be *Senecio flaccidus* Lessing (Turner and Barkley 1990). Three varieties are recognized with the following synonymies (Allred 2002, Kartesz 1994). Variety 1: *S. flaccidus* Less. var. *flaccidus*, with four synonyms; *S. douglasii* DC var. *longilobus* (Benth.) L. Benson, *S. filifolius* Nutt., *S. flaccidus* Nutt. var. *jamesii* Torr. & Gray, and *S. longilobus* Benth. This variety tends to be more uniformly white hairy with the column of the flower head narrower (8 to 10 mm wide at summit). Variety 2: *S. flaccidus* Less. var. *douglasii* (DC) B. Turner & T. Barkley, with two synonyms; *S. douglasii* DC var. *douglasii*, and *S. warnockii* Shinners. This variety is not white hairy throughout and the heads are wider (10 to 15 mm). Variety 3: *S. flaccidus* Less. var. *monoensis* (Greene) B. Turner & T. Barkley, with two synonyms; *S. douglasii* DC var. *monoensis* (Greene) Jeps., and *S. monoensis* Greene. This variety is generally hairless throughout, more herbaceous, and has a more comb-like leaf, the linear lobes curling upward.

Range.—Threadleaf groundsel occurs from western Texas, west through New Mexico, Arizona, to California, north to Wyoming and Nebraska, Utah, and Nevada, and south into northern Mexico. It is a wide ranging species occurring in a variety of soil types and elevations from about 760 to 2,440 m.

Ecology.—This species grows in short grass prairies of the southwestern Great Plains and a wide variety of scrubland and grassland habitats in the Southwest. It has been considered a diagnostic or climax species for desert grassland (Dick-Peddie 1993). It tends to become more abundant in disturbed habitats and overgrazed rangelands and often grows in washes. It is a taprooted plant that grows relatively quickly and tends to be a short-lived perennial shrub to subshrub. Oxygen flux, as it relates to photosynthesis, from leaves and twigs was constant with increasing drought stress, up until leaf drop occurred (Ehleringer and Cooper 1992). Twigs may serve to maintain some photosynthesis through drought periods when new foliage cannot easily be produced, such as during dry springs and early summers. Threadleaf groundsel was one of several shrub and subshrub species, studied in Mojave and Sonoran desert areas that generated substantial net carbon gains from twig photosynthesis (Comstock and others 1988).

Reproduction.—Threadleaf groundsel generally blooms in the late summer and fall but will bloom earlier in the summer if sufficient moisture is available. It produces numerous yellow flower heads with eight to 17 ray florets, the rays 10 to 15 mm long (Carter 1997, Martin and Hutchins 1980-81). Seeds (fruits) are wind-borne with a white fluffy pappus.

Growth and Management.—Threadleaf groundsel is a fast growing, short lived perennial. Plants may live 3 to 6 years or more. It increases in rangelands as a result of overgrazing pressure. Its abundance may be controlled through proper grazing management and careful use of herbicides. Spraying with 2,4-D has been used to control this species.

Benefits and Disadvantages.—Because this species will colonize open disturbed areas, it helps achieve a quick ground cover in a natural succession process. The perennial nature of the plant further helps stabilize soil for longer-lived perennials to eventually become established. Direct human uses are minimal, but it was once used medicinally by Native Americans. It is a poor forage plant for cattle and horses and is known to be toxic (Gay and Dwyer 1998, Stubbendieck and others 1997, Warnock 1974) and causes liver damage when consumed in large quantities (Kirkpatrick 1992). All parts of the plant are poisonous, younger leaves more so, and poisoning is more of a problem on drier range conditions. Symptoms in cattle may include a dry scaly nose, a rough coat, and continuous walking with no direction (Phillips Petroleum Company 1963). Because it has low palatability, it tends to be avoided except during long droughts or in heavily overgrazed areas where it may increase in abundance (USDA 1937). Toxicity of threadleaf groundsel may be attributed to the pyrrolizidine alkaloids (PA). About 50 percent of all identified PA are toxic, and some are carcinogenic in rodents (Stegelmeier and others 1999). Threadleaf groundsel contains the pyrrolizidine alkaloids: senecionine, seneciphylline, florosenine, otonecine-based florosenine, and retrorsine (Cooper and others 1996). As with many toxic plants, concentration and preparation are critical factors. For example, the Navajo would boil entire plants and drink the mixture to assist the voice and singing during some ceremonial songs (Elmore 1976). The Navajo would also use the flower heads to clean cactus fruits of their spines.

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***Senecio spartioides* Torr. & Gray** many-headed groundsel
ASTERACEAE

Synonym: *Senecio multicapitatus* Greenm. ex Rydb.

James E. Nellessen

General Description.—Many-headed groundsel is also known as broom groundsel, broom butterweed, or grass-leaved ragwort (Elmore 1976, Epple 1995). This plant produces many stems from a large woody crown, in a tight to spreading cluster, giving it a broom-like appearance. Plants range in height from 20 cm to slightly more than 1 m. In large plants, some stems may lean over, becoming almost decumbent. The leaves are bright green, both lobed (pinnately) or nonlobed, alternate, linear, 4 to 10 cm long, and to 5 mm wide, generally hairless or slightly pubescent (Carter 1997, Great Plains Flora Association 1986, Ivey 1995, Martin and Hutchins 1980-81, Weber and Wittman 2001a and 2001b). This plant is best classified as a subshrub because even though the stems do become woody, especially the bases, it often dies back during the winter to less than 20 cm above the ground-line.

Taxonomy.—Two varieties are recognized: the typical variety, *S. spartioides* var. *spartioides*, and *S. spartioides* var. *multicapitatus* (Greenm. ex Rydb.) S.L. Welch (Allred 2002). The leaves of variety *spartioides* are generally simple, or infrequently with small lobes near the base, and the plant is hairless. The variety *multicapitatus* tends to have leaves irregularly pinnately divided, more hairs, and smaller, more numerous flower heads. The latter variety is also synonymized with the full species designation: *S. multicapitatus* Greenm. ex Rydb. (Kartesz 1994).

Range.—This is a wide-ranging species occurring from western Texas, west through New Mexico, northern Mexico, into Arizona, Utah, and California, north to Wyoming, western Nebraska, and southwestern South Dakota. Variety *spartioides* tends to occur further north and west within this range, while variety *multicapitatus* tends to be more southern in its distribution (Kearney and others 1951, Great Plains Flora Association 1986). Within its range it occurs at elevations from about 1,070 m to 2,745 m.

Ecology.—Many-headed groundsel occurs on plains, open slopes, valleys, arroyos, and semi-stabilized dunes in piñon-juniper woodlands, ponderosa pine forests, and desert areas. It tends to be an early colonizer of disturbed soil situations, is a prolific seed producer because of the numerous flower heads, and is generally a short-lived (2 to 4 years) perennial.

Reproduction.—This species produces numerous yellow-flowered heads, the ray flowers numbering from four to eight per head (over 18 flowers with the disk flowers included). The heads are 7 to 12 mm high, 3 to 7 mm wide, subcylindric to cylindric with about eight to 12 phyllaries, and the rays are from 7 to 12 mm long. It generally blooms in the late summer and fall but will bloom early in the summer given sufficient moisture. Hence, the full range of potential blooming runs from May into early November, depending on local environmental conditions. A bright white fluffy pappus enables easy dispersal of seeds by the wind.

Growth and Management.—Seeds will germinate under moist conditions in the fall, the seedlings over-wintering. Growth continues slowly in the spring but is rapid once summer rains begin. Many-headed groundsel is a short-lived perennial. Most plants appear to survive only 2 to 4 years, some perhaps slightly longer. This species, although toxic to livestock, is not palatable and is generally not highly abundant or dominant in most habitats to be a significant management problem.

Benefits.—Many-headed groundsel will colonize open disturbed areas and provide quick ground cover in a natural succession process. Although relatively short-lived the perennial nature of the plant further helps stabilize soil for longer-lived perennials to eventually become established. Many-headed groundsel is toxic to cattle, but it is infrequently eaten (USDA 1937, Kearney and others 1951, Warnock 1974). This species should be utilized more in urban and native plant landscaping. When in bloom it bears, as the name implies, numerous yellow flower heads, adding considerable color to a desert backyard. It is a prolific seed producer and will easily regenerate itself. This may pose a problem for some gardeners, managing the abundance of seedlings, although many of the seedlings will not survive to maturity within a natural landscape anyway.

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***Senna atomaria* (L.) Irwin & Barneby** flor de San José
FABACEAE

Synonyms: *Cassia atomaria* L.
Cassia emarginata L.
Cassia arborescens Miller
Cassia triflora Vahl
Isandrina emarginata (L.) Britt. & Rose (and others: International Legume Database and Information Service 2002)

John K. Francis

General Description.—Flor de San José is also known as yellow candlewood, senna-tree, palo de chivo, palo de burro, cañafístola cimarrona, carbonera, alcaparro, chile perro, palo de zorrillo, arguchoco, vainillo, chivato, carángano, platanillo, bois cabrite, casse marron, and petite casse. It is a flowering, drought-deciduous shrub or small tree 2 to 12 m in height that occasionally exceeds 20 cm in stem diameter. The plant may or may not have multiple stems but almost always supports stout branches relatively low to the ground. The branches are brittle. It is supported by a tap and extensive lateral root system that has slender fine roots. The roots are woody and flexible with a dark gray bark over a pale yellow interior. The crown may be described as spreading and branchy but not dense. The bark is light gray. Leaves, twigs, and other vegetative parts have an unpleasant odor and are covered with soft hairs. The alternate, pinnate leaves have petioles 2 to 5 cm long and two to five pairs of ovate to obovate entire leaflets, 2 to 11 cm long. The flower clusters are corymbose racemes that bear many flowers and arise from the bases of the upper leaves. The flowers have five unequal sepals and five unequal yellow petals 8 to 15 mm long. The fruits are flattened, linear, red-brown to black, legumes 12 to 35 cm long and 8 to 12 mm broad, and contain numerous brown seeds 4 to 5 mm long (Howard 1988, Liogier 1988, Little and others 1974, Secretaría de Medio Ambiente, Recursos Naturales y Pesca 2002, Stevens and others 2001).

Range.—Flor de San José is native to the Bahamas, the West Indies, Mexico, Central America, Colombia, Venezuela, and Guyana (Howard 1988, Little and others 1974). It has been planted in Hawaii and probably other areas outside the natural range as an ornamental (Neal 1965).

Ecology.—Flor de San José is common to rare in coastal and upland dry forests at elevations from near sea level to 1,100 m that receive annual rainfalls of about 600 to 1,000 mm. Soils, often rocky and excessively drained, developed from both igneous and sedimentary parent materials with a wide range of textures and with pH's that are mildly acid to mildly alkaline. Flor de San José is moderately intolerant of shade; it grows in the open, as a codominant in low forest, and in the understory of open forests. The species may be found in remnant and late secondary forests.

Reproduction.—Flor de San José flowers and fruits throughout the year in Nicaragua (Stevens and others 2001). Although flowers and fruits have been observed at every season of the year in Puerto Rico, individual trees normally flower and fruit once per year. Because of extended flowering, flowers and fruits may be present on the same tree. Seeds collected by the author from Puerto Rico weighed an average of 0.0238 ± 0.0004 g/seed. Sown on moist filter paper, 96 percent germinated between 3 and 15 days after sowing. Germination is epigeal. A test of percent germination of sowings throughout the year in Mexico resulted in emergence varying from 1.2 to

44 percent over 45 day periods depending on ambient temperature and precipitation (Vera and Sánchez 1995). Reproduction may be common in areas overgrazed by cattle. Seeds germinate after pods rot on the ground under mother trees (Stevens and others 2001) and may be dispersed to a limited degree by ruminants.

Growth and Management.—Flor de San José has a moderate growth rate. Although planted as an ornamental, the author is not aware of any reports of wildland plantings. Management and protection of existing stands are recommended (Secretaría de Medio Ambiente, Recursos Naturales y Pesca 2002).

Benefits.—Flor de San José is planted widely but not abundantly as an ornamental for its beautiful floral display and moderate size. The sapwood is yellow and hard, and the heartwood is brown and hard with a density of 0.57 to 0.85 g/cm^3 (Timyan 1996). It is used for fuel and rude construction (Holdridge and Poveda 1975, Secretaría de Medio Ambiente, Recursos Naturales y Pesca 2002). Cows eat the pods but do not browse the leaves. Some of the common names imply that goats browse the species. Meal made from seed-free pods of flor de San José was eagerly consumed by lambs in an acceptance test (Palma and Román 2002b); the meal contained 6.5 percent crude protein, 6.8 percent fat, 4.5 percent ash, and 32.1 percent crude fiber (Palma and Román 2002a). It has been demonstrated that Baird's tapir (*Tapirus bairdii*) kills 100 percent of the flor de San José seeds when it consumes the pods, apparently because they germinate within the gut (Olmos 1997). Flor de San José is the principal or a key larval host for the yellow angled-sulphur butterfly, *Anteos maerula* (Fabricius), and the large moth, *Sphingicampa montana* (Packard) (Northern Prairie Wildlife Research Center 2002, Savela 2002). A tea made from the leaves is used as a purgative (Secretaría de Medio Ambiente, Recursos Naturales y Pesca 2002).

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Senna occidentalis (L.) Link coffee senna
FABACEAE

Synonyms: *Cassia occidentalis* L.
Ditremexa occidentalis (L.) Britt. & Rose

John K. Francis

General Description.—Coffee senna is also known as stinking weed, miki palaoa, hedionda, bucho, pico de pájaro, furrusca, bois puante, fedegoso, and many other names. The species varies from a semi-woody annual herb in warm temperate areas to a woody annual shrub or sometimes a short-lived perennial shrub in frost-free areas (Haselwood and Motter 1966, Henty and Pritchard 1975, Holm and others 1997). It usually matures at from 0.5 to 2.0 m in height. In Brazil it is reported to reach 5 to 8 m in height (Raintree 2002). Coffee senna produces a hard, woody tap root with relatively few laterals. It usually has a single purplish stem and sparse branching. Young stems are four-angled, becoming rounded with age. The crushed foliage has an unpleasant odor. Compound alternate leaves have four to six pairs of glabrous leaflets and a gland near the base of the petiole. Leaflets are ovate to ovate-lanceolate, pointed at the tip and rounded at the base. Inflorescences are few-flowered axillary racemes with yellow-petaled flowers about 2 cm across. The legumes (pods) are brown, flat, slightly curved and 5 to 12 cm long. They contain 40 or more brown to dark-olive, ovoid seeds about 4 mm long. The species has 2n = 26, 28 chromosomes (Henty and Pritchard 1975, Liogier 1988, Long and Lakela 1976, Stevens and others 2001).

Range.—Coffee senna grows throughout the tropics and subtropics (Liogier 1988, Stevens and others 2001) including the United States from Texas to Iowa eastward, Hawaii, the Pacific Island Territories, Puerto Rico, and the U.S. Virgin Islands (Natural Resources Conservation Service 2002). It appears to be of South American or New World origin (Haselwood and Motter 1966, Henty and Pritchard 1975, Raintree 2002).

Ecology.—In Cuba, coffee senna is said to be most common in fertile, cultivated areas (Sánchez and Uranga 1993) and in Nicaragua it also grows in disturbed sites (particularly fertile ones), river overflow areas, meadows, and forests from near sea level to 900 m in elevation (Stevens and others 2001). The species occurs on pinelands in Florida and grows better on near-neutral soils than acid (pH 4.7) soils (Long and Lakela 1976). Coffee senna grows in moist areas (mean annual rainfall from about 1000 to 2200 mm) in Puerto Rico.

Reproduction.—Coffee senna flowers and fruits throughout the year or seasonally, depending on rainfall and cold seasons. Seeds collected in Puerto Rico averaged 0.0158 $\pm$ 0.0002 g/seed or 63,000 seeds/kg. Some 95 percent of scarified seeds sown in potting mix germinated between 5 and 36 days after sowing (author's observation). Scarification is necessary for good seed germination (Institute of Food and Agricultural Sciences 2002). Mechanical scarification, acid treatment, and immersing in boiling water all worked well, giving 82 to 100 percent germination (Demel and Teketay 1996). The seeds are dispersed by grazing animals (Sánchez and Uranga 1993).

Growth and Management.—In seasonally cold or dry climates, the life cycle of coffee senna is complete in 6 to 9 months, but in warm, continually moist areas plants may last a full year or grow through the second year. Perhaps in Brazil where extraordinary heights are reached, the species may live a third or fourth year. Growth is moderately rapid. Plants add 0.5 to 1.5 m during the first season. Although coffee senna is planted to yield medicinal materials (Barbadine 2002), because of its short life and weedy potential, it is not advisable to plant it in wildlands. The species can be controlled with broadleaf herbicides (Henty and Prichard 1975).

Benefits and Detriments.—As the name implies, the seeds of coffee senna are roasted and used as a coffee substitute (Guzmán 1975). The plant's tissues contain a host of phytoactive chemicals that may support its numerous applications in folk medicine. Extracts or powdered leaves are used as an analgesic, antibacterial, anti-hepatotoxic, antifungal, anti-inflammatory, antiseptic, antispasmodic, antiparasitic, antiviral, carminative, diaphoretic, emmenagogue, febrifuge, insecticidal, immunostimulant, laxative, purgative, sudorific, and vermifuge. Several of these effects have been demonstrated in laboratory and clinical tests (Raintree 2002). While coffee senna can be a weed of cultivated fields and plantations, it is principally a problem because it accumulates in heavily-grazed pastures (Henty and Pritchard 1975). The foliage is poisonous and generally avoided by livestock (Stevens and others 2001). Ingestion of large amounts of seeds has been implicated in deaths of cows, horses, and goats (Raintree 2002). Poisoning of pigs fed coffee senna seeds resulted in muscle necrosis (Timm and Riet-Correa 1997).

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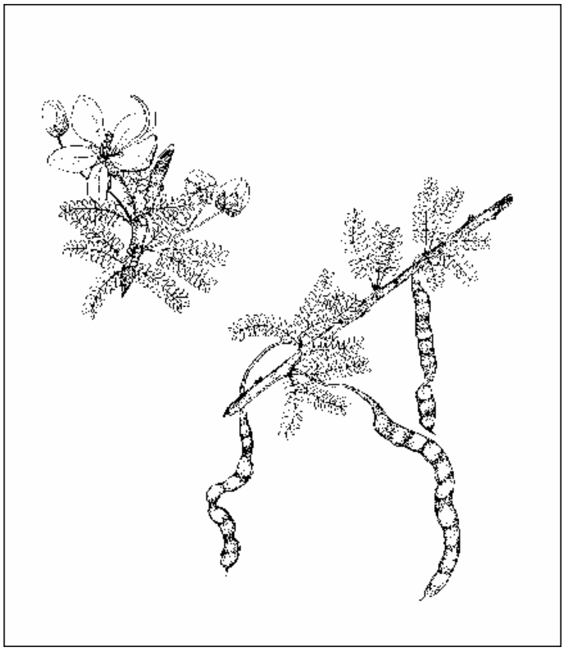
Senna polyphylla (Jacq.) Irwin & Barneby desert cassia
FABACEAE

Synonyms: _Cassia polyphylla_ Jacq.
Peiranisia polyphylla (Jacq.) Britt. & Rose

John K. Francis



General Description.—Desert cassia, also known in Spanish as hediondilla and retama prieta, is a shrub or occasionally a small tree of dry and moist forests of the middle Caribbean, now cultivated as an ornamental. It is usually 2 or 3 m in height, but rarely reaches 5 m in height and 12 cm in trunk diameter. The bark of older stems is dark gray and furrowed with short scaly plates. The inner bark is light brown. Multiple stems sprouting from the root crown are common, even in small plants. The stems are mostly clean, long and wand-like. Desert cassia develops a root system with a strong taproot. The twigs are slender, warty, and light green, maturing to brown. The leaves are alternate or clustered three to five at the nodes. These pinnately compound leaves have three to 15 pairs of leaflets that are 4 to 10 mm long. The five-petaled flowers are yellow and about 3.8 cm across, grouped in axillary racemes of mostly two flowers. The legume is linear, 8 to 15 cm long, slightly contorted, flattened between the seeds, and dark brown at maturity. The seeds are round, flattened, and dark brown (Howard 1988, Liogier 1988, Little and others 1974).

Range.—_Senna polyphylla_ var. _polyphylla_ Irwin & Barneby is native to Puerto Rico and the Virgin Islands and has been recorded under cultivation in Florida, Grenada, Guyana, Surinam, Brazil, and probably elsewhere. The variety _montis-christi_ Irwin & Barneby is an endemic of Hispaniola, and the variety _neglecta_ Irwin & Barneby is found only on the island of Anegada, British Virgin Islands (Liogier 1988).

Ecology.—In Puerto Rico, desert cassia grows on a wide variety of well-drained soils that have developed over igneous, metamorphic (including ultramafics), and sedimentary (including limestone) rocks. It is tolerant of salt spray (Botanics Wholesale 2001). The species occurs at elevations from near sea level to about 300 m above sea level (Little and others 1974). Annual rainfall ranges from about 750 mm to about 1200 mm. Because desert cassia is intolerant of shade and grows slowly, it is usually found in areas where competition is minimal—dry, very rocky, excessively drained, overgrazed, and sites subject to occasional fires. Bare ground is probably necessary for reproduction.

Reproduction.—Desert cassia flowers and fruits throughout the year (Little and others 1974). The seeds from a Puerto Rican collection averaged 20,400 seeds/kg. Placed on moist filter paper without any pre-treatment, they began germinating in 2 days and gave 59 percent germination (Francis and Rodríguez 1993). The principal mode of dispersal today is by livestock. Seedlings in the wild are scattered and not abundant.

Growth and Management.—Growth is slow. About 30 cm of annual height increase is normal in Puerto Rico. Diameter growth ranges between about 1 and 4 mm/yr. Although no planting experience is published, plantations could probably be established with containerized seedlings followed by several years of weeding until the seedlings grew above herb and grass competition.

Benefits.—Desert cassia is grown by commercial nurseries and widely planted as a flowering ornamental in the New World Tropics. It is employed as an accent plant or trained into a small background tree. The wood is light brown and hard and used occasionally for fence posts and fuel. Cows apparently do not readily eat the foliage of desert cassia—the species is more common in heavily grazed rangeland than elsewhere.

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***Serenoa repens* (Bartr.) Small** saw palmetto

PALMAE

Synonyms: None

Deborah K. Kennard, G.W. Andrews, Kenneth Outcalt, and Mary Carrington

General Description.—Saw palmetto, also known as palmetto, is a low-growing palm endemic to the Southeastern United States. Saw palmetto stems typically lie prostrate at the soil surface but can grow upright and reach heights of 5 to 7 m (Tanner and others 1996). Multiple, persistent, palmate leaves up to 1 m wide emerge from the stem's terminal buds. Short recurved spines line the petioles (Small 1933). Flowers are perfect and borne on paniculate inflorescences that emerge from the leaf bases. The fruit is a one-seeded ellipsoid or subglobose drupe with a fleshy mesocarp, 16 to 25 mm long and 12 to 19 mm wide. Fruit color turns from green, to yellow, to orange, and then to bluish-black when fully ripe (Hilmon 1968).

Range.—Saw palmetto is endemic to the Coastal Plain of the Southeastern United States. The northern limits of its range extend from southeastern Louisiana through Tifton Georgia to Charleston County, South Carolina (Hilmon 1968, McNab and Edwards 1980).

Ecology.—Saw palmetto occurs as a major understory plant in seasonally wet pine flatwoods, well-drained scrubby flatwoods, and on sandy berms and dunes along rivers and the coast (Tanner and others 1996). Within these habitats, it can grow in a variety of conditions from shade to full sun (Small 1926). Common associates include: gallberry [*Ilex glabra* (L.) Gray], wax myrtle (*Myrica cerifera* L.), staggerbush [*Lyonia ferruginea* (Walter) Nuttall], oaks (*Quercus spp*. L.), wiregrass (*Aristida beyrichiana* Trin. & Rupr.), several bluestem species (*Andropogon spp*. L.), and lop-sided Indian grass [*Sorgastrum secundum* (Ell.) Nash.] (Tanner and others 1996). Saw palmetto occurs on a wide range of soil types but most commonly is found on seasonally flooded, sandy, acidic spodosols typical of flatwoods ecosystems in the Lower Coastal Plain. Typical soil types are Leon fine sand, Myakka fine sand, and Immokalee fine sand. Saw palmetto also grows on deep, sandy entisols, on calcareous sandy soils near coasts, and on limestone in southern Florida. Annual rainfall varies from 114 cm in the northern part of its range to over 150 cm along the southeastern coast of Florida. Rainfall also becomes more seasonal going from north to south, with increasingly more rainfall occurring during summer. In southern Florida, the southernmost part of its range, 64 percent of average annual rainfall occurs from June to September (Hilmon 1968).

Reproduction.—Saw palmettos primarily reproduce vegetatively through suckers from the main stem (Fisher and Tomlinson 1973). Each sucker has the capacity to become a ramet, forming extensive clumps of genetically identical clones. Saw palmettos must be at least 0.6 m in height to flower (Carrington and others 2000) after which probability of flowering increases with plant height. Inflorescences emerge from buds at the bases of previous season's leaves in February to April, and flowering occurs from April to June (Hilmon 1968). Flowers are insect pollinated (Tanner and others 1996). While 34 insect species are known to pollinate saw palmetto flowers, the European honeybee (*Apis mellifera* L.) is the primary pollinator (Carrington and others in review). Emerging saw palmetto inflorescences are subject to attack by cabbage palm caterpillars (*Litoprosopus futilis* G. & R.), and green fruits are subject to anthracnose [*Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc. in Penz.]

(Carrington and others 2000). Fruits ripen in August to November. Saw palmettos flower heavily about every 2 to 4 years. During these years, individual ramets commonly produce two to three inflorescences. Due to high flower density (several thousand flowers/inflorescence), typically 0.4 to 0.5 kg of fruit are produced on each inflorescence. In some cases, individual inflorescences can produce up to 12 kg of fruit. Average fruit yield for a site is approximately 200 kg/ha; however, yields can vary from less than 100 kg/ha to more than 1,500 kg/ha (Carrington and others 1997). Fruits are bird and mammal dispersed (Tanner and others 1996). Seed germination ranges from 20 percent after 15 months in field conditions to 55 percent after 6 months under lab conditions (Hilmon 1968). Seeds can remain viable for up to 1 year, albeit with reduced germination rates (Carrington and others 2000). Seed germination may be enhanced by passing through animal digestive systems (Tanner and others 1996).

Growth and Management.—Growth of saw palmetto is slow, ranging between 0.6 and 2.2 cm/year in stem elongation (Abrahamson 1995, Hilmon 1968). Based on these estimates, some saw palmettos may be 500 to 700 years old (Abrahamson 1995, Tanner and others 1996). In some cases, land managers may want to reduce the density and cover of saw palmetto in order to improve cattle forage and/or timber production or to reduce fire hazard. Because saw palmetto is fire-tolerant, mechanical or chemical treatments are often needed for control. Roller-chopping reduces abundance of saw palmetto (Hilmon and others 1963, Lewis 1970) by crushing vegetative parts and removing terminal buds. This treatment is particularly effective during periods of low soil moisture (Moore 1974) or when followed by prescribed burning. Among herbicide treatments, repeated cycles of 2,4,5-T followed by burning will reduce palmetto cover (Altobellis and Hough 1968), but this chemical is no longer available. Metsulfuron, often sold as Escort, is the most effective herbicide currently available for control of saw palmetto (personal communication J.L. Michael, Southern Research Station, Auburn, AL). In other cases, land managers may want to enhance saw palmetto flowering and fruiting. The most cost-efficient practice to increase fruit production is prescribed burning (Carrington and others 2000). Optimal burning frequency is every 5 to 8 years. Soil fertilization has been used to increase coverage of saw palmetto (Carrington and others 2000).

Fire.—Saw palmetto naturally occurs in plant communities adapted to periodic burning. Saw palmetto itself is highly flammable due to the accumulation of dead fronds that remain on the plants for several years (Carrington and others 2000) and volatile waxes that cover green leaves. Fires commonly consume all above-ground foliage of saw palmettos, and therefore, prescribed fire is used to reduce leaf coverage for short periods. However, leaf growth usually begins a few days after fires, and saw palmettos can regain 80 percent of crown coverage the first year after burning (Hilmon 1968). Fire also benefits fruit production of saw palmetto, especially within the first year following burns (Carrington and others 2000). However, flowering may be reduced for several years after burns (Abrahamson 1999) as palmettos recover from both burning and heavy fruit production. Frequent burning (every 1 to 4 years) curtails flowering and fruiting by keeping carbohydrate reserves low (Hilmon 1968).

Detriments and Benefits.—Saw palmetto was viewed by early settlers in the Southeastern United States as an obstacle to establishing agricultural fields, cattle pastures, and home sites. Ranchers continue to regard it as a competitor of native forage grasses, and foresters cite that it inhibits pine regeneration. Despite these detriments, saw palmetto is viewed as a significant pharmaceutical resource in Florida and southern Georgia due to the effectiveness of certain fruit compounds (such as free fatty acids, phytosterols) in treating benign prostatic hyperplasia (Tasca 1985, Braeckman 1994, Wilt and others 1998), or swelling of the prostate gland. In 1995, saw palmetto fruits collected for pharmaceuticals sold for over $6/kg. Total estimated value of fruits sold in 1996 was approximately $5 million (Carrington and others 2000). In addition to its medicinal value, saw palmetto can be a significant source of honey production (Bennett and Hicklin 1998). Saw palmetto is also a good native plant for enviroscaping due to its natural drought- and insect-resistance, and low requirements for fertilization (Tanner and others 1996). Saw palmettos serve as nesting and denning habitat for over 100 animal species, including: the endangered Florida grasshopper sparrow (*Ammodramus savannarum* Gmein), Florida panther (*Felis concolor* Linnaeus), Florida woodrat (*Neotoma floridana* Ord), wild turkey (*Meleagris gallopavo* Linnaeus), and white-tailed deer (*Odocoileus virginianus* Zimmermann) (Tanner and others 1996). Fruits are eaten by black bears (*Ursus americanus* Pallas), white-tailed deer (*Odocoileus virginianus*), raccoons (*Procyon lotor* Linnaeus), turkeys (*Meleagris gallopavo*), bob-white quail (*Colinus virginianus* L.), gray foxes (*Urocyon cinereoargenteus* Schreber), opossum (*Dasypus novemcinctus* Linnaeus), and gopher tortoises (*Gopherus polyphemus* Daudin) (Maehr and Layne 1996).

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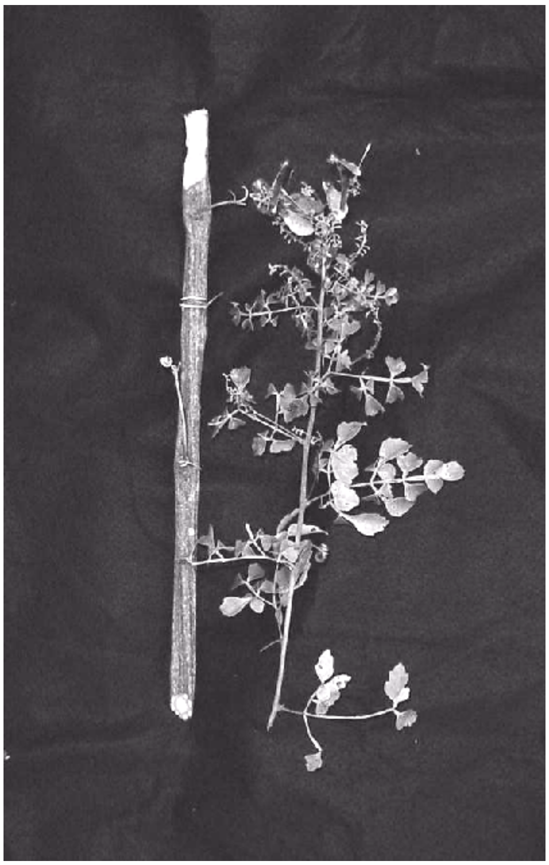
***Serjania polyphylla* (L.) Radlk.** bejuco de corrales

SAPINDACEAE

Synonyms: *Paullinia polyphylla* L.
Paullinia triternata Jacq.
Serjania lucida Schum.
Serjania triternata (Jacq.) Willd.
Serjania dubia Spreng.

John K. Francis



General Description.—Bejuco de corrales, also known as bejuco de canastas, bejuco de costillas, basket wood, and blackwith, is a woody vine that ascends as much as 20 m into the crowns of trees. Bejuco de corrales is a Spanish name meaning corral vine. The older stems are brown, rough, with three main striations and up to 5 cm in diameter. The stem cross section has a characteristic pattern reminiscent of a string of beads around a central core. The vines have a taproot, extensive lateral, and abundant fine roots, and all have a dark brown color. Periodic sprouting from the root crown replaces dying stems and gives rise to multiple stems, usually less than five. The branches are slender and flexible with few bifurcations. Tendrils, which support the vine on trees and other structures, grow at the leaf axils. The alternate compound leaves divide by threes. Leaflets, which number three to 19 or more, are dentate from the middle to the tip, 1.5 to 6.0 cm long and 1.0 to 3.5 cm broad. Inflorescences are axillary panicles and contain many white flowers. The brown or red-brown fruits are samaras, 1.5 to 2.5 cm long, that grow in groups of three. Each samara contains a single seed (Acevedo-Rodrígues 1985, Liogier 1994).

Range.—Bejuco de corrales is native to Puerto Rico and offshore islands, the Virgin Islands, and Hispaniola (Liogier 1994). It is not known to have been planted elsewhere.

Ecology.—Bejuco de corrales grows in remnant and secondary forests, on roadsides, fence rows, river banks, and brushy pastures. It is usually common but rarely abundant. The species is moderately intolerant of shade, requiring full sunlight to flower and fruit; yet it can survive in the understory of low basal-area forest. Bejuco de corrales grows on soils with textures from sand to clay that are derived from igneous and sedimentary (including limestone) rocks. In Puerto Rico, the species grows from near sea level to over 600 m in elevation and in areas that receive from 750 to over 2000 mm of annual rainfall. In the areas with the highest rainfall, it is confined to excessively drained sites. Bejuco de corrales tolerates drought and at least mild salt spray. Frosts are not known within the native range.

Reproduction.—Bejuco de corrales flowers and fruits from November through June (Acevedo-Rodrígues 1985). An infrutescence may contain 25 or more fruits, and a plant may produce several infrutescences per year. A collection of bejuco de corrales samaras averaged 0.0248 g/fruit or 40,000 fruits/kg. When the clusters break up, the samaras spin and fly sideways as they descend and may travel a considerable distance before reaching the ground.

Growth and Management.—Seedlings grow about 0.5 m in their first year. Older plants and sprouts grow 2 or 3 m each year. Individual stems can live for several years; by sprouting, plants may survive for at least several decades. No planting experience for the species has been reported. In the past, farmers controlled bejuco de corrales by repeated cutting with a machete. These vines could probably be killed faster by spraying the sprouts that arise after cutting with broadleaf weed killer.

Benefits.—The strong and flexible stems of bejuco de corrales are suitable for basketry, and some of the common names indicate that it was used for this purpose. Bejuco de corrales is considered to be a honey plant in the Dominican Republic (Marcano Fondeur 1973). Livestock eat young plants and the foliage of older ones that are within their reach. Bejuco de corrales is reputed to be a diuretic and purifier of the blood in herbal medicine (Liogier 1990).

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***Sesbania sericea* (Willd.) Link** silky sesban

FABACEAE

Synonyms: *Coronilla sericea* Willd.

John K. Francis

General Description.—Silky sesban, also known as papagayo in Spanish, is a short-lived woody shrub of frequently disturbed areas. Its mature height may vary from 1 to 6 m with basal diameters reaching as much as 10 cm under the most favorable conditions. A single stem is usually developed unless the plant sprouts after damage. Robust low side branches develop on open-grown individuals. Secondary branches on stems are usually unbranched. The species is unarmed or may occasionally have weak prickles. Stems are green when young, turning gray. There may or may not be a well-developed taproot, depending on the aerated rooting depth. The white lateral roots are relatively thick (3 to 5 mm) and support many nodules with reddish centers and abundant fine roots. The pinnately compound leaves are 5 to 25 cm long and support 10 to 20 leaflet pairs. The leaflets are oblong, rounded at both ends, mucronate at the apex, with a silky pubescence below. The racemes have two to eight yellow, greenish-yellow, or orange flowers. The brown pods that develop after flowering are 10 to 20 cm long, 3 mm broad, and contain 20 to 30 seeds (Howard 1988, Liogier 1988, Nelson 1996). The species has 2n = 24 chromosomes (Long and Lakela 1976).

Range.—There is confusion about the native range of silky sesban. Howard (1988) states that it is a native of Sri Lanka. Others refer to tropical Asia (Long and Lakela 1976) or Africa and the Caribbean (Evans and Rotar 1987) as the native ranges. It is clear that the species has been widely introduced. The current New World range covers southern Florida, the Bahamas, the West Indies, Trinidad, Surinam, the Guianas, Venezuela, and Central America (Liogier 1988).

Ecology.—Silky sesban is highly intolerant of shade and must have disturbed soil in which to germinate. Once established, it competes aggressively with grass and herbs, but it must dominate all its life or die. Stands of silky sesban vigorously self-thin. The species develops best on moist alluvial soils. It will grow on soils with low fertility, particularly when poorly or very poorly drained. Modest amounts of salts in the soil are tolerated. Apparently, the northern extent of the range is limited by cool weather and frost.

Reproduction.—A collection of 45 air-dry pods of silky sesban weighed an average of 0.378 $\pm$ 0.0008 g/pod. The seeds separated from them averaged 0.0053 $\pm$ 0.0001 g each or 189,000 seeds/kg. Sown without any pretreatment on commercial potting mix, these seeds germinated at 99 percent between 3 and 24 days after sowing. Germination is epigeal. Although the original mode of seed dispersal has not been documented, in the Caribbean it seems to be opportunistic, disbursing by wind, water, grazing animals, and farm machinery. Seedlings may be abundant in the presence of a seed source on moist bare soil.

However, relatively few of the seedlings progress past the early seedling stage.

Growth and Management.—Plants of silky sesban grow rapidly. Seedlings are about 10 cm tall at the end of 1 month and reach 2 to 6 m in height in about 6 months. Silky sesban was reported to yield 26.8 Mg/ha (fresh weight) in a 84-day growing period (Evans and Rotar 1987). After flowering, height growth of silky sesban ceases. Plants live from about 8 months to a little over a year, depending on conditions. When their seeds mature, the plants die. The species may grow and die in an annual cycle timed with wet and dry seasons, or it may simply grow in response to favorable soil conditions as they occur. If land managers find it necessary to establish silky sesban, sowing into a moist, prepared seedbed should be sufficient.

Benefits.—The species of *Sesbania*, including silky sesban, are used as green manure in India. Silky sesban is readily consumed by cattle in pastures. The closely related *S. sesban* (L.) Merr. has been shown to have moderately good nutritional values. Some of the species of *Sesbania* have toxic saponins and canavanine in their seeds. So far, the seeds of silky sesban have not been reported to be toxic. Crushed seeds of this species were fed to chicks at 1 percent of body weight each day for 3 days without any signs of toxicity (Evans and Rotar 1987). Silky sesban can be weedy but usually causes few problems. It was experimentally intercropped with maize and resulted in no depression in maize yield. In Guyana, the species grows in upland rice fields but does not occur in flooded rice paddies (Evans and Rotar 1987). The stemwood of silky sesban is brash, has a relatively low specific gravity, and offers few prospects for commercial use.

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Sida fallax Walp 'ilima
MALVACEAE

Synonyms: *Anoda ovata* Meyen
Sida cordifolia L.
Sida dielli Gray,
Sida fallax var. *kauaiensis* Hochr.
Sida ledyardii St. John

Sarah A. Taylor and Randy S. Senock

General Description.—*Sida fallax*, known as 'ilima, is an erect to prostrate perennial herb or subshrub that grows to 0.2 to 1.5 m tall. The shrub varies from smooth to densely covered in woolly hairs, the hairs usually stellate. 'Ilima has simple leaves, the blades from 1 to 12 cm long, lanceolate-ovate to oblong or elliptic. The upper surfaces are typically bright green and smooth, or sparsely to densely pubescent, the lower surface densely pubescent. Flowers arise from an axil, solitary or two to seven per node born in the pedicel, at the end branches or in the leaves. Corolla is usually yellow to orange-yellow, sometimes dark maroon at the base. Fruits split into two or more carpels at maturity. Extensive variation in the morphology of this species exists in leaf size and shape, stature, pubescence, and arrangement of its inflorescence (Wagner and others 1990).

Range.—S*ida* is a genus of 125 to 150 species of tropical and subtropical regions of the world, from the Pacific Islands to Hawaii. 'Ilima has a series of similar forms common to all islands but also exhibits morphological variation from island to island. The shrub exists on all the main islands of Hawaii, including the atoll Midway and the pinnacle Nihoa from coastal to subalpine environments.

Ecology.—'Ilima displays numerous ecological types, occurring from sea level to altitudes of 600 m. Beach forms are low growing, dense, spreading mats, while upland types may grow erect and shrub-like (Krauss 1998). Lowland types are typically densely pubescent, while upland types are glabrous. 'Ilima occurs on a variety of substrate, from limestone reefs, dry lava fields, and along sandy and rocky shores. Often 'ilima represents the only ground cover, aside from nonnative species, on arid, rocky coastlines. 'Ilima appears intolerant of wildfire as adult plants typically do not resprout within burned areas. In montane dry shrublands or leeward Hawaii, 'ilima re-established from seed within 4 years of burning (Sherry and others 1999).

Reproduction.—The flower parts are typically in fours or fives and are true flowers with stamen and pistils. The ovules are covered by ovaries. Seeds are brown or black, obovoid, with three angles, 1.7 to 2.2 mm long, minutely pubescent around the raphe. Somatic chromosome number of 2n = 28 has been identified (Wagner and others 1990). It is probably wind pollinated, though the native yellow faced bee species *Hylaeus* has been observed visiting the flowers of ‘ilima (Anonymous 2002).

Growth and Management.—Easily grown from seeds, 'ilima makes an excellent xeriscape plant. Seedlings germinate and grow quickly, while cuttings do less well. It requires full sunlight and light to moderate watering. Upland varieties can be susceptible to nematodes, while lowland types are resistant. Leaves may become yellow spotted and chlorotic, and will respond well to fertilizer with micronutrients (Krauss 1998). It does well in sandy or rocky soils.

Benefits.—'Ilima is an important plant to Hawaii and its people. Four separate types of 'ilima were recognized. These included 'ilima-ku-kala, ilima-lei, 'ilima-ku-kahakai and 'ilima-koli-kukui (Stephens 2000). 'Ilima-ku-kala is the wild tall form found in the mountains. 'Ilima-ku-kahakai is the creeping form found along the coastline. 'Ilima-lei were cultivated by the Hawaiians for use in lei making. 'Ilima-koli-kukui was another cultivar with reddish brown flowers (Stephens 2000). 'Ilima is considered a special flower of the island of Oahu. 'Ilima leis are among the most treasured leis and are difficult to make, requiring over a thousand blossoms. At one time, only royalty were allowed to wear an 'ilima lei (Anonymous 2001). 'Ilima was also used medicinally. The juice squeezed from the flowers was used as a mild laxative for children, and the root bark mixed with flowers was used to treat asthma (Krauss 2000). Buds were chewed to quench thirst on hot, dry days. Stems were used to make baskets. 'Ilima is said to be one of the forms that Laka, the goddess of hula, could take at will (Quensell 2000).

Detrimental Effects.—‘Ilima is known to be host to nonnative rust, *Puccinia heterospora*, which is now becoming established on native plants. Infection may be heavy and conspicuous.

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***Sida rhombifolia* L.** arrowleaf sida

MALVACEAE

Synonyms: *Sida hondensis* Kunth in Humb.
Sida ruderata Macfad.

John K. Francis

General Description.—Arrowleaf sida is known by many common names: broom weed, paddy's lucerne, Cuba jute, common sida, escoba dulce, escoba blanca, escoba dura, malva de cochino, huang hau mu, rhomboid ilima, antibala, idem, afata, guanxuma, and basbasot (Holm and others 1997). It is a short-lived perennial subshrub (woody stem and herbaceous branches) commonly growing to 60 cm, but sometimes reaching 1.5 m in height. (Holm and others 1997, Howard 1989, Liogier 1994). Arrowleaf sida develops a taproot and many lateral and fine roots. The plant usually has a single stem unless disturbed, but may branch near the ground. The stems are woody, flexible, and tough, and may reach 1 cm or more in basal diameter. The twigs are slender, green, and semiwoody. The alternate leaves are variable in both shape and size. They have a 3- to 8-mm petiole with broadly ovate to lanciolate (often rhomboidal) blades 2 to 6 cm long and serrate at the margins, especially from the middle to the tip. The axillary flowers are solitary on slender pedicels 2 to 3 cm long. The corolla contains five pale yellow to yellow-orange petals. The fruits are round, flattened schizocarps, 4 to 5 mm in diameter and contain 10 to 14 small dark-brown seeds. Both diploid (2n = 14) and tetraploid (2n = 28) forms exist (Holm and others 1997, Howard 1989, Liogier 1994).

Range.—Arrowleaf sida grows today in over 70 countries throughout the tropical, subtropical, and warm temperate regions (Holm and others 1997, Howard 1989). Its original range is not known, but the presence of multiple subspecies and varieties seems to indicate that it was from the Old World. The species was introduced into the United States in the late 1800's as a promising fiber crop (Holm and others 1997).

Ecology.—Arrowleaf sida grows only in disturbed areas and in situations where overhead competition is controlled or naturally light. It is common in cultivated fields, pastures, abandoned farmland, roadsides, vacant lots, construction sites, landslides, and river overflow areas. It does not survive in tall grass swards, tall brushlands, and closed forests. Arrowleaf sida grows on both fertile and degraded soils of all textures and derived from most parent materials. It may be found growing from near sea level to 2,000 m in elevation (Holm and others 1997). In Puerto Rico, the species grows in areas receiving from 900 to 3000 mm of precipitation.

Reproduction.—Arrowleaf sida flowers and fruits continuously starting at 3 or 4 months of age in Puerto Rico. In Central India, plants flower from September to December and fruit from October to January (Parrotta 2001). A single plant can produce as many as 11,600 seeds. Individual seeds have been reported to weigh between 0.0012 and 0.0015 g (Holm and others 1997). Seeds collected in Puerto Rico averaged 0.0016 g/seed or 625,000 seeds/kg. Sown on moist filter paper without any pretreatment, 33 percent germinated within 13 months (author's observation). Fresh seed is dormant, and dry storage, freezing, various light regimes, and several chemical treatments failed to induce germination. However, acid scarification, heating, and cold storage succeeded in breaking dormancy. Some 80 percent germination was obtained at the best soil depth for germination, which was 0.5 to 2 cm (Holm and others 1997). Arrowleaf sida plants sprout vigorously if cut. The seeds are dispersed by water, farm machinery, ruminant animals, and in impure agricultural seed. Ants disperse the seeds in Africa (Holm and other 1997).

Growth and Management.—Arrowleaf sida plants may reach 0.5 m or more in their first year. Growth is most rapid in warm conditions (days of 30 °C and nights of 25 °C). Growth nearly ceases below 20 °C. Plants survive frosts and winters as far north as Tennessee (Holm and others 1997). Although the species is able to perpetuate itself as an annual in difficult climates and under cultivated agriculture, the aerial portions of individual plants in favorable climates may live 3 years, and possibly more by resprouting. Control, but not elimination of arrowleaf sida in plantations and pastures may be achieved by hand weeding and herbicide spraying. Hand pulling and mowing are only partially effective because arrowleaf sida is difficult to pull and quickly sprouts after cutting. The weed problem from arrowleaf sida becomes more severe in reduced tillage agriculture (Holm and others 1997). Mowing or chain slashing is recommended in pastures to suppress arrowleaf sida and other unpalatable *Sida* species and allow pasture forage plants to grow (Food and Agriculture Organization 2002). Effective biological control has been obtained in Australia and Papua New Guinea by introducing the leaf-eating beetle *Calligrapha pantherina*, which feeds exclusively on three species of weedy *Sida*'s (Kuniata and Rapp 2001).

Benefits.—Arrowleaf sida stems are used as rough cordage, sacking, and for making brooms. The stems have a high quality fiber and were once exported from India and elsewhere as "hemp" (Guzmán 1975, Holm and others 1997). Chemical analysis revealed that the leaves contain respectable amounts of nutrients: 74,000 to 347,000 ppm protein, 94,000 to 475,000 ppm carbohydrates, 33,000 to 167,000 ppm fiber, 14,000 to 71,000 ppm fat, and 16,000 to 81,000 ppm ash. However, it was reported that the root contained 450 ppm alkaloids and the presence of ephedrine and saponin (Southwest School of Botanical Medicine 2002). Another source reports an alkaloid content in the root of 0.1 percent and the presence of choline, pseudoephedrine, beta-phenethylamine, vascin, hipaphorine and related indole alkaloids (Shaman Australis Ethnobotanicals 2002). Perhaps because of these chemicals, arrowleaf sida is unpalatable to cattle (Kuniata and Rapp 2001). Arrowleaf sida has significant medicinal applications for which it is cultivated throughout India. The pounded leaves are used to relieve swelling, the fruits are used to relieve headache, the mucilage is used as an emollient, and the root is used to treat rheumatism (Parrotta 2001). Australian Aborigines use the herb to treat diarrhea. Leaves are smoked in Mexico and a tea is prepared in India for the stimulation it provides (Shaman Australis Ethnobotanicals 2002).

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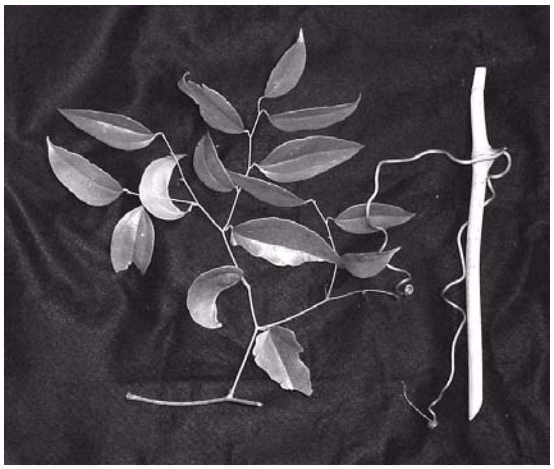
Smilax domingensis **Willd.** bejuco de membrillo
SMILACACEAE

Synonyms: *Smilax caudata* Lundell
Smilax microscola (B.L. Rob.) Killip & C.V. Morton

John K. Francis



General Description.—Bejuco de membrillo, also called bejuco de sarzaparilla and zarzaparilla, is an evergreen woody vine or scrambling shrub that reaches 5 to 20 m of extension and 5 cm of basal diameter and supports itself by means of tendrils. The roots produce rhizomes with occasional tuber-like structures. The plant has a round, smooth stem, gray in older parts and greenish-yellow in younger portions. The stem wood does not have annual rings. Some specimens have small spines or prickles in their lower stems. Bejuco de membrillo has few branches until it reaches increased sunlight and forms a crown. The alternate leaves are oval to lanceolate, glabrous, and leathery. Leaves have short petioles and entire blades 8 to 12 cm long. The inflorescences are axillary cymes of minute, greenish, fragrant flowers. The fruits are 7 mm in diameter, globose, juicy, maturing to dark purple or black, and contain one seed each (Acevedo-Rodríguez 1985, Stevens and others 2001). The fruits taste slightly sour and slightly sweet, somewhat like apples. The seeds are shiny tan or light brown and flattened on one side (author's observation).

Range.—Bejuco de membrillo is native to the Greater Antilles, and Mexico to Panama (Acevedo-Rodríguez 1985, Stevens and others 2001). Many herbarium specimens also exist from Colombia, Ecuador, and Peru (Missouri Botanical Garden 2003). At least one major authority (Natural Resources Conservation Service 2003) has bejuco de membrillo as conspecific under *S. smallii* Morong that ranges across the Southern United States. Time will tell whether this union is reliable or whether further taxonomic adjustments are necessary. It is not known to have been planted or naturalized elsewhere.

Ecology.—Bejuco de membrillo has been collected from near sea level to over 2,000 m elevation in Costa Rica (Missouri Botanical Garden 2002). It grows on most soils over nearly all types of parent material in areas that receive from about 1400 to over 3200 mm of precipitation. Bejuco de membrillo is moderately intolerant of shade and cannot sustain itself indefinitely under a closed forest canopy. It is most often found in natural openings of secondary and remnant forests. It may also grow in brushy pastures, fencerows, and roadsides.

Reproduction.—In Puerto Rico, bejuco de membrillo blooms during July and August and fruits in January and February (Acevedo-Rodríguez 1985). It is reported to flower and fruit throughout the year in Nicaragua (Stevens and others 2001). A collection of fresh fruits in Puerto Rico weighed an average of 0.486 $\pm$ 0.018 g/fruit. Seeds cleaned from these fruits averaged 0.105 $\pm$ 0.002 g/seed or 9,500 seeds/kg. Planted on commercial potting mix, 50 percent of the seeds germinated between 65 and 94 days after sowing (author's observation). The seeds are dispersed by vine extension and presumably by birds and animals. The plant suckers from rhizomes and sprouts heavily when cut.

Growth and Management.—The growth of established bejuco de membrillo sprouts is rapid, more than 3 m/year. Individual stems live several years, and plants, by suckering, live almost indefinitely. New plants can probably be established by planting the thickened rhizomes in tree-fall gaps and other forest openings. Creating the essential gaps could also promote the natural establishment of the species. The seeds must be collected by hand and can be cleaned by maceration and wet sieving.

Benefits.—Bjuco de membrillo adds to biodiversity, helps to protect the soil, and furnishes food and cover for wildlife. Extracts of the plant are used as a tonic, a sudorific, and a purifier, and to treat skin conditions, rheumatism, and venereal disease (Liogier 1990)

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***Solanum drymophilum* O.E. Schulz** erubia

SOLANACEAE

Synonyms: none

John K. Francis

General Description.—Erubia is a rare shrub that reaches 3 to 6 m and 7.5 cm or more in basal diameter. The plant may have a single stem or multiple branches from the base or near the base. It is supported primarily by semiflexible lateral roots. The foliage is concentrated near the ends of twigs. Alternate lanceolate to oblong leaves, 8 to 20 cm long and 2 to 4 cm wide, are long-pointed at the tip and obtuse or subcordate at the base with petioles up to 1 cm long. There are sharp, stiff, yellow spines up to 1 cm long on the mid-vein of the leaves and sometimes on the twigs and stems. Five-lobbed white flowers about 2 cm across with yellow anthers are grouped in lateral or subterminal racemes. The fruits are spherical, shiny black berries about 6 mm in diameter that contain many tiny seeds (Liogier 1995, Little and others 1974, U.S. Fish and Wildlife Service 2002).

Range.—Erubia is endemic to Puerto Rico. In 1974, it was known only from the upper Cordillera forest of the eastern and central mountains (Little and others 1974). Since then, the range has become constricted and fragmented until it is currently known from one natural site and one plantation (Miner Solá 1999) and has been declared an endangered species (U.S. Fish and Wildlife Service 2002). Deforestation and misguided weed control have contributed to the species' scarcity.

Ecology.—The environment of only the extant stands are known. Erubia may actually have a much wider ecological amplitude. The existing natural stand is situated at 840 m on clayey soil derived from volcanic rock. The area receives about 1800 mm of mean annual rainfall. The plantation is located on clay soil over porous limestone in an area that receives about 2200 mm of mean annual precipitation. The plants in the plantation are healthy but do not appear to be reproducing on the site. The species appears to be intolerant of shade and requires disturbance to become established. Before colonization, it probably relied on landslides, tree tips, and other natural disturbances to become established. The known wild stand is confined to a brushy pasture.

Reproduction.—Erubia appears to flower and fruit throughout the year (U.S. Fish and Wildlife service 2002). Flower and fruit production can be abundant. The flowers are insect pollinated. Twenty-eight fruits collected from a plantation in Río Abajo, Puerto Rico weighed (fresh) an average of 0.0504 ± 0.0050 g. The variability in weight is high (coefficient of variation = 52 percent). Air-dried seeds separated from them averaged 0.00092 g/seed or 1.1 million seeds/kg. Sown on moist potting mix without pretreatment, 89 percent of the seeds germinated between 12 and 50 days after sowing. Birds apparently disperse the seeds. Plants that are disturbed resprout.

Growth and Management.—Erubia has a moderate growth rate and probably lives at least 10 years. Nursery production appears to be easy, but field planting must be accompanied by at least 2 years of weed control.

Benefits.—Erubia helps reforest disturbed sites such as abandoned pastures and helps protect the soil. It contributes cover for wildlife, and presumably, the fruits are eaten by birds. As most other members of the Solanaceae family, its tissues probably contain physiologically active chemicals that might be useful in herbal medicine and control of pathogens.

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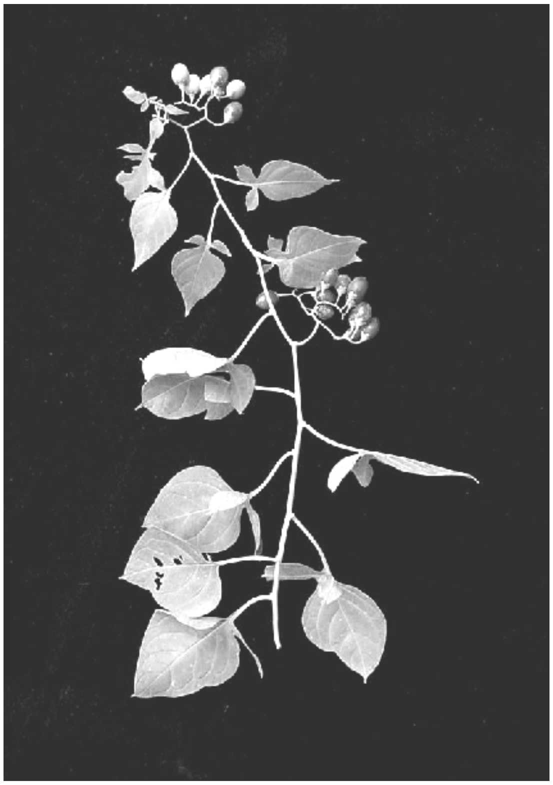
***Solanum dulcamara* L.** bittersweet nightshade
SOLANACEAE

Synonyms: none

John K. Francis



General Description.—Bittersweet nightshade is also known as bitter nightshade, climbing nightshade, woody nightshade, scarlet berry, fellenwort, poison bittersweet, and dulcamara. The name bittersweet comes from the report that stems first taste bitter, then sweet when chewed. It is a vine or slender scrambling shrub up to 7 m in extension and 2 or 3 cm in basal diameter. The base of the plant is woody, and the upper herbaceous branches die back to the woody portion each year. The slender branches are green becoming gray-brown and finely furrowed in the lower stem. The wood, which has annual rings, is creamy-white, brittle, and of light to medium density. The main root grows horizontally just below the surface and suckers frequently. Its bark is tan, corky, and knotty. The crushed bark and foliage have an unpleasant smell. The alternate, dark-green leaves are ovate to lanceolate, entire, simple or with small, opposite lobes or leaflets near the base. The blades are 5 to 12 cm long and the petioles 1 to 4 cm long. Inflorescences are drooping lateral cymes of usually more than 10 flowers. The corolla is deeply five-lobbed (star shaped), 12 to 16 mm in diameter, blue to violate (occasionally white), with exerted yellow anthers about 5 mm long. The ripe fruits (berries) are bright red, ovoid to globose, 8 to 12 mm long, and contain numerous flattened, pale-yellow seeds. Chromosome number of the species is 2n = 24 (Abrams 1951, Stance 1997).

Range.—Bittersweet nightshade is native to temperate Eurasia and northern Africa (Crossley 1974, Steyermark 1963). It is generally considered to be naturalized well into Canada and the United States including all the conterminous states except Arizona, New Mexico, Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Alabama, and South Carolina (Natural Resources Conservation Service 2003). Its observation by early botanists and its presence in native habit led one author to conclude that it is native to North America (Dean 1940). The species has been widely planted for ornamental and medicinal purposes.

Ecology.—Bittersweet nightshade often grows in wet sites or sites close to water, but also grows in moist upland sites: river banks, weedy ditches, sea shores, at the edges of lakes, bogs, and fens, roadsides, fencerows, orchards, and open forests. A wide variety of soils are colonized. The species tolerates dormant-season temperatures well below freezing but for unknown reasons has not invaded tropical climates. Continuous soil moisture is required. Seedlings are tolerant enough to grow under a moderate forest canopy (Samodien and others 2003). However, mortality of seedlings tends to be high (89 to 94 percent) (Kollmann and Grubb 1999). Plants in full sun or light shade flower and fruit much more heavily than those in moderate to medium shade. Bittersweet nightshade climbs into small trees, shrubs, weeds, and fences or remains prostrate as opportunities avail themselves. Plants of the species grow singly or in small patches.

Reproduction.—Bittersweet nightshade flowers from May to September (Horticulture Purdue 1998). Fruit and seed production can be abundant. Fresh fruits collected by the author in Utah (n = 50) averaged 0.441 $\pm$ 0.013 g/fruit. They contained an average of 30.9 $\pm$ 1.6 seeds/fruit, and the air-dried seeds averaged 0.00149 $\pm$ 0.00002 g/seed or 670,000 seeds/kg. Crossley (1974) reports 938,000 seeds/kg. The fruits can be collected by hand, cleaned by macerating and wet screening, and stored at 6 percent moisture for periods of less than 1 year. When seeds are germinated under light, stratification is not necessary and total germination percentages of 61 to 98 percent may be reached. Stems and branches layer (root) whenever they come in contact with the ground. Plants coppice when they are cut or damaged. Nursery propagation is usually by seeds, but the species can be propagated asexually by root or stem cuttings (Crossley 1974). Seeds of wild plants are dispersed by birds (Samodien and others 2003).

Growth and Management.—Bittersweet nightshade branches grow and die back 1 to 3 m or more each year. Larger stems examined by the author had two or three growth rings. Plants probably live much longer by resprouting, suckering, and layering. Bittersweet nightshade usually is not abundant or aggressive enough to need control. Occasional plants or patches in gardens, orchards, or landscaped areas can be eliminated by grubbing or spot spraying with broadleaf or broad-spectrum herbicides.

Benefits and Detriments.—Bittersweet nightshade contributes to the aesthetics of wildlands where it grows and furnishes food and cover for wildlife. It is a pretty plant, cultivated as an ornamental for its colorful flowers and fruits and dark green foliage. Several species of moths use it for larval food (Savela 2003). The fruits are eaten by birds, including pheasants (*Phasianus colchicus*). Although all parts are poisonous to cattle, horses, and sheep, which normally will not eat it, the stems are eaten by muskrats (*Ondatra zibethica*). The berries have been used to poison rabbits and dogs (Steyermark 1963). Although the fruits have an attractive appearance, the flavor is so disagreeable that it is doubtful that anyone would mistakenly eat enough to be poisoned. Also, poisonous principals are low in ripe fruits (Lambo Seeds 2003). Bittersweet nightshade contains the alkaloid solanine (the poisonous principal) and the glycoside dulcamarin (responsible for the bitter-sweet taste). Decoctions, usually of the twigs, were once used to treat a variety of ailments. These have been largely discontinued because of severe side effects. The herb is used today to treat scaly skin afflictions and deficient capillary circulation in the skin (Herbdata New Zealand 2003).

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***Solanum persicifolium* Dunal** berenjena de playa
SOLANACEAE

Synonyms: *Solanum ignaeum parvifolium* Vahl
Solanum persicifolium angustifolium Dunal in DC.
Solanum persicifolium belloni O.E. Schulz in Urban
Solanum persicifolium parvifolium (Vahl) O.E. Schulz

John K. Francis

General Description.—Berenjena de playa, which means beach eggplant, is a semideciduous shrub usually about 2 m in height with a basal diameter of 1.5 cm. The species is also known as rubia. It may have a single or multiple stems and is supported by a stout taproot and many lateral roots. The most striking feature of the species is the sharp yellow to orange prickles on the stem, branches and midveins of the leaves. The prickles may reach as much as 13 mm long. However, the density of prickles is variable and some plants have none. The branches and twigs are slender and form a thin crown. The alternate leaves, which have 4- to 7-mm petioles, are thin, oblong to linear-oblong, 5 to 13.5 cm long and 0.6 to 3 cm wide with pointed ends and edges rolled under (revolute). The leaves take on a wilted appearance during dry periods. The raceme-like inflorescences are lateral and contain up to 15 small, blue, violet, or rarely white flowers. The fruits are globose, red berries about 5 mm in diameter with the calyx still attached. Each contains several flattened, yellow seeds (author's observation, Liogier 1995).

Range.—Berenjena de playa is native to Hispaniola, Puerto Rico, and the Virgin Islands (Liogier 1995). It is not known to have been planted or naturalized elsewhere.

Ecology.—Berenjena de playa is most common near the sea shore but does occur several km inland. It grows on the whole range of soil textures on well-drained soils. In Puerto Rico, the species colonizes areas that receive from 750 mm to about 1700 mm of mean annual precipitation from near sea level to over 400 m of elevation. Berenjena de playa is moderately intolerant of shade and grows within low basal-area forest as well as in openings. The plants are apparently avoided by cattle and appear to benefit by overgrazing. Some degree of disturbance appears to be necessary for establishment. Vázquez and Kolterman (1998) report it as "occasional" in pasture, shrubland, and woodland. It may also be found on roadsides, trails, fencerows, bluffs, and beach strands.

Reproduction.—Berenjena de playa flowers and fruits more or less continuously in moist habitat but seasonally in dry habitat. A group of fruits collected in Puerto Rico averaged 0.0708 $\pm$ 0.0035 g/fruit. They contained from three to 20 seeds each, which averaged (air-dried) 0.00137 $\pm$ 0.0003 g/seed or 730,000 seeds/kg. The seeds are apparently dispersed by birds that eat the fruits. Plants sprout when they are broken or cut.

Growth and Management.—Sprouts of berenjena de playa grows about 0.5 to 1.0 m in the first year and slower thereafter. Seedling growth is undoubtedly slower. Stems apparently live about 3 to 10 years, but the rootstalks resprout and may be older than the top. No management experience has been published. Small areas of disturbance in suitable habitat would probably encourage natural establishment. The species is rarely common enough to control as a weed in pastures or plantations.

Benefits.—Berenjena de playa contributes to the biodiversity of habitat where it grows, helps to protect the soil, and furnishes food and cover for wildlife, particularly birds.

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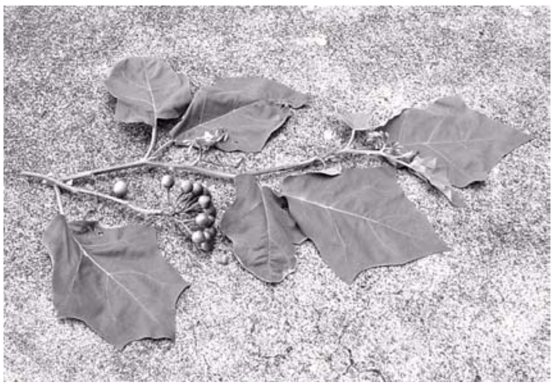
***Solanum torvum* Sw.** turkey berry

SOLANACEAE

Synonyms: *Solanum ficifolium* Ortega
Solanum daturifolium Dunal
Solanum torvum var. *daturifolium* (Dunal) Schulz
Solanum maccai L.C. Rich. ex Spreng.

John K. Francis



General Description.—Turkey berry is an erect spiny shrub that is also known by prickley solanum, shoo-shoo bush, devil's fig, wild egg plant, boo, terongan, berenjena cimarrona, berenjena de gallina, berenjena silvestre, tabacón, pendejera, tomatillo, bâtard balengène, zamorette, friega-platos, and many other names (Howard 1989, Little and others 1974, Pacific Island Ecosystems at Risk 2001). It is usually 2 or 3 m in height and 2 cm in basal diameter, but may reach 5 m in height and 8 cm in basal diameter. The shrub usually has a single stem at ground level, but it may branch on the lower stem. The stem bark is gray and nearly smooth with raised lenticels. The inner bark has a green layer over an ivory color (Little and others 1974). The plants examined by the author, growing on firm soil, had weak taproots and well developed laterals. The roots are white. Foliage is confined to the growing twigs. The twigs are gray-green and covered with star-shaped hairs. The spines are short and slightly curved and vary from thick throughout the plant, including the leaf midrib, to entirely absent. The leaves are opposite or one per node, broadly ovate with the boarder entire or deeply lobed. The petioles are 1 to 6 cm long and the blades are 7 to 23 by 5 to 18 cm and covered with short hairs. The flowers are white, tubular with 5 pointed lobes, and grouped in corymbiform cymes. They are shed soon after opening. The fruits are berries that are yellow when fully ripe. They are thin-fleshed and contain numerous flat, round, brown seeds (Howard 1989, Liogier 1995, Little and others 1974).

Range.—Turkey berry apparently is native from Florida and southern Alabama through the West Indies and from Mexico through Central America and South America through Brazil (Little and others 1974). Because of its rapid spread as a weed in disturbed lands, it is difficult to tell which populations are native and which are introduced. Turkey berry has been introduced and naturalized throughout tropical Africa, Asia, Australia, and the Pacific Islands including Hawaii, Guam, and American Samoa (Pacific Island Ecosystems at Risk 2001).

Ecology.—In Puerto Rico, turkey berry grows in upland sites that receive from about 1000 to 4000 mm of annual precipitation. It also grows in riparian zones in drier areas. Turkey berry grows on all types of moist, fertile soil at elevations from near sea level to almost 1,000 m in Puerto Rico (Little and others 1974) and 2,000 m in Papua New Guinea (Pacific Island Ecosystems at Risk 2001). Given an equal start after disturbance, turkey berry quickly overtops most herbs, grasses, and other shrubs. It grows best in full sunlight and does well in light shade or shade for part of the day, but cannot survive under a closed forest canopy. Turkey berry single plants, groups, and thickets are most frequently seen on roadsides, vacant lots, brushy pastures, recently abandoned farmland, landslides, and river banks.

Reproduction.—Flowering and fruiting is continuous after the shrubs reach about 1 to 1.5 m in height. Ripe fruits collected in Puerto Rico averaged 1.308 $\pm$ 0.052 g. Air dry seeds from these fruits weighed an average of 0.00935 g or 1,070,000 seeds/kg. These seeds were sown on commercial potting mix and 60 percent germinated between 13 and 106 days following sowing. The seedlings are common in recently disturbed ground. Frugivorous birds eat the fruits and spread the seeds (Pacific Island Ecosystems at Risk 2001). Turkey berry can be propagated vegetatively by placing branch cuttings, with or without leaves, in a mist chamber for one month (Badola and others 1993).

Growth and Management.—Turkey berry grows about 0.75 to 1.5 m in height per year. The species is not long-lived; most plants live about 2 years. Physical control of the shrub may be done by grubbing out the plants; lopping will not kill them. They can be killed by translocated herbicides applied to the leaves or the cut stumps (Pacific Island Ecosystems at Risk 2001).

Benefits.—The wood is soft and light and of little use except for emergency fuel. The fruits are edible and used in Thai cuisine (Royal Horticultural Society 2001) and incorporated into soups and sauces in the Ivory Coast (Herzog and Gautier-Béguin 2001). Turkey berry contains a number of potentially pharmacologically active chemicals including the sapogenin steroid, chlorogenin (Badola and others 1993). Aqueous extracts of turkey berry are lethal to mice or depress the erythrocytes, leukocytes and platelets in their blood (Tapia and others 1996). A related chemical, cholecalciferol, is the active ingredient in a number of commercial rodentacides (American Board of Veterinary Toxicology 2001). Extracts of the plant are reported to be useful in the treatment of hyperactivity (Null 2001), colds and cough (CPR Environmental Education Centre 2001), pimples, skin diseases, and leprosy (Liogier 1990). Turkey berry is being crossed with eggplant in an attempt to incorporate genes for resistance to *Verticillium* wilt into the vegetable (Bletsos and others 2001).

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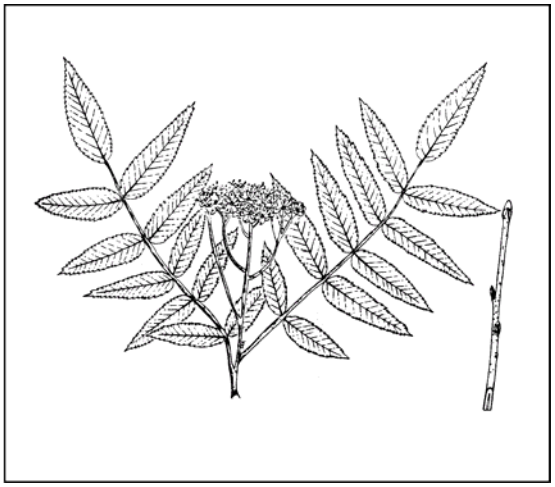
***Sorbus scopulina* Greene** Greene's mountain-ash
ROSACEAE

Synonyms: *Sorbus sambucifolia* non Roem.
Sorbus cascadensis G.N. Jones

John K. Francis



General Description.—Greene's mountain-ash, also known as western mountain-ash, is a deciduous shrub or small tree ranging in height from 1 to 6 m and up to 10 cm in stem diameter. It usually has multiple stems with smooth yellowish to grayish-red bark and slender light brown twigs that are white-hairy when young. Winter buds are glutinous and glossy. The alternate leaves are 10 to 20 cm long, odd-pinnately compound with seven to 15 lanceolate leaflets that are nearly sessile, pointed, and serrate on the margins. They are thin, shiny-green above and paler beneath. Inflorescences are much-branched corymbs, 6 to 12 cm broad, that contain many 10-mm broad, white to cream, five-petaled flowers. Fruits, which grow in clusters, are shiny, orange to red, berry-like, 5- to 10-mm-long, globose pomes with an attached calyx at the apex. Each contains up to eight flattened, brown or red-brown seeds 3 to 4 mm long (Davis 1952, Viereck and Little 1972, Welsh 1974).

Range.—Greene's mountain-ash is native to broad areas and disjuncts in the southern half of Alaska, disjuncts and broad areas of the Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Montana, Idaho, Washington, and scattered areas in Oregon, California, Wyoming, North Dakota, South Dakota, Utah, Colorado, Nevada, and New Mexico (Natural Resources Conservation Service 2003, Treeguide 2003). There are two varieties. The typical variety occupies the entire inland range and var. *cascadensis* (G.N. Jones) C.L. Hitchc. occupies coastal habitat from British Columbia into California (Natural Resources Conservation Service 2003). In addition, an intergeneric hybrid named *Amelasorbus jackii* Rehder between *Amelanchier alnifolia* Nutt. and Greene's mountain-ash has been observed in Oregon and Idaho (Love 2003). Greene's mountain-ash has been widely planted, but no reports of it naturalizing outside its range are known.

Ecology.—Greene's mountain-ash colonizes well-drained soils on rocky hillsides, canyons, wooded slopes, forest clearings, avalanche chutes, and along streams. It grows as dispersed individuals or in nearly pure (usually small) clumps. The sites are moist; the species is not drought resistant. Elevations range from near sea level in the northern portions of its range to 3,000 m in the Southern Rocky Mountains. Greene's mountain-ash is moderately intolerant of shade; it sometimes grows in the understory of open stands but usually grows in openings. Low-vigor plants are also common under closed, but not dense, conifer stands (Alaska Department of Fish and Game 2001, Ibiblio 2003, Luna and Wick 2001, Umatilla National Forest 2003, Utah State University Horticulture 2003).

Reproduction.—Flowering of Greene's mountain-ash occurs between May and July depending on location (Stein 2003). The flowers are pollinated by insects (Ibiblio 2003). The fruits ripen in July through September and remain on the shrubs into the winter (Alberta Agriculture, Food and Rural Development 2003). Fruits can be collected in quantity by hand after the fruits turn orange or red and the seeds are brown. The seeds are extracted by maceration, washing, and screening. The weight of seeds has been reported at 100 seeds/g (Luna and Wick 2001) and 180 seeds/g (Browse-Shrub and Forb Committee of the Association of Official Seed Analysis 1985). In a collection made by the author in Utah, fresh fruits weighed an average of 0.333 $\pm$ 0.009 g/fruit, and air-dried seeds weighed an average of 0.00386 $\pm$ 0.0001 g/seed (259 seeds/g). There were 24 to 117 fruits/cluster and an average of 2.4 seeds/fruit. Seed will remain viable in sealed, refrigerated containers at low relative humidity for 5 years. Recommended pretreatment is a 3:1 water/hydrogen peroxide soak for 10 minutes followed by a 25-hour water soak and a cold stratification in peat at 3 °C for 90 to 120 days. Germination varies from 90 to 100 percent (Luna and Wick 2001). A test of viability can be made by incubating imbibed, excised embryos at 20 °C for 6 days. Viable embryos either retain their freshly excised appearance or become deep green; nonviable embryos deteriorate or turn pale yellow green (Umatilla National Forest 2003). In the wild, seeds are dispersed mainly by birds. Greene's mountain-ash may be asexually reproduced using cuttings. Late-summer semihardwood stem cuttings 15 to 25 cm long and 0.3 to 1.3 cm in diameter are recommended. After hormone treatment, cuttings placed in a bottom-heated mistbed for 6 weeks yielded 47 percent rooted cuttings (Luna and Wick 2001).

Growth and Management.—This species grows slowly as seedlings and only at an intermediate rate later. Plants are able to flower and fruit after 3 to 5 years (Luna and Wick 2001). Greene's mountain-ash is usually grown for revegetation projects from seed in nurseries as container or bare-root stock. Potted seedlings can be expected to reach 15 cm tall with a 2.0 cm caliper by the end of the first year (Luna and Wick 2001). They are outplanted as either 1- or 2-year-old stock. Greene's mountain-ash planted in seven sites in Alberta averaged 1.2 to 2.3 m in height after 4 to 8 years of growth (Alberta Agriculture, Food and Rural Development 2003). Direct seeding is also possible. Drilling seed 2 mm deep in fertile, well-drained soil is recommended. Many seeds will not germinate until the second or third year (Umatilla National Forest 2003). Although the species is adapted to many soil conditions, it is sensitive to high pH in the nursery and the field and is damaged by the pear slug [*Caliroa cerasi* (L.)] (Alberta Food and Rural Development 2003). Browsing keeps the plants compact in many locations (Clark 1976). The author knows of no published data on management of natural stands.

Benefits.—Greene's mountain-ash is an important component of the Western shrub community and furnishes a number of benefits. The species helps protect the soil, adds to the aesthetics of wildland sites, especially with its yellow to orange-red fall foliage and red-orange berries, and furnishes cover for wildlife. The foliage and twigs are browsed by deer (*Odocoileus* spp.), elk (*Cervus canadensis*), moose (*Alces americana*), and to a lesser extent, cattle. The fruits are eaten by black bears (*Euarctos americanus*), martin (*Martes americana*), fisher (*Martes pennanti*), rodents, American robin (*Turdus migratorius*), hermit (*Catharus guttatus*), gray-cheeked (*Catharus minimus*) and Swainson's (*Catharus ustulatus*) thrushes, pine grosbeaks (*Pinicola enucleator*), Bohemian waxwings (*Bombycilla garrulus*), northern flickers (*Colaptes auratus*), Steller's jays (*Cyanocitta stelleri*), and blue grouse (*Dendragapus obscurus*) (Alaska Department of Fish and Game 2001, Gullion 1964, Stein, 2003, Wier 2003). The fruits are edible to humans, fresh, cooked, and dried, but it is necessary to wait until the bitterness disappears after multiple frosts (Moser 2003). A wine is also made from the berries (Keller 2003). In herbal medicine, infusions of bark have been used to reduce fevers and as a tonic, and infusions of branches have been given to children with bed-wetting problems (Ibiblio 2003). Greene's mountain-ash is planted to a limited extent as an ornamental, especially in naturalistic landscape settings. The wood is soft and has a specific gravity of 0.59 g/cm^3 (Ibiblio 2003). It is probably useful for firewood, but other uses are not known.

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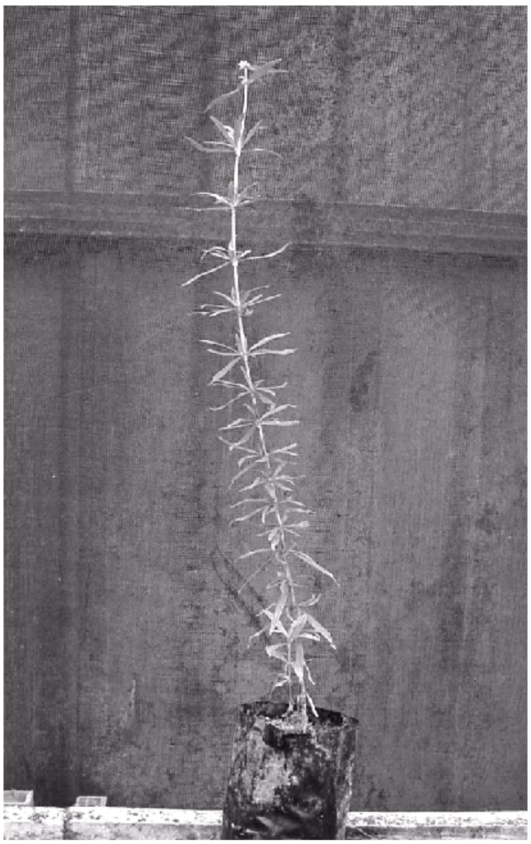
***Spermacoce verticillata* L.** botón blanco

RUBIACEAE

Synonyms: *Borreria verticillata* (L.) Meyer
Borreria podocephala DC.
Borreria stricta DC.

John K. Francis



General Description.—Botón blanco, which means white button in Spanish (Puerto Rico), is also known as shrubby false buttonwood, vassourinha, cardio de frade, poaia, borrerie verticillée, éribun, and many other names (Burkill 2000, Instituto de Biociências 2002, Natural Resources Conservation Service 2002). It is a fine-stemmed scrambling shrub that may reach a few meters of lateral extension and 1.2 m in height as a free-standing plant. The square stems are herbaceous to semiwoody in their first year, becoming woody and more rounded in the following year. The brown stems reach a maximum diameter of about 8 mm, have a solid pith, and lack visible annual rings. Botón blanco produces a weak taproot, many important laterals that are pale yellow and flexible, and a moderate amount of fine roots. Branching is bifurcate or ternate. The leaves are opposite but appearing with two or a cluster of smaller leaves in whorls at the nodes. The leaves are sessile or nearly so, linear or linear-lanceolate, 2 to 6 cm long, and pointed at both ends. The tiny white flowers grow in heads or glomerules in terminal or lateral positions. The terminals continue to grow through the center of the inflorescence so that the fruits develop at nodes in mid-stem. The capsules are oblong or subglobose with two carpels, each with one seed. The seeds are ellipsoidal, brown, and about 1 mm long (Correll and Johnston 1970, Howard 1989, Liogier 1997).

Range.—Botón blanco appears to be a native of the New World and possibly Africa, but the original range is uncertain. It grows as a native or naturalized species from Florida through the West Indies, and Texas through Central and South America to Argentina, and throughout the moist portions of Tropical Africa and Madagascar (Burkill 2000, Howard 1989, Instituto Botánico Darwin 2002, Liogier 1997, Natural Resources Conservation Service 2002). It has also been reported from India (Kudremukh Wildlife Foundation 2002).

Ecology.—Botón blanco grows on moist soils, both acid and alkaline, of all textures derived from nearly all types of rocks. The species grows in areas that receive from about 750 to 3000 mm of annual rainfall from near sea level to 600 m or more in elevation in Puerto Rico. It grows on sand and caliche in prairies and openings in Texas (Jones 1975). In Puerto Rico, it grows on roadsides, construction sites, old fields, and pastures. Botón blanco competes with cultivated crops and plantations in Brazil and Africa (Holm and others 1997). It is one of the major invaders of abandoned pastures and slash-and-burn fields (Ministério de Ciencia e Tecnología 2002). The species requires disturbance to establish itself and must have full or good partial sunlight to survive. It competes well with disbursed grass and weeds, but is overcome by dense, tall grass, brush, and trees. Because of grazing, mowing, and cultivation, most plants do not progress beyond the herbaceous stage. If allowed to grow, they will form dense clumps and mats.

Reproduction.—In Brazil botón blanco blooms from February through August (Instituto de Biociêcias 2002). In Texas, it flowers from March through May (Correll and Johnston 1970). Flowering is almost continuous in moist portions of Puerto Rico. Plants begin blooming in the nursery at about 9 months. The flowers are pollinated by several species of bees (Instituto de Biociências 2002). Seeds collected in Puerto Rico averaged 0.00016 g each or 6,250,000 seeds/kg. Sown on peat without pretreatment, these seeds germinated at 49 percent beginning in 13 days and ending at 74 days. The seeds are disbursed by grazing animals and farm equipment. Established plants root readily at the nodes when covered by soil or rotting plant material.

Growth and Management.—Botón blanco seedlings grow slowly at first but begin rapid growth after about 6 months. Twenty-three 9-month-old nursery plants averaged 64 cm in height with a maximum of 109 cm. Botón blanco shrubs appears to live at least 4 years and probably much longer in Puerto Rico. Botón blanco is controlled in crops and pasture by cultivation, mowing, and spraying with broadleaf herbicides. The importance value of botón blanco in a Colombian pasture was reduced by 39 percent by simply fertilizing with potassium and sulfur to increase the vigor of the pasture grasses (Tejos 1981).

Benefits.—Botón blanco is a forage plant, but not one highly favored by livestock. African material was found to contain 0.2 percent alkaloid including borreine and borreverine (Burkill 2000). At least part of the alkaloids are beta-carbolines and would represent a poisoning hazard if they were present in higher concentrations (Animal Science at Cornell University 2002). Botón blanco has a number of uses in herbal medicine, most frequently for skin conditions. In Africa, leaf extracts are used to treat leprous conditions, furuncles, ulcers, and gonorrheal sores (Burkill 2000, Environnement et Développement du Tiers-monde 2002). A lotion is prepared to relieve skin itches (Liogier 1990). Other preparations are used internally to treat diarrhea, as a diuretic in the treatment of schistosomiasis, and as an abortive. An essential oil extracted from the leaves has been shown to inhibit *Escherichia coli* and *Staphylococcus aureus* (Burkill 2000).

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***Strumpfia maritima* Jacq.** pride-of-Big-Pine
RUBIACEAE

Synonyms: none

John K. Francis

General Description.—Pride-of-Big-Pine, also known as snowbank, rosemary, strumpfia, lirio, and rosarin-bord-de-mer, is an evergreen shrub usually 1 m or less in height but sometimes reaching 2 m. Most plants have a profusion of gray stems and branches. The twigs are slender (3 to 4 mm in diameter), and prominently ringed from persistent stipule bases. The whorled dark-green foliage is crowded at the ends of branches. Leaves are linear and leathery, 1 to 3 cm long with petioles about 1 mm long, with an entire and revolute margin. Inflorescences are axillary, few-flowered racemes. The individual flowers are white to pink, campanulate with a tube about 1 mm long and corolla 6 mm across with five lobes. The fruit, a white, fleshy globose drupe, is 3 to 6 mm in diameter with a persistent calyx. It contains one or two seeds (Howard 1989, Liogier 1997, Nelson 1996).

Range.—Pride-of-Big-Pine is native to the Florida Keys, the Bahamas, the Greater and Lesser Antilles, Grand Cayman, several islands north of Venezuela, and Yucatan, Mexico (Howard 1989, Liogier 1997, Nelson 1996). The species is listed as endangered in Florida (Florida Fish and Wildlife Conservation Commission 1997). It is not known to have naturalized outside its native range.

Ecology.—Pride-of-Big-Pine is confined to coastal areas. Types of habitat include rocky headlands, coastal cliffs, beach strands, and coastal flats from near sea level to a few meters in elevation. It frequently grows in cracks in rocks or rocky rubble. The soils are salty, and the plant tolerates sea water overwash and heavy salt spray. Mean annual precipitation ranges from about 600 to 900 mm. Pride-of-Big-Pine grows singly, scattered, or in small thickets. When growing in severe habitats, it sometimes forms natural bonsais.

Reproduction.—Pride-of-Big-Pine blooms and fruits throughout the year (Nelson 1996). The flowers are probably pollinated by insects. The fresh fruits weigh about 0.02 g each. A collection of air-dried seeds (n = 99) from Puerto Rico averaged 0.0052 $\pm$ 0.0001 g/seed or 192,000 seeds/kg. The seeds were placed to germinate on the surface of moist peat, and 6 percent germinated between 4 and 6 months after sowing. Germination is epigeous. Plants coppice when broken or cut (author's observation). The seeds are probably dispersed by birds.

Growth and Management.—Pride-of-Big-Pine grows slowly. Planting experience for this species has not been published. Because it is rare or uncommon and never aggressive, control is not necessary. Probably the best management is to totally protect existing stands and suitable habitat from disturbance.

Benefits.—Pride-of-Big-Pine helps protect the soil in coastal sites and provides cover for wildlife. The Exuma Island iguana (*Cyclura cychlura figginsi*), an endangered species from the Bahamas, feeds on fruits, flowers, buds, and leaves of Pride-of-Big-Pine (Knapp 2002). Probably many other species eat the fruits. It is a pretty plant and adds to the aesthetics of coastlines. If propagation and cultural techniques can be worked out, it would make a valuable ornamental. Infusions of the leaves are reported to be a stimulant useful in treating poisonous bites, fever, and stupor and weakness caused by fever (Liogier 1990).

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***Styrax americanus* Lam.** American snowbell
STYRACACEAE

Synonyms: *Styrax pulverulentus* Michx.

Kristina Connor

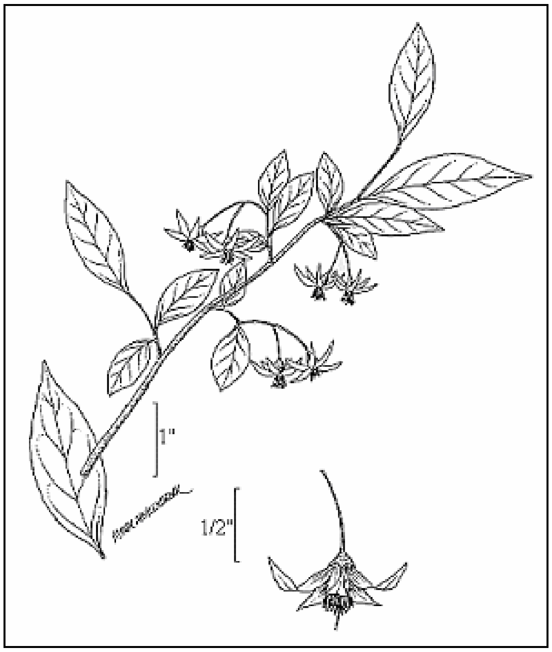

Illustration source: USDA—Soil Conservation Service, Southern Technical Center

General Description.—American snowbell, also known as mock orange or storax, is a deciduous shrub or small tree with a widely branched crown. It reaches 3 to 5 m in height, and the stems can reach 7.5 cm in diameter (Johnson and Hoagland 1999, Plant Identification Resource 2001). While the bark on the stems is smooth and dark grey to brown, branches range in color from green to grey to red-brown. Young stems are pubescent, becoming glabrous with age (Johnson and Hoagland 1999). The alternate, simple leaves are 2.6 to 9 cm long, ovate to elliptic, entire to finely serrate, glabrous above, and pubescent beneath (Bailey and Bailey 1976, Krüssmann 1986). The leaf apex is acute, venation is pinnate. The showy, fragrant white flowers for which the plant is noted form in racemes from April to June (Iverson and others 1999, Krüssmann 1986). American snowbell is distinguishable from bigleaf snowbell (*S. grandifolius*) by its smaller leaves and shorter flowering racemes with fewer flowers per raceme (Brown and Kirkman 1990).

Range.—American snowbell is found in the Southeastern United States, from Virginia south to Florida and west to Louisiana (Bailey and Bailey 1976) and eastern Texas. It is also recorded in McCurtain County in Oklahoma (Johnson and Hoagland 1999). It will grow as far north as southern Missouri, southern Illinois, Indiana, and southern Ohio but is rare, endangered or possibly extirpated in Ohio and Illinois (Ohio Department of Natural Resources 2002, Iverson and others 1999).

Ecology.—American snowbell grows primarily in rich, poorly-drained acidic soils along swamp margins, stream beds and lake edges, oxbow lakes, and in floodplains. (Johnson and Hoagland 1999). It grows well in the shade but will tolerate full sun. It is associated with trees commonly found in wet areas, such as baldcypress and overcup oak. Plants are particularly tender when young (Krüssmann 1986).

Reproduction.—American snowbell is named for its showy, fragrant, white flowers. Flowers are complete and their placement hypogynous (Iverson and others 1999). They occur in 2.5 to 12 cm long racemes, one to four flowers per raceme. Raceme stalks are pubescent. The flowers have five petals, and the white style extends beyond the 10 stamens. The calyx is shallowly five-lobed and has tiny, triangular teeth. The 6 to 8 mm subglobose fruits are one-seeded drupes that mature from July to October (Krüssmann 1986, Johnson and Hoagland 1999).

Growth and Management.—This species is often planted and grows well in cultivation. Since it requires moist soils and prefers shade, it can be seriously threatened by drainage and removal of the forest canopy. Its major pollinators are bees (Iverson and others 1999), and the species relies on seed dispersal for regeneration. It is, however, easily propagated from softwood cuttings (Johnson and Hoagland 1999).

Benefits.—American snowbell is an attractive landscape plant. Its leaves are also a preferred food of the caterpillar of *Callosamia promethea*, the promethea moth (Oehlke [no date]).

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***Suaeda suffrutescens* S. Wats.** desert seepweed
CHENOPODIACEAE

Synonyms: *Dondia suffrutescens* (Wats.) Heller
Suaeda nigrescens I.M. Johnst.

James E. Nellessen

General Description.—Desert seepweed is also known as inkweed, iodinebush, and quelite salado. Desert seepweed has stout stems and branches, woodiness greatest toward the base, side branches generally short, although the plant is highly branched. It could be classified as a subshrub. The plant is erect and ascending, or spreading. Desert seepweed ranges in height from about 50 to 120 cm, often forming mounds as broad as 150 cm. Young stems and leaves are soft and felty with numerous hairs. Leaves are simple, alternate, numerous, fleshy, linear to linear-lanceolate, 5 to 20 mm long, narrower at the base, semirounded to somewhat flat (Correll and Johnston 1970, Great Plains Flora Association 1986, Ivey 1995, Kearney and others 1951, Martin and Hutchins 1980). Two varieties have been recognized: *S. suffrutescens* var. *suffrutescens*, and *S. suffrutescens* var. *detonsa* I.M. Johnston. The latter variety (*detonsa*) has three synonyms: (1) *S. duripes* I.M. Johnst., (2) *S. nigrescens* I.M. Johnst., and (3) *S. nigrescens* var. *glabra* I.M. Johnst. (Allred 2002, Great Plains Flora Association 1986, Kartesz 1994). The latter variety, *S. suffrutescens* var. *detonsa* (*S. nigrescens* var. *glabra*) is distinguished by having smooth, or relatively smooth (hairless) stems and leaves. This variety is more common in Mexico, but extends into southern Texas.

Range.—Desert seepweed occurs from western Oklahoma and Texas across central and southern New Mexico into Arizona and California, and south into Mexico. It occurs at elevations from about 750 m to 1,830 m.

Ecology.—Desert seepweed is a perennial shrub of saline or alkaline soils in plains and valleys. These habitats include the margins of ephemeral lake beds, salt flats, and flood plains of rivers and streams. Some moisture needs to be relatively near the surface for part of the growing season. This species is classified as a halophyte, or salt tolerant plant. Desert seepweed may dominate alkali sink habitats in association with other salt tolerant species, including other species of *Suaeda* (seepweeds), *Salicornia* spp. (glasswort or saltwort), *Distichlis spicata* (L.) Green var. *stricta* (Torr.) Beetle (inland saltgrass), *Allenrolfea occidentalis* (Wats.) Kuntze (burro weed or quinine bush), and *Heliotropium curassavicum* L. (salt heliotrope), to name a few (Hendrickson 1974, Dick-Peddie 1993).

Halophyte Ecology and Physiology.—Although little if anything is reported about desert seepweed, much is known about the common salt tolerant characteristics of the genus *Suaeda*. Chapman (1942) used the term halophyte in describing species that could grow in an environment with greater than 0.5 percent sodium chloride (NaCl). Halophytes can be divided into two groups: (1) those requiring salt for survival and best growth, and (2) those tolerating or resisting salty environments (Waisel 1972). The second group, the salt tolerators, have adapted to saline habitats and survive there because salt-sensitive plants (glycophytes) cannot survive there. Halophytes accumulate salts obtained from the soil solution within their tissues during the transpiration process. Many members of the genus *Suaeda* readily translocate salts to upper portions of the plant. This second group of halophytes can be subdivided into three more categories of tolerance. Salt enduing species simply tolerate the presence of salt in their cells. Salt excluding species may excrete salt from shoots, including those with specialized hairs on the plant, or transport them back to the roots. Salt evading species have mechanisms to prevent transport to the leaves or prevent absorption from the soil solution (Waisel 1972). Some members of the genus *Suaeda* fall into the first group requiring salt for survival, while others are salt enduring halophytes. Salt (NaCl) and other ions (including sulfate and potassium) may be sequestered into cell vacuoles where they do not interfere with normal cell biochemistry. These plants will generally have higher water potential gradients between the soil and the leaves, which may add to succulence. Waisel (1972) proposed a new order to the classification of halophytic plant communities: Suaedetalia--persistent communities in dry desert saline habitats, dominated by annual and perennial members of the family Chenopodiaceae (as well as other families). Zahran (1982) likewise includes a *Suaeda* community classification. Some shrubby members of the genus (*S. fruticosa* Forsk. and *S. monoica* Forsk.) are reported to accumulate large amounts of salt annually when in dense stands, as much as 2 to 4 tons/ha (Waisel 1972). In this function they may help to desalinate some saline habitats.

Reproduction.—Flowers are small and greenish, and occur in spiked clusters of three to nine flowers in the leaf axils. The corolla is absent. The five-lobed calyx has all parts equal, may be hood shaped, and lacks appendages, that is, it is not winged. Seeds are small, black, and 0.7 to 1 mm wide. Desert seepweed blooms from March to September, depending on local environmental conditions (Correll and Johnston 1970, Great Plains Flora Association 1986, Kearney and others 1951, Martin and Hutchins 1980). Many of the salt tolerant members of the Chenopodiaceae have physiological seed dormancy (Baskin and Baskin 2001). Although no seed germination reports regarding this particular species were located, numerous studies have been performed on other members of the *Suaeda* genus. Three of four members of this genus required prior cold stratification of the seeds with optimal daytime germination temperatures of 25 to 27 °C (summarized in Baskin and Baskin 2001). NaCl concentrations ranging from 0.17 to 0.90 molar have depressed maximum germination of 75 to 100 percent down to 10 percent in four different species of *Suaeda* (summarized in Baskin and Baskin 2001).

Growth and Management.—Desert seepweed can grow relatively quickly. It has been observed to resprout readily in managed and mowed areas adjacent to levees along the lower Rio Grande floodplain in New Mexico. This species is restricted to saline and riparian habitats and is not highly browsed. Consequently, it does not pose as a major management concern on most rangelands. It does not typically form dense stands.

Benefits.—Desert seepweed leaves and young shoots have been added to vegetable greens or cacti fruits by Native Americans during cooking to add flavor. It has also been added between layers of cacti fruit and sotol butts (stems of *Dasylirion* sp.) during the 24 to 48 hour cooking process in mescal pits (Warnock 1974). Pima Indians would eat the plant for greens and the roasted seeds, called pinole. Coahuila Indians extracted a black dye from the plant used for artwork (Dodge 1985). This species is not browsed much by livestock but may be utilized when other vegetation is in short supply (Warnock 1974, Dodge 1985).

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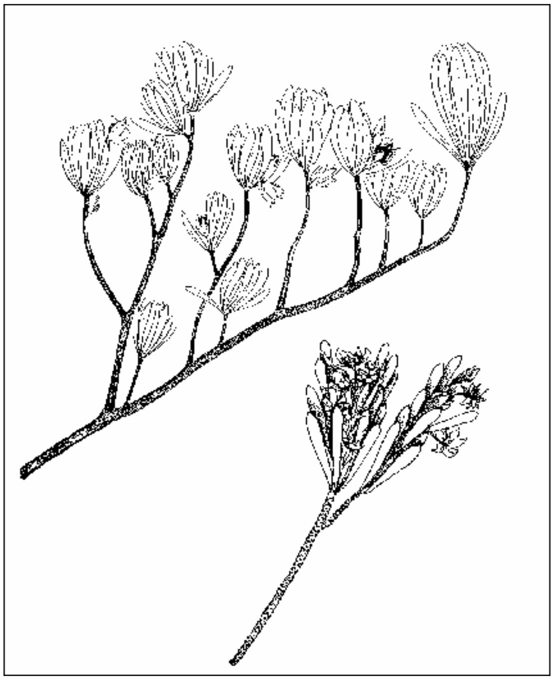
***Suriana maritima* L.** bay-cedar

SURIANACEAE (formerly in SIMAROUBACEAE)

Synonyms: none

John K. Francis



General Description.—Bay-cedar, is also known as tassel-plant, guitarán, temporana, jovero, cuabilla, pantsil, cucharo, palo corra, oseille bord de mer, romarin noir, and crises marine. It is an evergreen shrub usually 1 to 2 m in height but sometimes reaching 6 m. Multistemmed and much-branched, it has a prostrate to ovoid crown. Stems have a dark brown, rough and flakey bark. Heartwood is dark red or reddish brown; the sapwood being somewhat lighter. The wood is hard, heavy, fine-textured, strong, and durable. The gray-green, succulent, downy foliage has a salty taste and a cedar-like fragrance when crushed. Leaves are crowded at the ends of the branches, sessile, narrowly obovate, and 1 to 4 cm long. Inflorescences, solitary or few-flowered cymes, are almost hidden among the leaves. The small, five-merous, bisexual flowers are yellow and develop into clusters of five hard, 3- to 4-mm, dry drupes surrounded by five gray sepals. (Gilman 1999, Howard 1988, Liogier 1988, Little and others 1974).

Range.—Bay-cedar is native to the shores of southern Florida, Bermuda, the Bahamas, the West Indies, the eastern side of Mexico through Brazil, East Africa, tropical Asia, Australia, and many of the islands of the Indian and Pacific Oceans (not Hawaii) (Howard 1988, Stevens and others 2001). The species has been planted widely as an ornamental. It is listed as endangered in the wild in Florida (Smithsonian Institution 2002).

Ecology.—Bay-cedar is strictly costal. It grows on beaches, dunes, sandy thickets (Nelson 1996), and rocky headlands. It tolerates moderately salty soils, storm-surge overwash, heavy salt spray, blowing sand, high surface heat, drought, and strong winds (Wildflower Nervana 2002). If planted and given protection from competition, it will grow well on inland sites (Nelson 1996) on a wide range of well-drained soils. The species requires full sun to grow and flower. Bay-cedar is rare to uncommon in much of its habitat, but occasionally forms thickets.

Reproduction.—Bay-cedar flowers and fruits intermittently throughout the year (Little and others 1974). The fruits are buoyant and remain viable for long periods in sea water enabling colonization of tropical beaches throughout the world (Nelson 1996).

Growth and Management.—Growth rate of bay-cedar is described as moderate. The species is currently being propagated by seeds to produce nursery plants. The recommended spacing for ornamentals is 90 to 150 cm. Irrigation is recommended during establishment but afterwards is not needed (Gilman 1999).

Benefits.—Bay-cedar helps stabilize beaches and costal dunes, and furnishes food and cover for wildlife. It is widely planted as an ornamental for hedges, screens, borders, accents, seminatural covers, and potted plants. The fruits attract birds that feed on them (Gilman 1999). The foliage furnishes food for blue and hairstreak butterfly larva (Schaefer and others 2002). Key deer (*Odocolleus virginanus clavium*) and probably other ruminants will not eat the foliage of bay-cedar (Schaus and others 2002). Herbalists employ extracts of the leaves and bark to treat rheumatism and skin ulcers and to stop bleeding (Liogier 1990).

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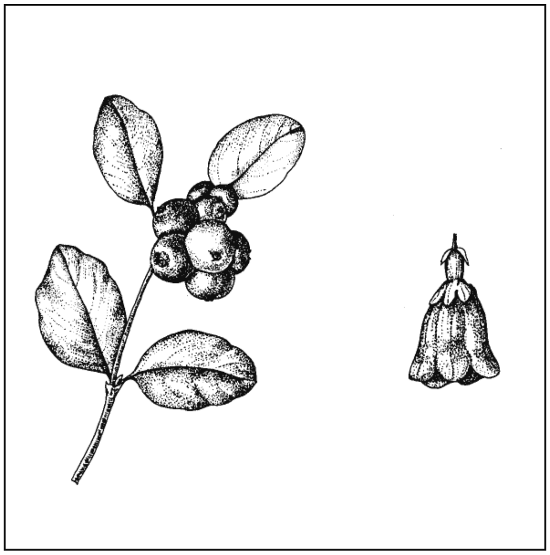
***Symphoricarpos albus* (L.) Blake** common snowberry
CAPRIFOLIACEAE

Synonyms: *Symphoricarpos racemosus* Michx.
Symphoricarpos rivularis Suksdorf
Viburnum album L.

John K. Francis



General Description.—Common snowberry, also known as snowberry, waxberry, and white coralberry, is a deciduous shrub. The slender, branchy, multiple stems are usually low (0.5 to 1 m) and arching or straight, but sometimes reaching as much as 2 m in height. The stems rarely exceed 2.5 cm in thickness. The bark is yellow-gray in young stems, tan to grayish-brown in older ones, becoming scaly or splitting lengthwise in larger stems. Stem wood is soft and greenish-white. The opposite-branching twigs are slender and flexible. Thin, papery leaves are opposite, simple, short-stalked, and round to oblong-elliptic with margins entire, lobbed, or wavy-toothed. Petioles are 3 to 4 mm long. The perfect flowers are solitary to several in terminal or lateral spikes. The five-lobbed corolla is pink and white, tubular or bell-shaped, and about 6 mm long. Fruits are white, spongy, berry-like drupes 6 to 12 mm in diameter. Each contains two white, flattened, elliptical nutlets with one seed per nutlet. Chromosome number is 2n = 54 or 72 (Gilbert 1995, Grimm 1966, McWilliams 2000, Soper and Heimburger 1982, Stephens 1973, Welsh and others 1987).

Range.—Common snowberry is native from Nova Scotia to southern Alaska, throughout the northern half of the United States, and in California, Utah, Colorado, New Mexico, Tennessee, and North Carolina (McWilliams 2000, Natural Resources Conservation Service 2003). It does not occur in Nevada and Kansas, and is reported to be only naturalized in Utah (Welsh and others 1987). The species was introduced to Great Britain in 1817 and has naturalized widely in the United Kingdom, Ireland, and northern Europe (Binggeli 1998, Gilbert 1995). There are two varieties, *albus* and *laevigatus* (Fern.) Blake. Variety *laevigatus*, a coarser and taller (up to 2 m) plant, and has a Western distribution. Variety *albus* occurs intermittently across the Continent (Natural Resources Conservation Service 2003). Both are cultivated and naturalized in many places, making determination of distribution somewhat complicated.

Ecology.—Common snowberry grows best in full sunlight or light shade on well-drained, moist, fertile soils. It does survive and grow slowly in medium shade. The species grows in many types of open forests, forest edges, shrublands, riparian vegetation, and fencerows. It does not grow in swampy sites, deserts, and mountain tops above the tree line. Common snowberry grows in soils with mildly acidic pH (6.0) and mildly alkaline conditions (pH's of 7.8) and does very well on soils derived from limestone; less aggressively on soils derived from granite. It tolerates poor fertility and has been used to revegetate disturbed sites. Common snowberry in interior Western United States grows at elevations from 800 to 2,800 m. It grows at much lower elevations in other areas of North America. Because it sprouts readily from rhizomes, common snowberry is resistant to fire and browsing. It may increase dramatically in density after logging opens the forest canopy (Gilbert 1995, McWilliams 2000, Natural Resources Conservation Service 2003).

Reproduction.—Common snowberry blooms between early May and late July depending on location and matures fruits in August to October (Grimm 1966). The flowers are pollinated by a range of bees, wasps, and syrphids (Gilbert 1995). Fruit and seed production can be abundant, especially when plants grow in full sun on fertile sites. Normally a good seed crop is produced every year. Fruits remain on stems until midwinter or early spring, if not eaten. Numbers of seeds per gram vary from 119 to 250 for var. *albus* and from 86 to 144 for var. *laevigatus.* Germination may be as high as 87 percent if exacting conditions of pretreatment are met. Germination is epigeal (Walker 2003). Seeds are dispersed by birds and mammals. Seedlings are relatively uncommon. However, vegetative reproduction is common by sprouting of underground stems that run horizontally at a depth of 2 to 5 cm for up to 60 cm before turning up to form new tops. Stems layer when they come in contact with the ground, and severed stems lying on the ground will also take root (Gilbert 1995).

Growth and Management.—Planted common snowberry reached 30 cm in height during the first year (Center for Urban Horticulture 2002). Shoot extension of plants in England is reported at 0.6 m per year. Individual stems have been aged up to 34 years old in England (Gilbert 1995). By suckering, plants may survive indefinitely. Fruits may be collected by hand picking or flailing the plants with a tarp spread underneath. The fruit is then macerated and water is used to float off the pulp and empty seeds. The residue is then dried and cleaned. The air-dried seeds can be stored at 5 °C for up to 5 years. Pretreatments are necessary for acceptable germination. Warm stratification for 3 to 4 months at 22 to 30 °C followed by cold stratification at 5 °C for 4 to 6 months is recommended. Sowing in the late fall can be used instead of the cold treatment. Sown seeds should be covered with about 6 mm of soil and 2 cm of mulch. Seedlings for planting can be grown successfully from cuttings, wildlings, and pieces of stem with roots collected in the spring. Transplant establishment success of bareroot and containerized nursery stock is as high as 90 percent when done properly (Walker 2003).

Benefits.—Common snowberry helps protect the soil, provides food and cover for wildlife, browse for livestock, and adds beauty to the landscape, especially in fall and winter when the white fruits are on the shrubs. Containing 4 to 13 percent protein, depending on tissue and season, it provides important early-season browse for cattle and domestic sheep. It is also browsed by most wild ungulates. It is generally unpalatable to horses and moose. The fruits are consumed by both black and grizzly bears and are eaten by a number of birds and small mammals (McWilliams 2000). Some sources refer to the fruits as being toxic to humans (Gilbert 1995, Moerman 1986). The toxic agent appears to be the isoquinoline alkaloid chelidonine and causes mild symptoms of vomiting, dizziness, and sedation in children (Canadian Biodiversity Information Facility 2003). The fruits were reported to have been eaten but not favored by Native Americans (McWilliams 2000). Various tissues were used by Native Americans as a diuretic, to treat gonorrhea, and for sore eyes (Moerman 1986). Common snowberry is planted as an ornamental and in conservation plantings for wildlife amenity, soil stabilization, and strip mine reclamation in temperate areas around the world (Gilbert 1995).

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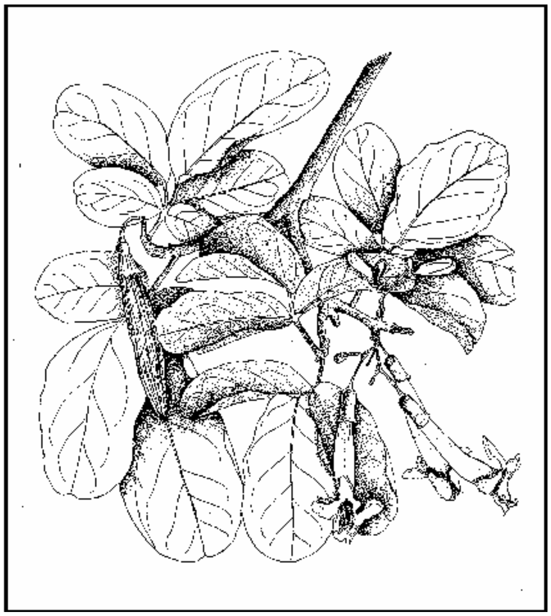
***Tabebuia haemantha* (Bertol. ex Spreng.) DC.** roble cimarrón
BIGNONIACEAE

Synonyms: *Bignonia haemantha* Bert. ex Spreng.
Tecoma haemantha (Bert.) Griseb.
Spathodea portoricensis Bello

John K. Francis



General Description.—Roble cimarrón, also known as roble colorado and roble bobo, is a shrub or a small tree up to 8 m in height and 15 cm in basal diameter. Commonly, plants are 3 to 5 m in height and 4 to 8 cm in diameter. Young roble cimarrón usually have a single stem, until they have been damaged mechanically or by fire. Older plants often develop multiple stems by spontaneously sprouting just above the ground level. The bark is gray, smooth except for a slight fissuring. The inner bark is nearly white and slightly bitter. There are relatively few branches. The twigs are light gray and slightly flattened below the nodes. The species develops a tap and lateral root system. The roots are brown and flexible. Roble cimarrón is evergreen with palmately compound leaves. There are three or five stiff, leathery leaflets on a stout 2.5- to 5.0-cm petiole. The 3- to 15-cm long leaf blades are elliptic or ovate with entire edges and rounded to pointed at the tip. The inflorescences are panicles of several to many flowers on short branches. The flowers have a crimson, tubular corolla 3 to 5 cm long with five irregular lobes. The capsules are 6 to 11 cm long and contain many membranous two-winged seeds 1.9 cm long (author's observations, Liogier 1995, Little and Wadsworth 1964).

Range.—Roble cimarrón is endemic to the island of Puerto Rico. Specifically, the species is found in the dry forests in the southern and eastern parts of the island and the moist slopes above them, including serpentine areas in western Puerto Rico, and on the limestone hills in the northern coast and inland (Little and Wadsworth 1964, Vélez and van Overbeek 1950).

Ecology.—Roble cimarrón grows on loamy and clayey soils with pH's from about 5.5 to 7.5. It often occurs in sites that have been eroded and partially compacted by grazing animals. The soils where it grows today are usually steep and rocky. The species formerly inhabited all types of topography from near sea level to about 400 m in elevation. These sites receive from about 700 to 2100 mm of precipitation. In areas that receive the higher rainfall of the range, roble cimarrón tends to grow on excessively drained sites. The species is frequently common in overgrazed pastures indicating that it is unpalatable to cattle. Roble cimarrón is moderately intolerant of shade. It grows well in the open and in low basal area forest stands. Adult plants are usually found in codominant and intermediate crown positions in dry forests. It is top-killed by fires but sprouts vigorously afterwards.

Reproduction.—Flowering occurs almost throughout the year according to Little and Wadsworth (1964). However, most shrubs in particular areas appear to flower synchronously (author's observation). Hummingbirds, other bird species, and insects pollinate the flowers. Capsules form and mature about 6 weeks after flowering. They are green, turning tan at maturity, after which they quickly split open. The seeds adhere to a flat central placenta but detach and become airborne in the slightest breeze (Vélez and van Overbeek 1950). A sample of 17 capsules collected in Salinas, Puerto Rico contained an average of 59.9 ± 2.01 seeds/capsule. The air-dry seeds averaged 0.0148 ± 0.0003 g/seed or 68,000 seeds/kg. Sown on peat moss, these seeds germinated at 90 percent between 7 and 31 days after sowing. The species grows and survives well in the nursery, similar to other *Tabebuia* seedlings. In the wild, seedlings are well scattered and uncommon.

Growth and Management.—Roble cimarrón grows about 0.5 m/yr in early years after it is well established. It does not appear to be a long-lived species. Unfortunately, no plantations are known and no management experience has been reported.

Benefits.—Roble cimarrón would probably be suitable as an ornamental for background plantings in moist and dry frost-free areas. It would have the advantage of being drought-hardy and tolerant of infertile and partially compacted soils and should be a good species to plant in environmental restoration plantings within its native range. The light brown, hard wood is suitable for firewood and charcoal but is little used because of the plant's small size and relative scarcity.

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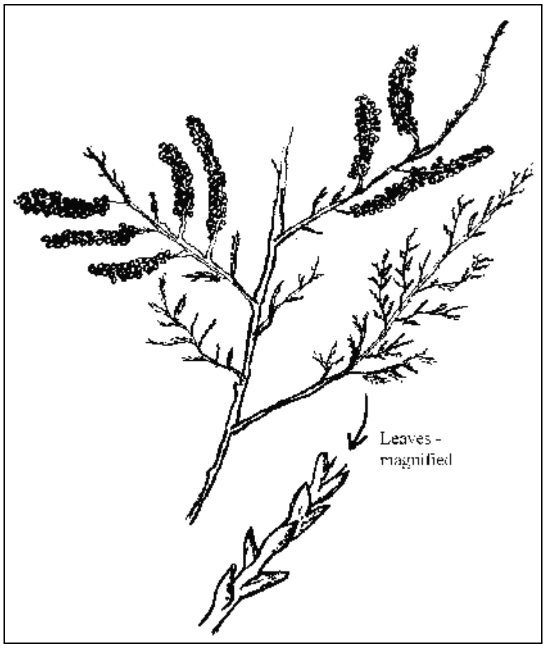
***Tamarix chinensis* Lour.** tamarisk
TAMARICACEAE

Synonyms: *Tamarix pendandra* Pallas
Tamarix ramosissima Ledebour
Tamarix gallica L. var. *micrantha* Ledebour
Tamarix pentandra Pallas ssp. *tigrensis* (Bge.) Hand.-Mazz.

Juanita A.R. Ladyman



General Description.—*Tamarix chinensis* Loureiro is commonly known as tamarisk or saltcedar. Occasionally it grows with a defined trunk as a tree but generally it grows as a multiple-stemmed shrub up to 6 m tall. The bark of larger trunks, or stems, is reddish-brown to dark brown or blackish. The leaves, that are only 1.5 to 3.5 mm long and appear scale-like, are deciduous. The tiny flowers are five-merous, having five sepals, five petals, five stamens, and a five carpellate pistil, and are arranged on a flowering stalk that is 2 to 7 cm long. The petals are 1 to 2.3 mm long, and persistent in fruit. They are frequently a shade of pink but may be white or red. The sepals are 0.5 mm to 1.3 mm long. The scale-like leaves and shape of the shrub are reminiscent of a juniper or cedar and this accounts for the common name "saltcedar." This shrub has been the subject of considerable taxonomic confusion. McClintock (1951) stated "there is probably not another genus of plants as well known as the tamarisks in which the species is so poorly understood or separated on more obscure characters." For most species, the tiny floral organs and the use of a microscope, or at least hand lens, are essential for identification (Allred 2002). *Tamarix pentandra* var, *pentandra* Pallus has been mistakenly applied to this species within North America. Actually, *T. pentandra* Pallus is synonymous with *T. hispida* Willd. that is distributed throughout central Asia (Baum 1978). Other confusion has resulted from this species being referred to as a sub-species of *T. gallica* L., which is a unique taxon originally from Europe, and now also naturalized within the United States (Allred 2002, Baum 1978). Although Baum's treatment (1978) described *T. chinensis* Loureiro and *T. ramosissima* Ledebour as unique taxa placing them in two different sections, recent chloroplast and nuclear DNA studies suggest the two entities should be merged (Allred 2002). These two names are synonymized in the Utah Flora (Welsh and others 1993). *Tamarix chinensis* has a chromosome number of 2n = 24 (Welsh and others 1993).

Range.—Tamarisk is a common, wide-ranging species that has been collected across Asia from western Turkey through Mongolia, Afghanistan, and China to Korea and Japan. It was introduced into the Western United States and has become naturalized.

Ecology.—Tamarisk grows in generally moist sites at seeps, streams, and along river banks and roadsides (Dick-Peddie 1993). It tolerates saline soils and also contributes to salinization of the soils in which it grows. It forms equally dense stands in both the Western United States and in central China where it is an apparent native (author's personal observation). It has an extensive root system and uses such large volumes of water that streams and ponds become dry. Studies in the Southwestern United States show that tamarisk stands have far less biodiversity than stands of native riparian vegetation. Miles of riverbank can be almost monotypic with dense tamarisk stands that have 50 percent fewer small mammal species as well as fewer reptile and amphibian species than native riparian stands (Olson 1999). Although bees visit the flowers (Epple 1995) the diversity of insects is also low, and nestling birds rely on insects brought to the nests by their parents. Although some birds can nest in the shrubs the trunks are not large enough to provide habitat for animals such as wood-peckers, owls, chickadees, and squirrels. The tiny, hairy seeds provide poor nutrition and are largely indigestible.

Reproduction.—Tamarisk generally flowers in April through August. The pink, fragrant flowers are insect pollinated. The seeds, which are small, mature in summer and fall and are dispersed by birds and by water. However, the seed may have limited longevity under humid conditions. Seeds retain high viability if stored in sealed containers with desiccant at temperatures between 3 to 27 ^{o}C but lose viability if stored at "moderate humidity" (Wilgus and Hamilton 1962, Baskin and Baskin 2001). Germination temperature appears to be flexible. Freshly matured seeds germinated from 87 to 98 percent when kept at constant temperatures between 19 to 43 ^{o}C. Percent germination did not appear related to temperature; 96 percent germinated at 19 ^{o}C and 91 percent at 43 ^{o}C (Wilgus and Hamilton 1962, Baskin and Baskin 2001). Vegetative reproduction by suckers and rooting branches is copious.

Growth and Management.—Tamarisk is an aggressive, invasive species. Its invasive behavior is illustrated by its colonization of the Pecos River Valley in New Mexico (Allred 2002). In 1912, a few seedlings were observed at Lake McMillan. By 1915 the shrub covered 600 acres and extended up and down the riverbanks. By 1926 it covered 12,300 acres and extended to 57,000 acres by 1960 (Allred 2002). It out-competes many native species and is difficult to eradicate once established (USDA Forest Service 1988). The extremely deleterious impact of this species on the riparian and wetland areas of the Southwest has led to intense study on how to control and reverse its spread. There are four general methods--biological control, physical removal by hand or by machine, herbicides, and fire--that can be used to control tamarisk, and each has shortcomings. The most appropriate method, or combination of methods, depends upon the particular site. Biological controls for tamarisk are not yet commercially available, although a variety of insects have been investigated--from grasshoppers to leaf hoppers. Two species specific to tamarisk, a mealybug (*Trabutina mannipara*) from Israel and a leafbeetle (*Diorhaba elongata*) from China, have received advance testing (DeLoach and others 1996, DeLoach, 1994). Physical cutting and removal of tamarisk will only be successful if the roots are removed or killed. By itself, cutting tamarisk by hand (that is by chain saw, weed eater, or axe) is not often an effective treatment. Cutting tamarisk tends to just cause more shoots to grow. However, there was a report of successful control where large tree stumps (20 to 25 cm diameter) had been cut back to the soil surface and then covered by a black, liner material (Cinnamon 1990). Purely mechanical removal is also sometimes successful if there is enough standing vegetation to substantially shade the resprouting tamarisk. For example, in Nevada (Busch and Smith, 1995) when tamarisk had been completely cleared above ground in a stand of willows, there was essentially no grow back during the 4 years follow up. Tamarisk is sensitive to numerous herbicides (Kunzman and Bennett 1990, Sisneros 1991). At the present time, the most successful approach to control tamarisk is by cut-stump herbicide or cut-stump/frill herbicide treatments (Neill 1990, Hughes 1996). This approach is quite costly but it is very controlled, does not affect non-target organisms, and causes the least environmental impact. The tamarisk shrubs should be cut to within 2.5 cm of the ground surface (Cinnamon 1990) and a systemic herbicide applied to the stump within a few minutes after cutting. The time between cutting and herbicide treatment should be as short as possible. Leaving the cut stump for 2 to 5 days before herbicide treatment reduces success rate from greater than approximately 88 percent tamarisk death to less than 10 percent (Hays and Mitchell 1990). Fire is often ineffective. The high water and salt content of tamarisk makes it difficult to burn. Too light (low temperature) a fire will permit, or even encourage, tamarisk to re-sprout and become even denser. If the fire burn is so hot it kills the tamarisk, it is likely that the fire will leave the soil bare and in such a poor condition that it cannot support grasses and desirable vegetation. In the horticultural trade, tamarisk is propagated from hardwood cuttings in the spring or softwood cuttings in the summer (Tykač 1990). Plants grown for a long time in containers often do not establish after transplanting (Tykač 1990).

Benefits.—Tamarisk were once planted for erosion control and as wind breaks (Baum 1978, Allred 2002). It is not significantly grazed or browsed. The tannin substances in the vegetation are likely to make it unpalatable. Tamarisk has commercial value in the landscape and horticultural trade. It is a popular ornamental shrub although its use in the United States is now generally discouraged. Many cultivars exist that have been chosen for flower color and growth form (Bailey and others 1976, Tykač 1990). *Tamarix* species, although not specifically *T. chinensis*, have been used for fuel and building materials by Native American tribes in the Western United States (Moerman 1998).

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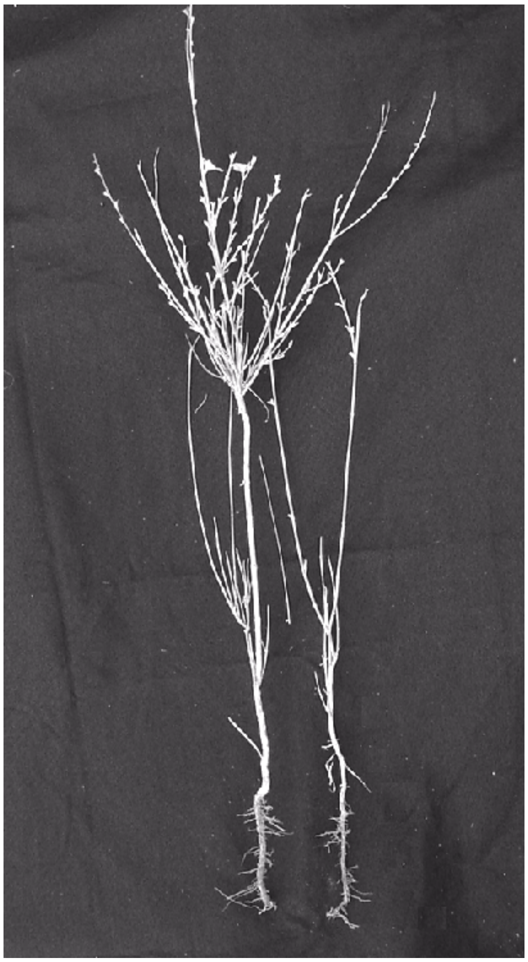
***Tamonea boxiana* (Moldenke) Howard** crow broom

VERBENACEAE

Synonyms: *Ghinia boxiana* Moldenke
Tomonea spicata sensu Urban
Ghinia spinosa sensu Britt. & Wils.

John K. Francis



General Description.—Crow broom, also known as coast broom and cardero, is a branchy shrub 40 cm to 100 cm in height. The stems are slender and woody with many bifurcating branches. Crow broom plants are supported by robust taproots with laterals through their lengths. The short-petioled lower leaves are oblong, 0.8 to 1 cm long and may have three to five lobes; the upper leaves are linear and up to 2.5 cm long. Leaves and twigs are yellow-green. The plant is deciduous or semideciduous during the dry season. Tiny purple or whitish flowers are grouped in terminal racemes. The fruits are dry and shiny with four horns and contain a four-celled central cavity with 1-mm oblong seeds (Howard 1989, Liogier 1995).

Range.—Crow broom is native to Puerto Rico, the Virgin Islands, Barbuda, and Antigua (Howard 1989, Liogier 1995). It is not known to have been planted or naturalized elsewhere.

Ecology.—Crow broom grows in dry habitats that receive from about 700 to 900 mm of annual precipitation. It is normally found within a few km of the coast at elevations from near sea level to about 450 m. Soils are variable in texture, pH, and parent material, but are always well drained. Crow broom is intolerant of shade and heavy competition and apparently requires disturbance to become established. It is usually open-grown but also occurs in savannas. Crow broom is not eaten or is browsed little by cattle and appears to benefit from control of competition in overgrazed pastures. Vasquez and Kolterman (1998) list it as “occasional” in pasture and shrublands in Southeastern Puerto Rico. It is also found on roadsides, disturbed areas, and on rocky ridges and hill sides.

Reproduction.—Crow broom blooms during the dry season (March and April). It is insect pollinated. The fruits mature during the wet season and are released at the end of the wet season (December through February). The seed-like fruits are dispersed by sticking to animals or clothing, and after being released, germinate (presumably during the wet season) and grow. A collection of air-dried fruits from Puerto Rico weighed an average of 0.0108 $\pm$ 0.0003 g/seed or 93,000 fruits/kg.

Growth and Management.—Crow broom plants grow 20 to 30 cm/year and live about 4 or 5 years. No management experience has been reported. There appears to be no reason to encourage the species and possibly motivation in rangeland to control it. However, it is seldom common enough to warrant control measures.

Benefits and Detriments.—Crow broom contributes to biodiversity in the habitat where it grows, helps protect the soil, and furnishes cover for wildlife. It may become a minor weed in rangelands and the clinging seeds can be a nuisance.

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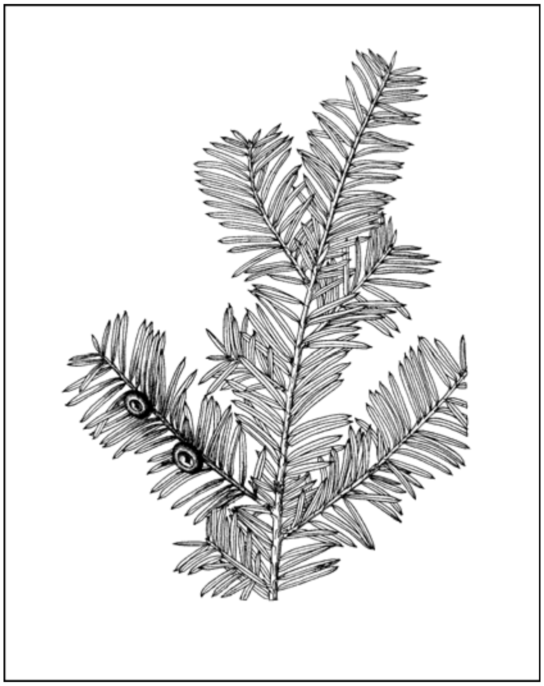
***Taxus brevifolia* Nutt.** Pacific yew
TAXACEAE

Synonyms: *Taxus baccata* L. ssp. *brevifolia* (Nutt.) Pilger
Taxus baccata var. *canadensis* Benth.
Taxus boursieri Carrière
Taxus lindleyana A. Murray

John K. Francis



General Description.—Pacific yew, also known as western yew and mountain mahogany, is an evergreen large shrub or small tree. In good sites in coastal areas and a few inland areas, old specimens sometimes reach 60 cm in diameter at breast height and 15 m in height. In high elevation and poor sites, Pacific yew usually grows to only a few meters in height and a few centimeters in diameter, sometimes forming low mats. The bark of stems is thin (6 mm) and has a multihued purplish scale pattern. Bark on young twigs is rose colored and on older ones, reddish-brown. The sapwood is yellow and the heartwood red to reddish brown. Roots are deep and wide-spreading. The green leaves are linear, 8 to 35 mm long and 1 to 3 mm broad, acute at the tip, with a median ridge on the upper surface and two yellow-green bands on the lower surface. They are whorled but bent to give a two-ranked appearance. Inconspicuous male and female strobili are borne on the underside of branches and occur on different trees (dioecious). The fruit (seed) is two- to four-angled, ovoid, 5 to 6.5 mm long, enclosed in a cup-like, fleshy red aril about 10 mm in diameter. Seeds have a large oily endosperm and a small embryo (Abrams 1940, Bolsinger and Jaramillo 1990, Earle 2002, Rudolf 1974, Viereck and Little 1972).

Range.—Pacific yew is native to the coastal forests from southern Alaska through northern California and a moist interior corridor from southern British Columbia and Alberta to northwestern Montana, north-central Idaho, and a little of eastern Washington and Oregon (Bolsinger and Jaramillo 1990). Although the species has been planted to a limited extent in Europe, it is not known to have naturalized outside its native range.

Ecology.—Pacific yew is very tolerant according to the five-step tolerance rating. Seedlings grow, develop, and eventually fruit under heavy conifer forest canopies. The species is most often found in deep ravines, along streams, and under coniferous stands (Sargent 1923). It grows as an understory dominant in most of the forest types where it occurs. Under closed stands, the limbs are often as long as the trees or shrubs are tall (Bolsinger and Jaramillo 1990, Termenstein 1990). Leaves persist on the twigs 4 to 5 years (Abrams 1940). Although initially shocked, it is able to adapt to full sunlight after overstory removal by logging, and it sometimes grows in the open in avalanche chutes, and on ridges and rocky slopes at high elevations (Bolsinger and Jaramillo 1990, Termenstein 1990). Plants growing in the interior of the continent are more often shrubby than those near the coast (Sargent 1923). It typically grows as an understory tree 3 to 5 m tall near the coast and as a shrub about 1 m tall east of the Cascade Mountains. It grows from near sea level to about 2,200 m in elevation (Earle 2002).

Reproduction.—Pacific yew flowers mostly in June, matures fruits August to October, and releases seeds in October. The pollen is dispersed by the wind. There are 32,000 to 36,000 seeds/kg (Washington source). About 50 to 99 percent will eventually germinate under proper conditions. The seeds are dispersed primarily by birds. Natural germination usually takes place in the second spring after dispersal (Rudolf 1974). Development of seedlings is slow. Pacific yew sprouts from stumps and rootstalks after being cut or top-killed. It commonly layers when branches or stems are pressed to the ground by snow or falling debris (Bolsinger and Jaramillo 1990).

Growth and Management.—Growth of Pacific yew is slow. Trees in Idaho took 25 years to reach a stem diameter (15 cm above the ground) of 2.5 cm and 100 years to reach 15 cm. Height growth is correspondingly slow (Bolsinger and Jaramillo 1990). Even in moist, rich soils, few plants live long enough to reach tree sizes. Fruits should be picked by hand as soon as they are ripe. The fruit pulp is removed by maceration and floating off the pulp, or by soaking in water at room temperature for 4 or 5 days, rubbing the fruits on screens, and washing away the pulp. The seeds should be air-dried for 1 to 2 weeks and should be sown or stored as soon as drying is complete. Air-dried seeds can be stored for 5 to 6 years in sealed containers at 1 to 2 °C. Seeds sown in nursery beds should be covered by about 1 cm of mineral soil and mulched. Germination primarily occurs in the second spring afterwards. To obtain germination a shorter time after sowing, seeds should be stratified for 90 to 210 days at 16 °C followed by 60 to 120 days at 3 to 6 °C (Rudolf 1974).

Benefits.—Pacific yew contributes to the aesthetics of the forest, helps protect the soil, and provides food and cover for wildlife. It is a preferred moose browse. Although eaten in all seasons, during the winter, moose will eat all the available leaves and twigs, and even strip the bark. Deer, elk, and rabbits also browse the species. Livestock make limited use of it during the winter and when other food is lacking. The fruit is sweet and eaten by many species of birds (Tirmenstein 1990). Plants growing along streams help protect against streambank erosion and shade the water and help maintain cool stream temperatures (Termenstein 1990). Pacific yew wood is fine-grained, heavy, hard, elastic, and strong. It has been used and still is used to a limited extent (due to scarcity) for archery bows, harpoon shafts, canoe paddles, household utensils, tool handles, mauls, splitting wedges, gunstocks, boat decking, fence posts, musical instruments, carved figurines, novelty items, furniture, oriental ceremonial "Toko" poles, turnery, cabinetry, and firewood (Bolsinger and Jaramillo 1990, Termenstein 1990). Infusions, decoctions, and poultices of leaves, twigs, and bark were used by Native Americans to treat lung problems, stomachache, wounds, and pain (Moerman 1986). Pactitaxel (often called by the trade name Taxol) was discovered during a massive anticancer activity screening program by the National Cancer Institute during the 1960's (21cecPharm 2003). Paclitaxel is a white crystalline powder extractable from any of the *Taxus* species. It is a cytotoxic anticancer drug used to treat ovarian, breast, and lung cancers, and Kaposi's sarcoma (SFT Enterprise 2003). Harvesting for peclitaxel extraction threatened to decimate the species' populations until it was discovered that other *Taxus* species were better sources and that the drug could be produced by semi-synthesis and by cell cultures (21cecPharm 2003). Pacific yew is used to a limited extent as an ornamental shade tree, foundation plant, hedge, and topiary plant (Bolsinger and Jaramillo 1990).

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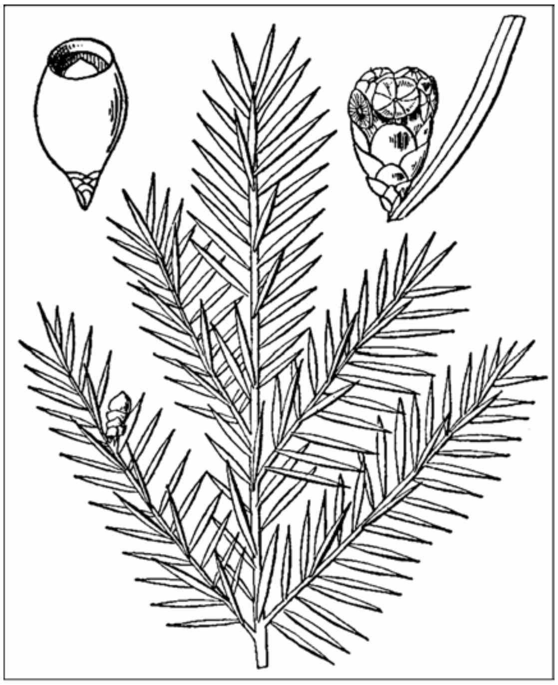
***Taxus canadensis* Marsh.** Canada yew
TAXACEAE

Synonyms: *Taxus minor* (Michaux) Britt.
Taxus procumbens Loddiges
Taxus baccata L. var. *canadensis* Gray
Taxus baccata L. var. *minor* Michx.
Taxus baccata L. var. *procumbens* Loud

Gerry Moore and John K. Francis



Drawing source: Britton and Brown 1913

General Description.—The common name most often used for *Taxus canadensis* is Canada yew. It is also known as American yew and ground hemlock; a common French name used in Quebec for this species is buis de sapin. This evergreen species is usually a low-growing, straggling non-aromatic shrub, with ascending branches up to 2 m tall. Branches often extend two-thirds of their length laterally before curving upwards. The bark is thin, scaly and red to reddish-brown. Twigs are green and alternately arranged, and winter buds are composed of imbricate (overlapping), lanceolate, keeled scales. The leaves are needle-like, on short stalks, and persist for several years. The leaf blades are spirally arranged, flattened, often in two ranks, linear, abruptly narrowed into a fine point, 1.2 to 2.2 cm long, with pale green bands on the under surface. The midrib is slightly elevated on the top surface. The leaves lack resin ducts. In winter, the leaves can be slightly reddish. Being a gymnosperm, Canada yew lacks true flowers or fruits. It does produce pollen and seeds, on separate plants (dioecious) or on the same plant (monoecious) in axillary cones. The pollen is produced by the male cones, which appear as stalked heads and mature in the first season. Each male cone is a compound of four to 16 reduced, stalked, specialized leaves called sporophylls. The stalk is attached to the center of the sporophyll (i.e. they are peltate). Each sprophyll produces two to nine pollen sacs (sporangia) where the pollen is produced. The pollen is spherical and lacks wings. The female cones are reduced, subtended by a series of small, inconspicuous bracts. Each cone produces one ovule that develops into a single seed, maturing in one season. The seeds are brown, flattened, slightly broader than long, 4 to 5 mm long. Each seed is surrounded by a fleshy, scarlet, cup-shaped aril that is open at the top, exposing the seed. Inside the aril is a clear, mucilaginous liquid called albumen (Fernald 1950, Pilger 1903, Soper and Heimburger 1982).

Range.—Canada yew is native to Eastern Canada (Manitoba, New Brunswick, Newfoundland, Nova Scotia, Ontario, Prince Edward Island, Quebec) and the Northeastern United States (Connecticut, Illinois, Indiana, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Tennessee, Vermont, Virginia, West Virginia, Wisconsin) (Hils 1993, Natural Resources Conservation Service 2003). It becomes rare above 50 °N (Soper and Heimburger 1982).

Systematic Botany.—The genus name *Taxus* is from the Greek word, taxos, for yew. Approximately eight species of *Taxus* are recognized, and all of them are similar morphologically, even though they are well-separated geographically (Hils 1993). Canada yew is the only native yew throughout its range. However, it can be confused with two other yew species--English yew (*T. baccata* L.) and Japanese yew (*T. cuspidata* Sieb. & Zucc.)--and a hybrid between them, (*T. media* Rehd.) that occasionally escapes from cultivation. Canada yew can be distinguished from these by its low-growing, straggling nature. Immature saplings are unidentifiable to species. Canada yew has 2n = 24 chromosomes (Hils 1993).

Ecology.—Canada yew, a slow-growing species, is tolerant of shade, which gives it a competitive advantage over other species with which it must compete. It grows best in at least partial shade (Sullivan 1993). Canada yew is found in rich soil in a variety of habitats including bogs, swamps, and rocky banks at elevations up to 1,500 m. It prefers soils that are well-drained and that have pH's between 5.0 and 7.5. The climate is humid and cool. Exposure to winds from the ocean is not tolerated. The species grows in many forest associations and is taken as an indicator of old-growth forest. It does not occur in seral communities. Canada yew is apparently easily killed by fire. Wildfires and other influences that open the forest canopy reduce the competitive ability of the species (Sullivan 1993).

Reproduction.—Canada yew flowers in April and May and is wind pollinated. Individual plants are not self-fertile (Plants For a Future 2003). It produces seed almost every year (Sullivan 1993). The seeds mature in late summer and autumn. There are 33,000 to 62,400 seeds/kg (Rudolf 1974). The seeds are dispersed by birds (Sullivan 1993). Canada yew spreads vegetatively by layering (Rook 1998). The connections between plants of a clonal group usually rot away (Sullivan 1993). Small plants tend to be males and browsing and other stresses on a population tends to increase the proportion of male plants in the population (Sullivan 1993).

Growth and Management.—Canada yew is slow growing (Public Forest Council 2003). It is the hardiest of all yew species; however, it is the least attractive yew species used as an ornamental due to its low-growing, straggling habit (Rehder, 1940). The species may be propagated with seeds and by cuttings of half-hardened or hardened terminal shoots that root with good success (Plants For a Future 2003). Warm stratification for 4 months followed by 4 months of cold stratification are suggested to promote more rapid germination of seeds (Dirr and others 1987). Seeds may be sown in nursery beds in the fall and covered by 10 to 12 mm of mineral soil topped by mulch. However, fall-sown seeds usually germinate the second spring (Rudolf 1974). Seedlings should be transplanted while still small. However, they are slow growing and they must be maintained for 2 years in nursery beds or pots at a minimum. Seedlings should be outplanted in late spring or early summer after the last frost has occurred. Established plants will tolerate pruning (Brand 2003).

Benefits.—Canada yew is an important component of the forest understory in Northeastern forests, helping to protect the soil and imparting beauty to forest landscapes. The species is used as an ornamental for ground cover and mass plantings, and for parental stock in yew breeding (Sullivan 1993). The toxic compound that is present in the plant is the alkaloid taxine (Kingsbury 1964). The seeds and the dried foliage have been fatal to livestock, but the fresh foliage is browsed by deer (Fernald 1950, Hils 1993). Moose also browse the species and have seriously reduced Canada yew abundance on Isle Royale, Michigan, since their introduction. The fleshy aril is eaten by numerous species of birds (Sullivan 1993). The pulp of the arils is sweet and edible to humans (Fernald 1950) but has a slimy texture (Soper and Heimburger 1982). A number of Native American groups made decoctions of leaves and twigs to treat rheumatism. Infusions and decoctions were also used to treat numbness of fingers and legs, colds, gonorrhea, and as a diuretic (Moerman 1986). New foliage and green stems are commercially harvested for the extraction of paclitaxel (Public Forest Council 2003). Paclitaxel is a white crystalline powder extractable from any of the *Taxus* species. It is a cytotoxic anticancer drug used to treat ovarian, breast, and lung cancers, and Kaposi's sarcoma (SFT Enterprise 2003).

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***Tecoma stans* (L.) Juss. ex Kunth** ginger-thomas
BIGNONIACEAE

Synonyms: *Bignonia stans L.*
Gelseminum stans (L.) Kuntze
Stenolobium stans (L.) Seem.

John K. Francis

Illustration source: USDA-Forest Service collection, Hunt Institute

General Description.—Ginger-thomas, also known as roble amarillo, saíco amarillo, bois caraîbe, trumpet flower, yellow-elder, and many other common names (Little and Wadsworth 1964), is a medium-sized shrub with many branches and basal stems. The leaves are opposite, pinnately compound with 5 to 13 saw-toothed leaflets. The twigs are green, turning brown, and the older bark is light gray and very furrowed. A profusion of bright yellow flowers has made the species much loved throughout the tropics. Ginger-thomas is the official flower of the U.S. Virgin Islands.

Range.—The native range extends from southern Texas, New Mexico, and Arizona to Bolivia and northern Argentina and from Florida and the Bahamas to Trinidad in the Caribbean. It has naturalized in much of tropical and subtropical Africa, Asia, the Pacific islands, and Australia.

Ecology.—Ginger-thomas does not tolerate heavy frost. However, it will grow in most well-drained soils, including calcareous fill, infertile sands, acidic Ultisols, and volcanic regolith in areas receiving from 700 to 1800 mm of rainfall. The species is described as a water spender that is able to convert to a water saver (Tipton 1994). It requires minimal competition and nearly full sunlight to survive (shade intolerant). Roadsides and disturbed areas are the most common habitats. Given a start in secondary forest, it is usually present for only 10 to 20 years following disturbance. Many species of insects feed on ginger-thomas, and it is attacked by the genera of parasitic plants, *Cuscuta*, and a number of disease organisms; but, nothing seems to pose a serious threat to the species.

Reproduction.—Ginger-thomas produces flowers that have functional male and female parts. The tubular flowers are fragrant, 4 to 5 cm in length, and pollinated by bees and other insects and hummingbirds. The 10- to 25-cm pods (capsules) develop in about 1 month and liberate large numbers of papery-winged seeds. The species may flower and fruit nearly throughout the year (Little and Wadsworth 1964) in climates without strong seasonal change, or flower heavily in autumn in seasonal climates such as southern Florida. Developing pollen becomes sterile when temperatures rise above 34 °C. This leads to seed failures during summer months in many areas (Kumar and Singh 1988). Natural reproduction may vary from dense to scattered. In nurseries, ginger-thomas is usually propagated from seed, although greenwood cuttings can also be rooted (Baily 1941). A collection of seeds from Puerto Rico averaged 208,000 seeds/kg. Germinating began in 3 days and finished with 97 percent germinated (Francis and Rodríguez 1993). No pregermination treatments are necessary.

Growth and Management.—Early growth is relatively rapid. About 1 m of height growth can be obtained during the first year. Depending on the environment, maximum height of plants may vary from 1.5 m to 7 m, and diameters of 8 cm are sometimes achieved. Establishment activities may include removal of competition and disturbance of the soil to encourage natural regeneration, planting (more reliable for smaller numbers of plants), and control of competing vegetation. When control of ginger-thomas is needed, cutting, grubbing out stumps, or poisoning is recommended. In Brazil, tebuthiuron was found to effectively kill plants, but picloram and 2, 4-D were not (Passini and Kranz 1997).

Benefits.—Ginger-thomas is planted as an ornamental throughout the topics and subtropics. It is especially prized as a flowering hedge plant. The shrub is planted and managed to enhance the beauty of green belts and natural forests used for recreation. Used in combination with trees, ginger-thomas contributes to effective windbreaks and sound breaks. Growing in thick patches that shade out grass, the species has become a serious weed in Brazilian pastures (Kranz and Passini 1997). Browsing cattle and goats in Mexico consume up to 20 percent of the leaves and 100 percent of the available flowers (Susano Hernandez 1981). The foliage in one study in India contained 17 percent crude protein, 6 percent ash, 18 percent fat, 25 percent fiber, and 14 percent total polyphenols (Nag and others 1994). Ginger-thomas leaves, bark, and roots contain many biologically active chemicals, and extracts from those tissues have been used in traditional folk medicine to treat many diseases and conditions (Liogier 1990). Perhaps the most promising compounds are monoterpine alkaloids, which have been shown to effectively reduce the symptoms of diabetes mellitus in rats, dogs, and mice (Aguilar and others 1993, Lozoya-Meckes and Mellado-Campos 1985, Perez and others 1984)

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Tetrapterys inaequalis Cav. bejuco de paralejo

MALPIGHIACEAE

Synonyms: *Tetrapteris citrifolia* (Sw.) Pers.
Banisteria bracteata DC.
Triopteris citrifolia Sw.
Tetrapteris paniculata Bello

John K. Francis

General Description.—Bejuco de paralejo, also known as brjuco de sopla and aile à ravet, is a woody vine or climbing shrub that may extend 15 m laterally and reach 10 m into the crowns of trees, with stems as thick as 8 cm. The root system is superficial, especially roots arising from layered stems. The stems are cylindrical, smooth, and have rings at the nodes. The wood is moderately hard and has growth rings. The stems tend to be long and little branched except near the extremities. The simple, opposite ovate or elliptical leaves have petioles 1 to 1.5 cm long, and blades 5 to 17 cm long and 5 to 8 cm broad, rounded to cordate at the base and pointed at the tip. Inflorescences are panicles of four-flowered cymes flanked by leaves of reduced size that often shrivel as the fruits mature. The five-merous, yellow-petaled flowers are about 2 cm in diameter. The fruits consist of four samaras united at the base. Each has an upper lateral wing 17 to 28 mm by 6 to 10 mm and a lower lateral wing about half as large and a medial ridge protruding about 1 mm (Acevedo-Rodríguez 1985, Howard 1988, Liogier 1988).

Range.—The range of bejuco de paralejo includes Puerto Rico and the offshore island of Vieques, St. Thomas, and St. Croix in the U.S. Virgin Islands, Antigua, Guadaloupe, Martinique, and St. Vincent (Howard 1988). This differs from Liogier (1988) and Acevedo-Rodríguez (1985) who use the synonym *T. citrifolia* and add Jamaica, Hispaniola, and Tobago to the range. Howard states: "The flowering specimen from Tobago that Niedenzu called *T. citrifolia* is almost certainly *T. discolor* (G. Meyer) DC. ...Niedenzu considered [*T. inaequalis*] a synonym of *Tetrapterys citrifolia* (Sw.) Pers. They are certainly closely related, both belonging to the difficult group called Section *Lophogynixa* by Niedenzu. However, *T. citrifolia* from Jamaica, the type locality, has a well-developed dorsal wing on the samara and young stems that are tightly sericeous with straight appressed hairs. These differences lead me to consider *T. citrifolia* endemic to Jamaica and apply the later name *T. inaequalis* to the plant of Puerto Rico and the Lesser Antilles. ...The species of the Lesser Antilles seems not to occur on Hispaniola..." In their latest checklist, Liogier and Martorell (2000) now concur with Howard.

Ecology.—Bejuco de paralejo colonizes a wide range of soils derived from both sedimentary and igneous rocks. It requires mean annual rainfall of from about 1200 to about 2500 mm. The species grows at elevations between 110 and 500 m in the Lesser Antilles (Howard 1988) and from a few meters above sea level to 600 m or more in Puerto Rico. Bejuco de paralejo does not tolerate shade well. It will survive and grow slowly in light shade but requires full or nearly full sunlight to flower and fruit. The species may be found on roadsides, along rivers, in brushy pastures, early secondary forests, and clearings in secondary and remnant forests.

Reproduction.—Bejuco de paralejo usually flowers in Puerto Rico in October and November and fruits in July to October (Acevedo-Rodríguez 1985). Howard (1988) notes collections in the Lesser Antilles with flowers and fruits in every month except May and June. Hundreds of seeds can be produced by a large plant. Air-dried samaras from Puerto Rico collected by the author in April averaged 0.0953 $\pm$ 0.0014 g/fruit. Planted on commercial potting mix without any pretreatment, 79 percent germinated between 34 and 82 days after sowing. Samaras spiral sideways a few meters from fruiting adult plants. While young plants are relatively common in many areas; fruiting plants are relatively rare. Layering (rooting in contact with the ground) is common and appears to be an important means of perpetuating established plants.

Growth and Management.—Bejuco de paralejo vines extend rapidly from sprouts. A large vine (7.7 cm in diameter) cut by the author had 27 growth rings. Although large plants are capable of smothering small trees, the species causes few problems. No planting or management experience has been published.

Benefits.—Bejuco de paralejo contributes to the biodiversity of forests, helps protect the soil, and furnishes cover for wildlife.

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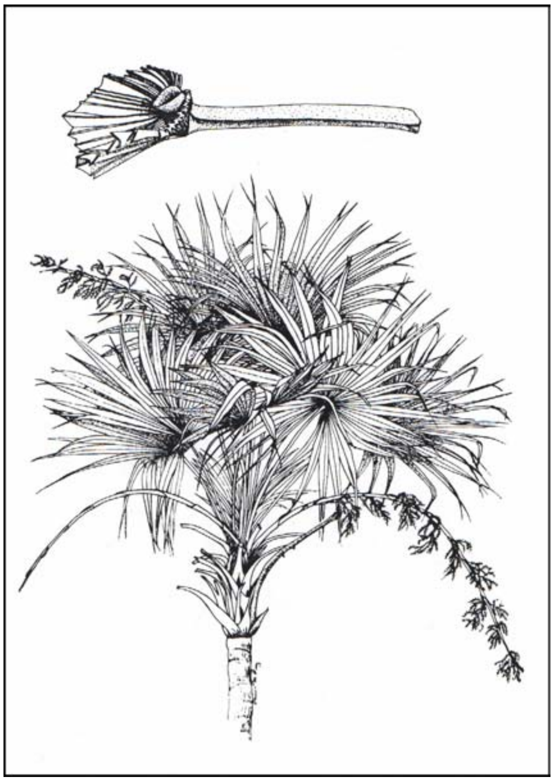
***Thrinax morrisii* H. Wendl.** brittle thatch palm

ARECACEAE

Synonyms: *Sampsonia microcarpa* (Sarg.) O.F. Cook
Thrinax keyensis Sarg.
Thrinax microcarpa Sarg.
Thrinax ponceana O.F. Cook
Thrinax praeceps O.F. Cook

John K. Francis



General Description.—Brittle thatch palm is also known as Key thatch palm, small-fruited thatch palm, broom palm, buffalo-tip, palma de escoba, yaray, pandereta, palma de petate, palma de cogollo, guano de sierra, miraguano, and palmita. It is an evergreen, single-stemmed shrub or small tree 1 to 6 m in height. Although most plants in natural stands do not live long enough to develop a discernable stem, when formed, it is brown or gray, 7 to 13 cm in diameter at breast height, with many vertical cracks and prominent leaf scars in the clean portion, covered with old leaf bases near the top, and thick with rootlets at the base. Brittle thatch palms maintain about 20 fan-shaped, pale blue-green or yellow-green leaves, spirally arranged on the trunk. The petioles are 27 to 84 cm long, split at the base. There are deeply incised leaf segments 33 to 75 cm long and 2.3 to 4.8 cm broad. The inflorescences (spadixes or panicles) are 55 to 100 cm long, arching or straight and usually extend beyond the leaves. Small, white flowers are borne in large numbers. The fruits are white (turning yellow at maturity) drupes, 3.5 to 8 mm in diameter, containing one hard, spherical seed 2.7 to 4.2 mm in diameter. Chromosome number is 2n = 36 (Gilman and Watson 1994, Howard 1979, Little and others 1974, Long and Lakela 1976, Nelson 1996)

Range.—Brittle thatch palm is native to southern Florida, the Bahamas, Cuba, Hispaniola, Puerto Rico, the Virgin Islands, Anguilla, and Barbuda (Howard 1979, Little and others 1974). It is considered endangered in Florida (Institute of Systematic Botany 2002). The species is planted as an ornamental within and outside its natural range (Hoyos-F. and Braun 2001, Little and others 1974) but has not been reported to have naturalized.

Ecology.—Brittle thatch palm grows in sites where it suffers a minimum of competition. It grows along the edges of hammocks and in pinelands in the Florida Keys (Nelson 1996). In Puerto Rico, it grows primarily on cliffs, and ridges of dry and moist limestone and ultramafic rocks at elevations from near sea level to 300 m (Little and others 1974). The soils are sands, or are loams or clays shallow over fractured rocks. Brittle thatch palm is moderately intolerant of shade. It occurs singly, in small groups or in nearly pure thickets in the open, in small openings, or under open stands, usually of low trees. The species can withstand temperatures as low as -4 °C (Deserttropicals 2002), is tolerant of drought and salt spray, and resists breakage in storms (Gilman and Watson 1994).

Reproduction.—Brittle thatch palm in natural stands flowers seasonally or irregularly in response to favorable conditions in Puerto Rico (Little and others 1974) and flowers in the spring in Florida (Gilman and Watson 1994). The flowers are insect pollinated. A collection of seeds in Puerto Rico averaged 0.0396 $\pm$ 0.0007 g/seed or 25,000 seeds/kg. Sown without pretreatment on moist blotter paper, 85 percent germinated in 17 months (author's observation). The seeds are reported to begin germination 50 to 70 days after sowing (Hoyos-F. and Braun 2001). The seeds can stand storage at -40 °C and 66 °C for at least 1 week without loss of viability (Broschat and Meerew 2000). Because seeds have such a long dormant period, they can be collected by hand from plants or from the ground at almost any time of the year. The seeds are dispersed by animals. Surviving seedlings are not usually common, but the plants are long-lived and populations can build to high levels.

Growth and Management.—Brittle thatch palm is slow growing. A specimen in the Fairchild Tropical Garden, Florida was 42 years old and 1.16 m in height (Zona and Maidman 2000). Plants mature and begin flowering and fruiting with only a rosette of basal leaves, long before they develop a discernable stem. Plants with long stems are uncommon and are probably more than 50 years old. Wildland plantings are not documented but presumably could be done with container stock. Either they must be established in poor sites where few other species will grow, or weed protection must be given almost in perpetuity. Management of existing stands should consist mainly of protection from fire, development, or heavy grazing.

Benefits.—Brittle thatch palm helps protect the soil, contributes to the aesthetics of natural stands, and furnishes food and cover for wildlife. The species is grown and sold as an ornamental. It is used as a container plant and for buffer strips in parking lots and medians on highways as well as background and specimen plantings (Gilman and Watson 1994). Leaves are still used to make brooms, thatch, and mats (called petate) (Osvaldo 2002), although now for ornamentation rather than necessity. The fruit pulp contains 4,083 µg/g of oxalate—capable of causing a burning sensation on the skin of sensitive people—that may reduce its palatability to some species of wildlife (Broschat and Meerew 2000). However, it is eaten in Florida by the introduced Mexican red-bellied squirrel (*Sciurus aureogester* (Cowley 2002) and the eastern box turtle (*Terrapene carolina*) (Liu and others 2002), and in the Bahamas by the Bahamas amazon parrot (*Amazona leucocephala bahamensis*) (Attril 2002).

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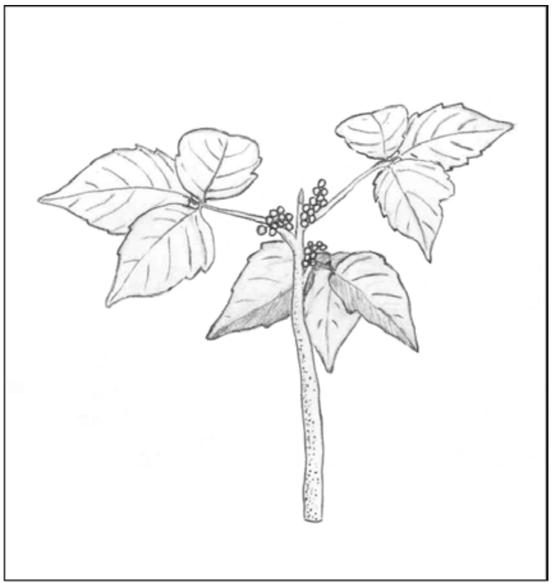
***Toxicodendron radicans* (L.) Kuntze** eastern poison ivy
ANACARDIACEAE

Synonyms: *Rhus radicans* L.
Rhus littoralis Mearns
Rhus blodgettii Kearney
Philostemon radicans Raf.
Toxicodendron blodgettii (Kearney) Greene
Rhus scandens Salisb. (and others: Institute of Systematic Botany 2003)

John K. Francis



General Description.—Eastern poison ivy, also known as climbing poison ivy, common poison ivy, poison ivy, poison vine, and bemberecua, is a deciduous vine or shrub capable of ascending into tree crowns 20 m or more and along the ground for as much as 45 m. The stems sometimes reach 15 cm in diameter. The older stems are brown and covered with brown adventitious roots by which they cling to tree trunks and other surfaces and layer (root) whenever they come in contact with the ground. The small stems are lighter colored and covered with dark brown dots. The alternate leaves have long (to 15 cm) petioles and three ovate to lanceolate leaflets 4 to 20 cm long with entire, coarsely toothed, or lobed margins. Small white or greenish white flowers grow in axillary panicles. Clusters of white or greenish-white drupes 3 to 6 mm in diameter develop later and remain on the vine well after the leaves fall. The leaves are dark green during the summer, turning yellow to red in the fall. The species has 2n = 30 chromosomes (Long and Lakela 1976, Pavek 1992, Secretaría de Madio Ambiente y Recursos Naturales 2003).

Range.—Eastern poison ivy is native to Prince Edwards Island and from Nova Scotia to southern Ontario of Canada, all of the Eastern and Midwestern States of the United States (except for North Dakota), Arizona, Mexico, Guatemala, the Bahamas, Bermuda, China, Taiwan, and Japan (Brooks 2003, Griffiths 1994, Natural Resources Conservation Service 2003, Pavek 1992). The species has been planted as an ornamental and medicinal plant and presumably naturalized in Great Britain, Europe, and Australia (Schwartz 1999).

There are at least seven subspecies of eastern poison ivy. Subspecies *divericatum* occurs in Arizona, ssp. *eximium* ranges from Texas to Guatemala, ssp. *negundo* grows in the Midwestern and Northeastern sections of North America, *pubens* is native to the Southwestern States, ssp. *radicans* ranges across the Southern and Eastern portions of U.S., ssp. *verrucosm* occurs in Texas, Oklahoma, and Missouri, and ssp. *barkleyi* inhabits the Far East portion of the range (Griffiths 1994, Natural Resources Conservation Service 2003).

Ecology.—Eastern poison ivy grows in soils of all textures from nearly all parent materials. Although it grows best in fertile, near-neutral, moist but well drained soils, it tolerates a wide range of fertility, pH, and other conditions. Mean annual precipitation ranges from 391 mm to 1,450 mm in the United States and Canada. It grows from sea level on the Eastern and Gulf Coasts to 2,158 m in elevation in New Mexico. In Florida swamps, it survives inundation by fluctuations in water level and tolerates mildly saline water. An average growing season of 150 days with a mean annual temperature of 5.3 °C occurs at the northern extent of its range. There is an average growing season of 240 days in southern Florida, and a mean annual temperature of 19 °C in Arizona (Pavek 1992). The mean annual temperatures are probably higher, precipitation greater, and growing seasons may approach 365 days in Central America. Eastern poison ivy is moderately tolerant of shade. It is often the most important understory plant, climbs nearly every tree in many Southern river floodplain forests, and is a component of most forest and vegetation types in its ample range. It also grows in full sunlight in forest openings, fencerows, bluffs, railroad tracks, and vacant lots. Eastern poison ivy grows in old-growth forests in some portions of its range and is an early invader during succession in many environments. It is tolerant of fire, browsing, insects, and disease, and competes aggressively with weeds and brush.

Reproduction.—Eastern poison ivy blooms from May through June in Virginia (Von Essen 2000) and from March through May in Mexico (Secretaría de Madio Ambiente y Recursos Naturales 2003). The start of flowering corresponds with leaves being about half formed in the spring (Pavek 1992). The flowers are pollinated by insects, including honey bees (*Apis mellifera* L.) (Pollen Lab 2003). Good crops of fruits and seeds are produced annually. Seeds are dispersed by birds and mammals and sometimes by water. Seeds that have been regurgitated from the crop or passed through the digestive tract of birds demonstrate excellent germination (Pavek 1992). Eastern poison ivy spreads extensively by means of scandent stems that root along their whole lengths and below-ground stems (rhizomes) that send up shoots frequently.

Growth and Management.—Eastern poison ivy grows rapidly after establishment and assumes several forms. It scrambles along the ground and sometimes forms thick mats. When given the opportunity, it ascends trees as a woody vine. Plants take 3 years to reach the flowering stage from seed (Pavek 1992). It often forms diffuse stands of short upright stems. It can be partially controlled by grazing, but there is a resurgence of Eastern poison ivy after secession of grazing because of the reduction in competition. Spot spraying or wiping with the herbicide glyphosate during the active growing season can effectively control it (Pavek 1992). Grubbing and mowing offers some degree of control but puts the worker at risk of contracting dermatitis.

Poison Effects.—The pale yellow oil called urushiol, present in all plant parts, is the source of all the allergenic pain and suffering associated with this species. Even in minute amounts, if it stays in contact with human skin for more than 5 minutes, it will be absorbed and metabolized. The metabolites bind with proteins, forming compounds that the immune system recognizes as "foreign" and attacks. The immune response results in rash, blisters, and an intense itch (Borialforest.org 2003) that lasts for 1 to 3 weeks. Sensitivity can vary over the life of a person. A few people have life-threatening reactions to the allergen (Schwartz 1999). The chemical is the same and the effect (called rhus dermatitis) is the same for all *Toxicodendron*s. Ten to 15 percent of the U.S. population is completely immune to rhus dermatitis, 25 to 35 percent react only to high doses, and 50 percent have a consistent reaction to relatively small doses of the allergen (Family Practice Notebook.com 2003). The best defense is to avoid contact with the plant, especially with the sap or smoke from burning *Toxicodendron* material. The next line of defense is to quickly wash the exposed skin with soap and copious amounts of water, or if not available, with mud and water or an alkaline material such as baking soda or wood ashes and water. After a rash develops, the sufferer is advised to apply hydrocortisone cream or any of several creams sold over-the-counter for the treatment of rhus dermatitis. A folk remedy mentioned in the literature (Felter 1922) and found by the author to almost instantly and completely (but temporarily) stop the itch and irritation of rhus dermatitis is to rub the mashed juicy stems of jewel weed (*Impatiens spp.*) on the affected area.

Benefits.—Eastern poison ivy, for its dark green foliage during the summer and bright fall colors, adds considerably to the beauty of forests and shrublands where it grows. It has been used to a limited extent as an ornamental and for conservation plantings. Eastern poison ivy is an important browse species. It is one of the seven most important food species for white-tailed deer in Indiana (Pavek 1992). Goats are said to like eastern poison ivy and have been used to control it (Schwartz 1999). The fruits are an important fall, winter, and early spring food for upland game birds and many species of song birds (Pavek 1992). Rabbits and rodents also eat the leaves and fruits. In herbal medicine, extracts of the leaves have been and still are used to treat herpetic eruptions, palsy, and rheumatism. Small internal doses will act as a sedative but must be used with care (Felter 1992, Grieve 2003).

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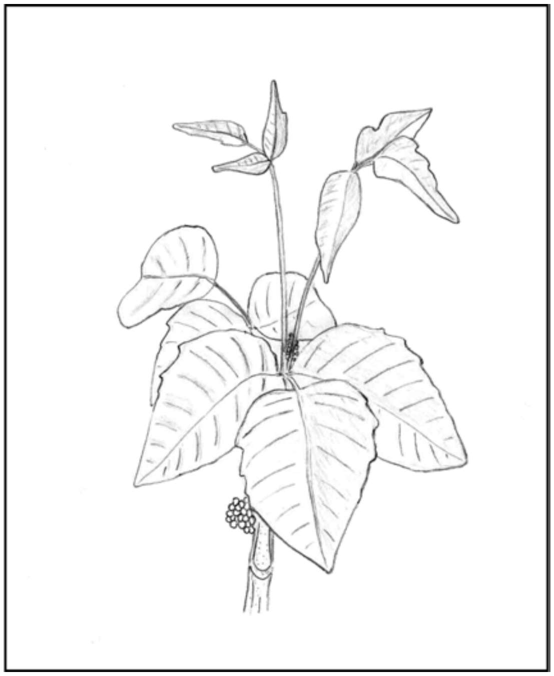
***Toxicodendron rydbergii* (Small ex Rydb.) Greene** western poison ivy
ANACARDIACEAE

Synonyms: *Rhus radicans* L. var. *rydbergii* (Small ex Rydb.) Rehd.
Rhus radicans L. var. *vulgaris* (Small ex Rydb.) Rehd.
Rhus toxicodendron L. var. *vulgaris* Michx.
Toxicodendron desertorum Lundell

John K. Francis



General Description.—Western poison ivy, also called poison oak, poison ivy, and Ryberg's poison ivy, is a deciduous, normally upright shrub, occasionally a scrambling vine, usually 20 to 100 cm in height with stems 4 to 10 mm in diameter. The woody stems, which arise from underground stems that extend up to 2 m from the parent plant, are sparingly branched and have smoothish, brown to gray bark, with dark brown lenticels, and wooly, brown, winter buds. The alternate, bright-green leaves are trifoliate with long petioles. Leaflets are ovate to rhombic, 3 to 15 cm long, the lateral leaflets usually somewhat oblique and shorter than the central leaflet. Leaflet margins are lobbed, rounded-dentate, or entire. Small yellowish flowers are grouped in dense axillary panicles. The fruits, which remain attached throughout the winter, are ivory-colored, globose drupes 4 to 6 mm in diameter and contain one seed each. There are 2n = 30 chromosomes (Lasica 2002, St. John 1963, Welsh and others 1987). Western poison ivy is similar in appearance to eastern poison ivy [*T. radicans* (L.) Kuntze] except that it is a shrub and rarely and weakly climbs. It is known to hybridize with eastern poison ivy (Rook 1998).

Range.—Western poison ivy is native across southern Canada from Nova Scotia to British Colombia and throughout the United States except California and New Jersey and from Missouri, Kentucky, and South Carolina southward (McMurray 1988, Natural Resources Conservation Service 2003). Although it has been planted outside its natural range (botanic gardens, etc.), there are not reports of it escaping.

Ecology.—Western poison ivy grows on a wide range of sites--on river bottoms, streambanks, disturbed upland sites such as roadsides, fencerows, sand dunes, logged areas, orchards, talus slopes in subalpine areas, and around seeps and on shaded canyon sides in cold desert areas. It grows from 600 to 2,500 m elevation in the interior West and probably near sea level in coastal areas. It tolerates short-term flooding. The species grows in both full sun and under forest canopies. It colonizes all soil textural types derived from most parent materials with pH's from mildly acid to mildly alkaline. Western poison ivy often grows on skeletal soils, rocky slopes, and cliff sides. The species invades quickly after disturbance. Bare mineral soil is the best surface for seed germination and seedling establishment (Moye 1999). It often forms clonal thickets. Western poison ivy tolerates fire well by sprouting from underground stems but does not increase in density as a result (McMurry 1988, Welsh and others 1987).

Reproduction.—Flowering occurs in late spring through early summer. Plants on the Great Plains sometimes flower a second time in August or September (McMurry 1988). Good fruit and seed crops occurs almost every year. The seeds are dispersed by birds, mammals, and gravity.

Seedlings are necessary to establish new colonies but vegetative (by sprouts from underground stems) reproduction is more important for local spread.

Growth and Management.—Western poison ivy grows at a moderate rate. Clones are relatively stable over time. Although it is not as invasive as eastern poison ivy, it is often desirable to eliminate it from areas of heavy human use. Spot spraying or wiping with the herbicide glyphosate during the active growing season can effectively control eastern poison ivy (Pavek 1992) and probably will be effective for western poison ivy. Grubbing and mowing offers some degree of control but puts the worker at risk of contracting dermatitis so that protective clothing should be worn during the operation. Branches and roots should be piled to rot in an out-of-the-way place or bagged and sent to the landfill, never burned.

Poison Effects.—The pale yellow oil called urushiol, present in all plant parts, is the source of the allergenic pain and suffering associated with this species. If even a minute amount (nanograms) the oil stays in contact with human skin for more than 5 minutes, it will be absorbed and metabolized. The metabolites bind with proteins, forming compounds that the immune system recognizes as "foreign" and attacks. The immune response results in rash, blisters, and an intense itch (Borialforest.org 2003) that lasts for 1 to 3 weeks. Sensitivity can vary over the life of a person. A few people have life-threatening reactions to the allergen (Schwartz 1999). The chemical is the same and the effect (called rhus dermatitis) is the same for all *Toxicodendron*s. Ten to 15 percent of the U.S. population is completely immune to rhus dermatitis, 25 to 35 percent react only to high doses, and 50 percent have a consistent reaction to relatively small doses of the allergen (Family Practice Notebook.com. 2003). The best defense is to avoid contact with the plant, especially with the sap or smoke from burning *Toxicodendron* material. The next line of defense is to quickly wash the exposed skin with soap and copious amounts of water, or if not available, with mud and water or an alkaline material such as baking soda or wood ashes and water. After a rash develops, the sufferer is advised to apply hydrocortisone cream or any of several creams sold over-the-counter for the treatment of rhus dermatitis. A folk remedy mentioned in the literature (Felter 1922) and found by the author to almost instantly and completely (but temporarily) stop the itch and irritation of rhus dermatitis is to rub the mashed juicy stems of jewel weed (*Impatiens spp.*) on the affected area.

Benefits.—Western poison ivy helps protect the soil and adds beauty in the summer with its dark green leaves and in autumn with bright colors to forest and shrublands. Although it causes browsing animals no ill effects, western poison ivy is low in protein and energy and consequently is only occasionally grazed by domestic animals and wild ungulates. However, the fruits are eaten by quail, wild turkeys, and some songbirds. It does provide cover for small mammals and birds (McMurray 1988). In herbal medicine, extracts of the leaves of this and other *Toxicodendron* species have been and still are used to treat herpetic eruptions, palsy, and rheumatism. Small internal doses will act as a sedative but must be used with care (Grieve 2003).

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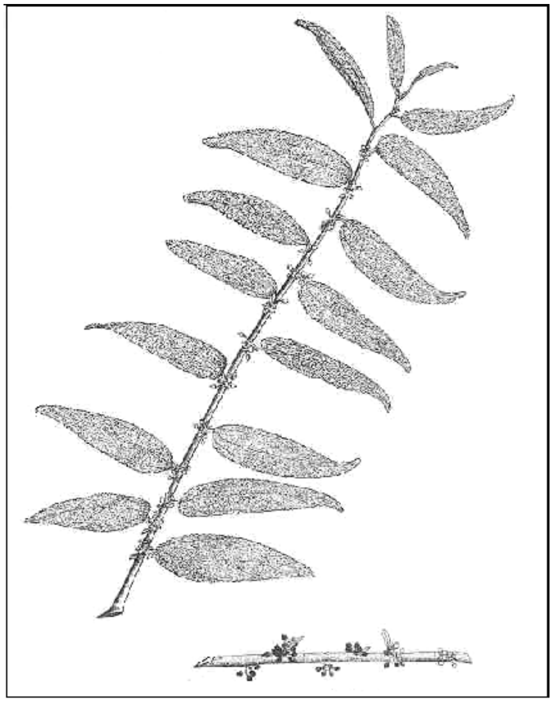
***Trema lamarckianum* (J.A. Schultes) Blume** West Indian trema
ULMACEAE

Synonyms: *Celtis lamarckiana* Roem. & Schult.
Sponia lamarckiana (Roem. & Schult.) Decne.
Celtis lima Lam.
Trema lima authors, not Blume

John K. Francis



General Description.—West Indian trema, also known as Lamarck trema, pain-in-back, cabrilla, memizo de majagua, capulí cimarrón, and orme petites feuilles, is an evergreen shrub or small tree to 8 m in height and 20 cm in diameter at breast height. The plant is supported by a system of tan-colored, stiff, but flexible, tap, lateral, and fine roots. There is usually a single main stem. It is covered by smoothish, light brown to gray bark with many tiny warty lenticels over a light brown to pinkish, fibrous inner bark. The species has a monopodial branching pattern, in which the main stem produces a continuous progression of fine lateral branches (Massey and Murphy 1996) some of which may thicken and become major branches in older plants. The alternate leaves, which are attached to twigs by petioles 8 to 10 mm long, have ovate-lantiolate, green to gray-green blades that are rough on both surfaces and have fine-toothed edges. The 2-mm diameter, greenish flowers are clustered at the leaf axils. The fruits are rounded, fleshy, 1- to 3-mm pink drupes. The fruits have little flavor and each contain one brown seed (Howard 1988, Liogier 1985, Little and Wadsworth 1964).

Range.—West Indian trema is native to Florida, Bermuda, the Bahamas, Grand Cayman, and the Greater and Lesser Antilles south to St. Vincent (Liogier 1985, Little and Wadsworth 1964).

Ecology.—West Indian trema is a pioneer species. It colonizes disturbed sites on a wide variety of soil types over both sedimentary and igneous rocks. It is especially common in ultramafic (serpentine) areas. Areas in Puerto Rico with West Indian trema populations receive annual rainfall ranging from about 1200 to about 3000 mm at elevations ranging from a few meters above sea level to about 900 m. The species is intolerant of shade and usually grows in areas with a sparse to moderate cover of herbs, shrubs and trees. It does not grow under a closed forest canopy. Common sites are road cuts and fill, abandoned roads, unstable slopes, landslides, mechanically disturbed sites, and hammocks (author's observation, Long and Lakela 1976).

Reproduction.— After West Indian trema reaches about 1 m, it flowers and fruits continuously throughout its life. During periods of favorable moisture, plants produce fruits and seeds in large numbers. A collection of fruits from Puerto Rico weighed an average of 0.0077 $\pm$ 0.0001 g/fruit. Air-dried seeds cleaned from them averaged 0.0024 $\pm$ 0.0000 g/seed or 416,000 seeds/kg. Placed in commercial potting mix, 38 percent of the seeds germinated between 60 and 120 days after sowing. Birds disperse the seeds. Seedlings are common on disturbed ground near seed-bearing plants. Young plants sprout when cut.

Growth and Management.—Early seedling growth is slow. Later, growth reaches about 1 m/year, slowing as the plants get old. West Indian trema lives about 10 to 20 years. The species has not been reported as weedy. Reproduction probably can be promoted by scarifying the soil near seed-bearing plants before the start of seasonal rains.

Benefits.—West Indian trema is an important colonizer of disturbed areas and helps protect the soil from erosion. It has not been used for, but might be useful for, site stabilization plantings. West Indian trema is listed as a nitrogen-fixing species (Winrock International 2002). The wood is soft and seldom used. The fruits are one of the most important foods of the endangered Puerto Rican plain pigeon, *Columba inornata wetmorei* (Division of Endangered Species 2002).

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***Trichilia hirta* L.** broomstick
MELIACEAE

Synonyms: *Trichilia spondioides* Jacq.
Trichilia wawrana antillana C. DC.

John K. Francis

General Description.—Broomstick is also known as broomwood, cabo de hacha, garbancillo, guaita, jojobán, jabillo, molinillo, palo de anastasio, retamo, canalete, conejo colorado, mata piojo, carrapeta, and mombin bâtard. It is an evergreen to semideciduous shrub or small tree ranging in mature height from 3 to 15 m in different parts of its range. The shrubs usually grow with a single stem in closed stands but often have multiple stems when open-grown or when they have been damaged. The bark is brown or gray, rough and lightly furrowed or scaly. Sapwood is yellowish white, and the heartwood is reddish brown with darker streaks. Twigs are green, becoming brown with age. The plants are supported by a tap and extensive lateral root system of flexible, somewhat brittle roots with thin, reddish-brown bark. The alternate leaves are pinnately compound, 20 to 35 cm in length with nine to 21 ovate to lanceolate leaflets. The inflorescences are unisexual axillary racemes. However, these plants are dioecious. The flowers are small and greenish white. The two- to four-chambered capsules split open to expose one or two seeds per chamber. The 6- to 8-mm ovular seeds are covered by a thin, scarlet to orange aril (Howard 1988, Liogier 1988, Little and Wadsworth 1964, Stevens and others 2001).

Range.—Broomstick is native to the West Indies and from Mexico through Central America to Brazil and Bolivia in South America (Killeen and others 1993, Little and Wadsworth 1964). It has been planted in southern Florida (Little and Wadsworth 1964).

Ecology.—Broomstick is relatively common and widely scattered through most of its range. It does not form stands but tends to be scattered in open forests, roadsides, brushy pastures, and disturbed areas. Although the species is found in primary remnants, it is more common in secondary forests, usually with low basal areas. Broomstick may be found in Puerto Rican forests that receive from 750 to about 1700 mm of mean annual precipitation at elevations from near sea level to 600 m. It grows in Nicaragua in deciduous to moist forests from 0 to 1,000 m elevation (Stevens and others 2001). Broomstick is reported in mountain rainforests up to 3,000 m in elevation in Bolivia (Killeen and others 1993). Although the species grows on a wide range of soil types, it is more often seen on rocky and infertile sites where competition is less severe. Broomstick can grow in partial shade but requires good overhead sunlight to flower and fruit.

Reproduction.—Broomstick flowers and fruits throughout most of the year (Little and Wadsworth 1964). The species is reported to flower from March through May and fruit from January through April in Nicaragua (Stevens and others 2001) and flowers from May through July in Panama. The flowers are insect pollinated (Center for Tropical Forest Science 2002). Plants receiving ample sunlight can produce several hundred seeds per year. A collection of fresh fruits from Puerto Rico weighed an average of 0.129 $\pm$ 0.0019 g/fruit. Surface-dry seeds separated from them weighed an average of 0.0891 $\pm$ 0.0020 g/seed or 11,000 seeds/kg. Sown without pre-treatment on moist blotter paper, 100 percent of them germinated between 17 to 232 days after sowing. Germination is hypogeal, and they appear to be recalcitrant (lose viability if dried beyond a certain point) (author's observation). In Panama, the seeds are animal-dispersed (Center for Tropical Forest Science 2002). In Puerto Rico, seedlings are relatively common but only an occasional individual lasts more than a few weeks or months.

Growth and Management.—Broomstick in Puerto Rico appears to have a moderate growth rate and to live about 10 to 30 years. Management information is not available.

Benefits.—Broomstick adds to secondary forest biodiversity, helps protect the soil, and furnishes food and cover for wildlife. The species is used to a limited extent for landscaping and is considered a honey plant. The wood is of medium density (specific gravity 0.5), moderately hard and somewhat brash, and is resistant to attack by dry-wood termites (*Criptotermes brevis* (Walker)). Another source lists the wood density as 0.48 to 0.96 at 12 to 15 percent moisture content (World Agroforestry Centre 2002). It has been used for oars, broom handles, and rustic furniture; today the wood is mainly used for fuel, stakes, and fence posts (Little and Wadsworth 1964). An infusion of leaves, flowers, and roots has been used as a treatment for skin ulcers and as an emetic that has the unfortunate side effect of causing abortions and bleeding. Young branches were strewn on floors to control fleas and lice (Núñez Meléndes 1982).

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***Trichostigma octandrum* (L.) H. Walt.** hoop vine
PHYTOLACCACEAE

Synonyms: *Rivinia octandra* L.
Rivinia humilis var. *scandens* L.
Rivinia scandens (L.) Miller
Trichostigma rivinoides A. Rich. in Sagra
Villamilla octandra (L.) Hook. f. in Benth. & Hook.

John K. Francis

General Description.—Hoop vine, which is also known as basket wiss, bejuco de paloma, bejuco de nasa, bejuco de palma, murette, liane à barriques, and liane à terre, is a scrambling shrub that may extend 10 m laterally or 6 m up into the crowns of trees and develops stems with diameters of 5 to 15 cm. These plants produce weak taproots, extensive lateral roots and many fine roots. The stems are gray, cylindrical, smooth, and relatively stiff. Older plants often have several branches near the base and then few branches until near the growing tips. Young branches of hoop vine are cylindrical, slender, and covered with elongated lenticels. The leaves are alternate, elliptic to lanceolate, 5 to 15 cm long and 1.5 to 6 cm broad. The petioles and young leaves are reddish. The inflorescence is a many-flowered raceme about 15 cm long, often terminal on a leafless stem. The flowers are about 10 mm across, greenish-white, becoming red as the fruits develop. Hoop vine fruits are elliptic, about 5 to 6 mm in diameter, and purple to black when fully ripe. They have little flavor but leave a slightly unpleasant aftertaste. The seeds are 4 to 5 mm in diameter, black, and shiny (Acevedo-Rodríguez 1985, Howard 1988, Liogier 1985).

Range.—Hoop vine is native to southern Florida, throughout the West Indies, and from Mexico to northern Argentina (Anonymous 2002, Howard 1988, Liogier 1985). Although relatively common in most other areas, the species is listed as critically endangered in Florida (Gann and others 2001).

Ecology.—Although hoop vine has no specialized climbing structures, it often ascends into the lower and mid-crowns of trees. The shrub also covers windfalls, fences, rocks, and forms mounds of tangled stems to 2 m high in open areas. Hoop vine grows on soils of all textures in a wide range of pH's derived from both igneous, metamorphic (including ultramafics) and sedimentary (including limestone) rocks. In Puerto Rico, the species occurs in areas receiving from 900 mm to 2400 mm of precipitation. In Costa Rica, herbarium specimens have been collected from near sea level to 1,100 m in elevation (Anonymous 2002). Hoop vine is moderately intolerant of shade. It invades early successional forest and continues at least into the late secondary forest stage, and also occurs in remnant forests, especially in tree-fall gaps and on the edges of natural openings. In farms and urban areas, the species grows on roadsides, fencerows, woodlots, brushy pastures, brushy vacant lots, and stream bottom galleries.

Reproduction.—In Puerto Rico, hoop vine plants flower from April to August and again in October (Acevedo-Rodríguez 1985). In Costa Rica, herbarium specimens were collected with fruit and flowers from November through June (Instituto Nacional de Biodiversidad 2002). Fruits collected in Puerto Rico weighed an average of 0.178 $\pm$ 0.007 g/fruit. Air-dried seeds separated from them averaged 0.0324 $\pm$ 0.0004 g/seed or 31,000 seeds/kg. Sown in commercial potting mix, 32 percent of these seeds germinated between 10 and 71 days after sowing. Birds apparently disperse the seeds. Natural seedlings are not common. Stems layer (root) whenever they are covered with soil or organic material.

Growth and Management.—Growth of hoop vine is rapid from sprouts, as much as 3 m/year. Established plants appear to live for several decades, about as long as the trees they use for support. No management experience has been published.

Benefits.—The young leaves of hoop vine are cooked and eaten as a vegetable after the cooking water is discarded to remove the bitter flavor (Educational Concerns for Hunger 2002). Both the split stems and the bast fibers of hoop vine are used for making baskets. The stems are also used for making bent furniture and craft items (Ruiz 2002). Juice from the fruits leaves a purple stain on whatever it contacts and may have potential as a natural stain for cloth and crafts. The species contributes to biodiversity and soil stability, and provides food and cover for wildlife. In herbal medicine, the vegetative parts are used as a treatment for heart palpitations, and a powder of the root bark is applied topically to treat colds and water retention (Liogier 1990).

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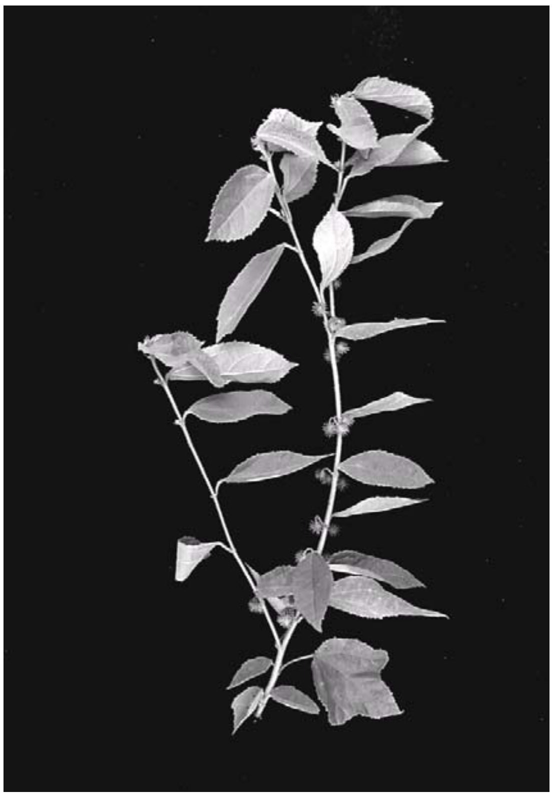
***Triumfetta semitriloba* Jacq.** burweed

TILIACEAE

Synonyms: *Triumfetta hirta* Vahl
Triumfetta ovata DC.
Triumfetta tiliifolia Vahl
Heliocarpus hirta (Vahl) R.O. Williams & Sandw.

John K. Francis



General Description.—Burweed is also known as Sacramento bur, black bush, cadillo de perro, cousin-petit, petit mahot-cousin, mahot-cousin rouge, tête à nègre, and nedyah (Howard 1989, Liogier 1994, Pacific Island Ecosystems at Risk 2001). It is a single-stemmed, short-lived shrub that reaches 1 to 2 m in height and 3 cm in stem diameter. The stems have gray, smooth bark and a woody center. Burweed plants are supported by a weak taproot and many lateral roots. The roots are tan colored, flexible, and have a fleshy outer layer over a woody center. The leaves have petioles from 0.8 to 9.5 cm long, growing progressively shorter toward the plant apex. The leaves, 3 to 8 cm long, are broadly ovate to rhombic-ovate, and sometimes three-lobed, nearly hairless above, but densely stellate-pubescent below. The flowers, which are located at the leaf axils, have yellow petals about 5 mm long. The fruits, round burs 6 to 8 mm in diameter with numerous hooked spines, are borne in groups of two or three. Each fruit has three compartments and contains three seeds, if complete (Howard 1989, Liogier 1994, Long and Lakela 1976).

Range.—Burweed is native to southern Florida, Bermuda, the West Indies, Mexico, Central America, and South America (Howard 1989, Liogier 1994, Long and Lakela 1976). It was thought that burweed had been recently introduced to Rapa Nui (Easter Island), but fossil pollen indicates that it has been present for at least 35,000 years (National Geographic Society 2001). The species has naturalized in Hawaii, Guam, Western Samoa and a number of other Pacific Islands, and in fact is reported to be a pantropical weed (Pacific Island Ecosystems at Risk 2001).

Ecology.—Burweed grows in pinelands and hammocks in Florida (Long and Lakela 1976) and in roadsides, neglected pastures, and wastelands in Puerto Rico. It grows in sand to clay soils with pH values from about 5.5 to 8.0. In Puerto Rico, burweed grows from near sea level to about 700 m in elevation. This diverse habitat receives annual precipitation from about 900 to 2200 mm. In Hawaii, it grows from sea level to 1,067 m in elevation in areas with annual rainfalls of 760 to 1500 mm (Haselwood and Motter 1966). The species needs disturbance for establishment. If given an equal start, it competes well with other herbs, grasses, and shrubs in full sun or partial shade. Burweed may be found growing in small patches and as single, dispersed plants.

Reproduction.—Burweed blooms and fruits continuously (Long and Lakela 1976), beginning at about 6 months of age. Seed production is guaranteed by self-pollination, but cross-pollination increases seed set and probably quality (Collevatti and others 1997a). The species has a chromosome count of 2n = 32 (Long and Lakela 1976). In Brazil, solitary and social bees visit and pollinate burweed (Collevatti and others 1997b). It is an abundant seed producer. Fruits collected in Puerto Rico averaged 0.0040 ± 0.0016 g/fruit. Seeds separated from those fruits averaged 0.0039 ± 0.0001 g/seed or 256,000 seeds/kg. Placed on filter paper, 41 percent germinated between 10 and 119 days from sowing. Germination is epigeal. Seeds are dispersed when they cling to passing animals.

Growth and Management.—Burweed lives between 1 and 3 years. In seasonally dry habitat, this species behaves as an annual. The plants grow about 1 m the first year, with growth slowing in subsequent years. Because of its weedy nature, planting burweed is unlikely, and ill-advised outside its native range. Indeed, control is often needed in croplands and pastures. Treatments follow normal practice for coarse broadleaf weeds: mechanical cultivation or grubbing and spraying with herbicides such as 2,4-D.

Benefits.—The stem wood has moderate strength and hardness, but because of the plant's small size the wood is of little value. Fibers from the stem bark were once used by the inhabitants of Rapa Nui to make fishing lines (Moanalua Gardens Foundation 1999). Burweed is reported to have little or no forage value for domestic livestock (Haselwood and Motter 1966).

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***Turbina corymbosa* (L.) Raf.** Christmas vine
CONVOLVULACEAE

Synonyms: *Rivea corymbosa* (L.) Hall.f.
Convolvulus corymbosus L.
Convolvulus sidaefolius HBK.
Ipomoea sidaefolia (HBK.) Choisy
Ipomaea corymbosa (L.) Roth.

John K. Francis

General Description.—Christmas vine, also known as Christmas wreath, aguinaldo blanco, corona de novia, ololiuqui, and badoh, is a woody vine that may extend 5 m or more laterally and into the crowns of trees and shrubs. Older stems reach about 2.5 cm in diameter. The gray, three-sided stems have many lenticels and may be grooved. The young stems are cylindrical and tough. The foliage is concentrated on current year's growth. The leaves, with slender petioles, have cordate blades 5 to 8 cm long with an elongated point. The inflorescences are corymbose cymes that arise from leaf axils. The 2.5- to 3-cm corolla is trumpet shaped, white with a red or purple throat and green or greenish gray radiating stripes. The ellipsoidal capsule has three long and three short sepals that cause it to spin and glide laterally when released. Each capsule contains one brown, pubescent seed (Acevedo-Rodríguez and Woodbury 1985, Howard 1989, Liogier 1995).

Range.—Christmas vine is native to the West Indies, Mexico through Central America, and the tropical portion of South America (Liogier 1995). It has naturalized in Florida (Correll and Johnston 1970), Hawaii, a few other Pacific Islands, Australia (Pacific Island Ecosystems at Risk 2002), and some parts of the Old World Tropics (Howard 1989).

Ecology.—Christmas vine grows as single plants or matted patches of vines in secondary forest openings, old fields, neglected pastures, road sides, stream banks, and vacant lots. In Florida, it may be found in hammocks and brushy areas (Long and Lakela 1971). It demands full or nearly full sunlight and will not grow under a closed forest canopy. Christmas vine will grow on most well-drained soils. It is reported to bloom more profusely on "red" and limey soils (Woman's Club of Havana 1952). The species has been observed by the author growing in areas of Puerto Rico that receive from 1000 to 2000 mm of annual precipitation.

Reproduction.—A collection of fruits from Puerto Rico weighed an average of 0.0389 $\pm$ 0.0004 g/fruit. Seeds separated from those fruits weighed an average of 0.0265 $\pm$ 0.0002 g/seed or 38,000 seeds/kg. Sown in commercial potting mix, 95 percent of the seeds germinated between 33 and 48 days after sowing (author's observation). Well-established plants root whenever vines touch the soil. Natural seedlings tend to be widely scattered. Besides spreading by wind, water, and lateral vine extension, seeds of the species are now widely sold, exchanged, and grown for the narcotic the seeds contain.

Growth and Management.—Seedlings of Christmas vine grow slowly at first and develop a strong tap and lateral root system. Leaders of well-established plants may extend 2 m or more per year. The plants can be pruned back to the woody stems or thinned in the spring after blooming is complete (Woman's Club of Havana 1952). No specific recommendations are given for controlling the species when it grows as a weed in agricultural settings. Cutting the vines near the ground, and spraying the resulting sprouts with broad-leaf weed killers, should be effective.

Benefits.—Christmas vine is sometimes grown as an ornamental for the clusters of white, scented flowers it produces during the early winter. The nectar gathered from its flowers makes one of the finest honeys (Woman's Club of Havana 1952). Extracts from the seeds are used as an analgesic in herbal medicine (Schultes and Hoffmann 1992).

Narcotic Properties.—The seeds of Christmas vine were valued as a sacred hallucinogen by Chinantec, Mazatec, Mixtec, Zapotec, and other groups in Southern Mexico in Pre-Columbian times and are still cultivated and used today as aids in divination and witchcraft. It was administered by grinding about 13 seeds, adding water, filtering, and drinking the filtrate in a quiet, secluded place. Hallucinations follow that last about 3 hours, sometimes with aftereffects. The active ingredients are the ergoline alkaloids, lysergic acid amide, and lysergic acid hydroxyethylamide that are closely related to LSD (Schultes and Hoffmann 1992).

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***Urena lobata* L.** Caesar weed
MALVACEAE

Synonyms: *Urena americana* L. f.
Urena grandiflora DC.
Urena trilobata Vell.
Urena lobata L.
Urena diversifolia Schumach.
(and others: Institute of Systematic Botany 2003).

John K. Francis

General Description.—Caesar weed is also known as hibiscus bur, aramina, pink Chinese burr, bur mallow, grand cousin, cadillo, carrapicho do mata, malva, mahot cousin, cousin petit, cousin rouge, jut africain, cooze mahot, dadangsi, and mautofu. It is a subshrub 0.6 to 3 m in height and up to 7 cm in basal diameter. The species usually has a single stem emerging from the ground but normally produces several stems or major branches low on the stem and many branches throughout. The nearly smooth bark is tough and fibrous, brown on the outside and green within. Its pale yellow wood is of medium density. Plants are supported by a tap and lateral root system of tan or ivory-colored, tough and flexible roots. Grayish-green, discolorous, alternate leaves are stellate-pubescent both above and below, ovate, angulate or shallowly lobbed, 1 to 12 by 1 to 12 cm, and have serrate margins. Axillary flowers are usually solitary and have five pink petals. The flowers are about 1 cm broad. The fruits are 8- to 10-mm globose capsules that break into five fine-barbed (glochidate) mericarps. (Howard 1989, Liogier 1994, Stevens and others 2001)

Range.—The original range of Caesar weed is probably Asiatic. Today it grows throughout moist tropic and subtropical regions including American Samoa, Florida, Guam, Hawaii, Louisiana, Puerto Rico, and the U.S. Virgin Islands (Natural Resources Conservation Service 2003, Pacific Island Ecosystems at Risk 2003).

Ecology.—Caesar weed readily invades disturbed areas, especially poorly managed pastures, scarified and eroded areas, and perennial crop plantations but is much less of a problem in annual crops. The species does not compete well in tall grass swards and brushlands and does not grow under forest canopies. Ceasar weed grows on a wide variety of soils of varying fertility derived from most parent materials. It tolerates salt spray and a moderate amount of salt in the soil but does not grow in saturated soils. The species ranges to elevations of 1,500 m (Pacific Island Ecosystems at Risk 2003). In Puerto Rico, it occurs in areas that receive from about 1400 to 3000 mm of mean annual precipitation, forming thickets in favorable sites.

Reproduction.—Caesar weed flowers and fruits throughout the year (Stevens and others 2001). A collection of seeds from Puerto Rico averaged 0.0239 $\pm$ 0.0003 or 41,800 seeds/kg. Placed on moist blotter paper without pretreatment, just 3 percent germinated in 9 months. Germination is epigeal (author's observation). Sulfuric acid scarification was tested as a means of breaking dormancy of seed from Sierra Leone. The best treatment (18 molar solution for 90 minutes) gave 96 percent germination as compared with distilled water that gave 4 percent germination (Harris 1986). Seeds are dispersed by clinging to fur and clothing. Seedlings are common in disturbed sites near seed sources.

Growth and Management.—Caesar weed grows rapidly and can reach 0.5 to 2 m by the end of the first year. In Puerto Rico, it can live 2 years, usually dying back to midheight after the first growing season. It is not known whether the shrubs sprout from the roots multiple times. A fiber crop yielding 1,800 kg/ha is ready to harvest after 6 to 7 months and seed crops of 300 to 500 kg/ha are ready after 7 or 8 months (Fagundes 2003). Fiber crops are established with seed. Because of the aggressive nature of the species, wildland plantings are not recommended. The author knows of no published specific control measures.

Benefits and Detriments.—Caesar weed colonizes disturbed areas and helps to protect the soil while furnishing cover for wildlife. It has attractive flowers and contributes to aesthetics of areas it has colonized. Tens of thousands of tons of a jute-like fiber from Caesar weed called aramina fiber and Congo jute are produced in Brazil (Fagundes 2003) and Africa (Câmara de Comércio e Indústria Portugal-Angola 2003). Various extracts of leaves and roots are used in herbal medicine to treat such diverse ailments as colic, malaria, gonorrhea, fever, wounds, toothache, and rheumatism (Forest Research Institute of Malaysia 2003). A semipurified glycoside obtained from Caesar weed leaves was 86 percent as effective an anti-inflammatory as aspirin in rats (Bautista 2000). The leaves and flowers are eaten as famine food in Africa (Freedman 1998). Raw leaves are reported to contain 81.8 percent moisture, 54 cal, 3.2 g of protein, 0.1 g fat, 12.8 g carbohydrates, 1.8 g fiber, and 2.1 g ash, 558 mg calcium, and 67 mg of phosphorous per 100 g (FAO 2003). However, the plant is little browsed by cattle and can become a severe weed in pastures and plantations. Burs that collect on clothing and in animal fur are a nuisance.

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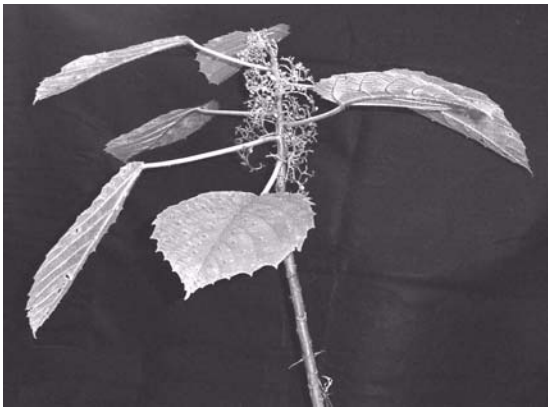
***Urera baccifera* (L.) Gaud.** ortiga brava

URTICACEAE

Synonyms: none

John K. Francis



General Description.—Ortiga brava means “bad nettle” in Spanish. The species is known by a host of other common names, among which are: stinging nettle, ortiga, pringamoza, mala mujer, chichicaste, nigua, guaritoto, ishanga, manman guêpes, and urtiga bronca (Little and others 1974). Ortiga brava is a weak-stemmed woody shrub that sometimes becomes a small tree. Individual plants may have one or several stems, branching near the ground. Probably the most recognizable feature of the plant is the presence of many sharp, stinging spines on the leaves, branches, and stem. The alternate leaves are 12.5 to 25 cm in length and 7.5 to 12.5 cm in width, coarse-toothed with thin blades and stout petioles. The stem bark is smooth, light gray with green-over-white inner bark, and thick greenish pith. There are raised leaf scars and lenticels on the stems and branches.

Range.—Ortiga brava ranges throughout the Greater and Lesser Antilles, Trinidad, and Tobago and on the mainland from Mexico to Brazil, Argentina, Bolivia, and Peru (Little and others 1974). The species is not known to have naturalized outside its native range.

Ecology.—Ortiga brava grows in the higher rainfall portion of the moist forest (>1600 mm precipitation), especially along drainages, and throughout the wet and rain forests (2000 to 4000 mm of precipitation). Alluvial, coluvial, and residual soils from acidic and calcareous rocks make suitable habitat. Well-drained and somewhat poorly drained soils of all textures are colonized. Being moderately shade intolerant, disturbance is generally required for the species to get started, and it disappears after the forest understory becomes dark. A high importance value of ortiga brava in a Brazilian forest and an unbalanced diameter distribution was used to infer past disturbance (Bertoni and others 1988).

Reproduction.—Minute male and female flowers are borne in pink or purple, branched clusters on the stem on different plants (dioecious). The fruits are white or pinkish, spongy and watery, with one greenish-black seed per fruit (Little and others 1974). A Puerto Rican collection of seeds averaged 4.36 $\pm$ 1.17 g each (Francis and Rodríguez 1993) or 500,000 seeds/kg. They began germinating in 26 days with a final germination of 49 percent (Francis and Rodríguez 1993). Ortiga brava built up to high populations in a fire-disturbed forest in the Atlantic forest in southern Brazil through a high recruitment rate and low mortality (Nascimento and others 1999). The seeds are disbursed by birds.

Growth and Management.—Individual stems of ortiga brava may grow for 5 years or more and reach 5 m in height. Heights of 1.5 to 2 m are more typical. Ortiga brava stems cut during site management activities quickly sprout and regain their former height. Whether sprouting from the rootstalk occurs after senescence and death of individual stems is not known.

Benefits and Detriments.—In Central America, ortiga brava has been planted in hedges and fences to make an almost impenetrable barrier (Little and others 1974). Although not generally sought after for food under normal conditions, ortiga brava is one of the first plants to fruit after hurricanes, and, as such, is an important factor in the survival of frugiverous birds (personal communication with Joseph Wunderle, IITF, Río Piedras, PR). The stems of ortiga brava were used by Aztec and Otomi Indians in Mexico for making paper (Hagen 1943). The plant is considered a weed in shaded coffee plantations. (Francis and Rodríguiz 1993).

All parts of the plant are covered with the spine-like hairs that cause considerable pain when they penetrate the skin. Normal clothing does not protect against the stinging effect. However, the pain is usually short-lived, lasting from a few seconds to a few minutes. Although no permanent injury results, some people may experience rash or blisters; swelling, fever, and ulcers can occur in extreme cases (Allen 1943). The plant has long been used in folk medicine. Recent laboratory tests using rats have shown anti-inflamatory and analgesic activity of aqueous extracts of ortiga brava (Badilla and others 1999). Amerindians in Costa Rica chastised themselves with branches of ortiga brava in a toughening ritual (Badilla and others 1999).

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***Vernonia albicaulis* Pers.** Santa María
ASTERACEAE

Synonyms: *Vernonia vhliana* Less.
Vernonia thomae Benth.
Cacalia thomae (Benth.) Kuntze
Vernonia longifolia vahliana (Less.) Urban
Vernonia longifolia sintenisii Urban
Vernonia sintenisii (Urban) Gleason
Lepidaploa glabra (Willd.) H. Rob.

John K. Francis

General Description.—Santa María, also known as tabac à jacot, is a shrub to 2 m tall and stem basal diameter to 1 cm. The ribbed, woody, gland-dotted, hairy stems are upright or arching. Several stems may arise from the root crown. The lateral root system has brown bark and a moderate amount of fine roots. The alternate leaves are evenly dispersed on the branches and have petioles 1 to 11 mm long. The blades are oblong to elliptic, rounded at the apex and pointed at the base, and have entire to weakly sinuate margins. Inflorescences are cymes of heads of 10 to 23 florets having lavender to white corollas 5 to 10 mm long. The fruits (achenes) are 3 mm long with pale brown to white pappus with bristles 0.5 to 1 mm long (Howard 1989, Liogier 1997).

Range.—Santa María is native to Puerto Rico, the Virgin Islands, Anguilla, St. Martin, St. Barts, Antigua, Saba, St. Eustatius, St. Kitts, Monserrat, Guadeloupe, La Désidade, and Dominica (Howard 1989). A second subspecies, *longistylis* Keeley, a taller and more robust plant, has been described on Guadeloupe (Howard 1989). Santa María is not known to have been planted or naturalized elsewhere.

Ecology.—Santa María is moderately intolerant to intermediate in tolerance of shade. It grows at forest edges, small openings, under low basal-area stands, and on difficult terrain with few trees. This may be in secondary or remnant forests. The species is most common in limestone areas from near sea level to 600 m elevation (Liogier 1997) but also occurs in terrain underlain by igneous rocks. Mean annual precipitation varies from about 900 to 2400 mm. The soils are well-drained, usually clayey or loamy, and have pH's from about 5.0 to 8.0.

Reproduction.—Seed production is abundant. A sample of seeds from Puerto Rico averaged 3.9 million per kg. They were sown on the surface of wet peat but failed to germinate. The seeds are dispersed by the wind. Seedlings are common to widely scattered.

Growth and Management.—Santa María has a moderate growth rate. Individual stems live about 2 to 4 years, and plants may live much longer by resprouting from the roots. No planting or management experience has been published. Because Santa María appears to benefit from disturbance to existing forest, thinnings and other silvicultural activities may help maintain it.

Benefits.— Santa María contributes to the diversity and beauty of the forest, helps protect the soil, and furnishes cover for wildlife.

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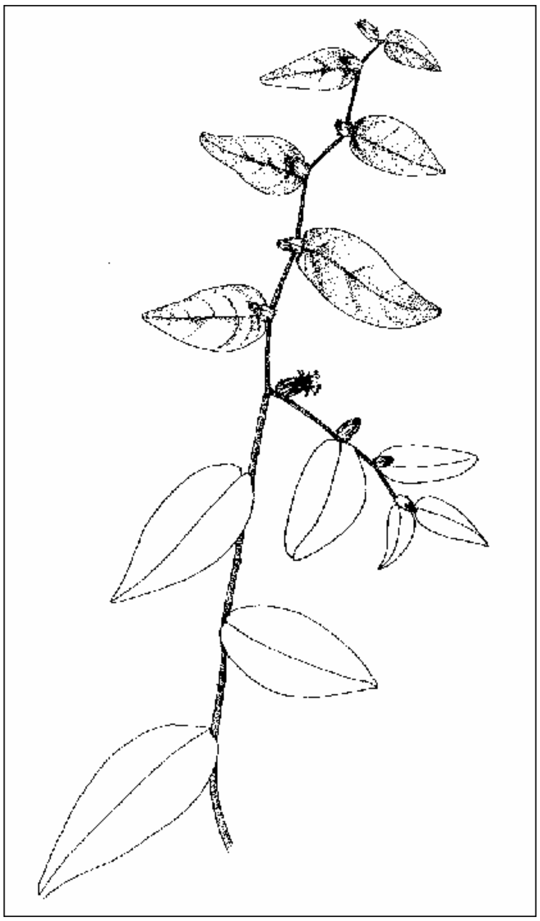
***Vernonia borinquensis* Urban** Puerto Rican ironweed

ASTERACEAE

Synonyms: *Vernonia borinquensis* var. *resinosa* Gleason
Vernonia borinquensis var. *hirsuta* Gleason

John K. Francis



General Description.—No local name is known for this species in Puerto Rico. The Natural Resources and Conservation Service (2002) has assigned it the name Puerto Rico ironweed. The plant is a vine-like scrambling shrub reaching 5 to 10 m of lateral extension and sometimes as much as 3 m into the crowns of trees and shrubs. Younger plants often have a single stem, but older plants may form clumps and mats. The root system consists mainly of slender lateral roots and abundant, fleshy, fine roots. The principal branches are cylindrical, about 0.5 cm thick, and covered with gray bark. Fine branches are densely hairy, striated, and have a zig-zag form. Leaves, concentrated near the branch ends, are somewhat stiff, have a short petiole, and blades in an ovate to lanceolate form. They have a rounded base and a pointed tip. Leaves remain on the twigs 1 year and twigs remain green for an additional year. Inflorescences are leafy cymes of sessile campanulate heads, 5.5 to 8 mm long, of 13 to 22 florets. The corolla is white or pale lavender. At maturity, the fruits (achenes) are 1 to 2 mm long, ribbed, and have a brown pappus 5 to 6.5 mm long (Acevedo-Rodríguez 1985, Liogier 1997).

Range.—Puerto Rico ironweed is endemic to Puerto Rico and mainly found in the Cordillera Central (Acevedo-Rodríguez 1985). The species is not known to have been planted or naturalized elsewhere.

Ecology.—Puerto Rico ironweed grows on well-drained soils with a wide range of textures derived from most parent materials. Fertility is usually moderate to good, and pH's range from about 5 to 7. Exposed subsoils are not colonized. Mean annual precipitation ranges from about 900 to 2400 mm and at elevations from a few to about 800 m above sea level. Puerto Rico ironweed has an intermediate tolerance to shade. It grows in openings but is often found under low to medium basal-area forest canopies. It is resistant to grazing and/or avoided by cattle enough to survive in light- to moderately-grazed semiforested range and brushy pastures. The species may be found in both remnant and secondary forests.

Reproduction.—Puerto Rico ironweed flowers from November to July and fruits from February to September (Acevedo-Rodríguez 1985). Presumably, flowers are insect pollinated. In a sample of seeds collected near Calley, Puerto Rico, about 3 percent of the seeds were filled. Sorted by examination under a microscope, apparently filled seeds weighed an average of 0.00098 g/seed or about 1 million seeds/kg. After being placed on moist filter paper, 76 percent germinated within 24 days. The seeds are wind-dispersed. Although seed production can be heavy, established seedlings are relatively uncommon.

Disturbance is probably necessary for seedling establishment. The plants layer (root) whenever stems come in contact with the soil.

Growth and Management.—Puerto Rico ironweed grows at a moderate rate. Established plants extend stems about 0.5 m/year. Although individual stems probably do not live more than 2 to 4 years, plants may live much longer by sprouting and layering. No management experience has been published; thinning the forest overstory with accompanied soil disturbance is recommended to encourage regeneration.

Benefits.—Puerto Rico ironweed helps protect the soil and furnishes cover for wildlife. It adds a pretty aspect to trailsides and forest edges but gives the understory a "closed" appearance and makes it somewhat more difficult to walk through.

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Vernonia proctori **Urbatsch** Proctor's vernonia
ASTERACEAE

Synonyms: none

John K. Francis

General Description.—Proctor's vernonia (a name assigned by the author) is an upright gray-green shrub to 1.5 m in height and 1 cm in basal stem diameter. Older plants may have as many as 50 stems arising from the root crown. The plants have many lateral and abundant fine roots. Branches are greenish gray, turning brown or gray with age. The foliage is crowded on new twig growth. Alternate leaves have short petioles and blades that are broadly elliptic to suborbicular, 1.2 to 3.5 cm long, and rounded at the tip. They are dark green above and white beneath and have a densely ciliate margin. The inflorescences are terminal, sessile clusters of usually three heads with 16 to 22 florets. The corollas are purple or blue. At maturity, the heads contain 2- to 3-mm long achenes with a white pappus (Liogier 1997, Miner-Solá 1999, U.S. Fish and Wildlife Service 2002).

Range.—Proctor's vernonia is endemic to Puerto Rico and found only at the summit of Cerro Mariquita in the range of hills known as Sierra Bermeja in southwestern Puerto Rico. The species is endangered and has an estimated population of 950 individuals in an area of a few hectares (U.S. Fish and Wildlife Service 2002).

Ecology.—Proctor's vernonia grows in exposed rock crevices and in shallow cherty clay loam soil up to 30 cm deep that has developed over weathered siliceous rock. Mean annual precipitation is about 900 mm/year with a fall wet season and spring dry season. Humidity is high and breezes are almost continuous. Elevations where the population grows ranges from 270 to 300 m above sea level (U.S. Fish and Wildlife Service 2002). Proctor's vernonia is intolerant of shade. It grows in the open or in broken stands of low trees, but not under closed-canopy forest. Bare ground and 3 to 4 weeks of almost daily precipitation is probably necessary for establishment. The endemic area was once severely grazed and cut over for fuelwood, but has been much less disturbed in recent years.

Reproduction.—Proctor's vernonia flowers and fruits during April and May (U.S. Fish and Wildlife Service 2002). The plant produces seed in abundance. A small quantity of seeds collected by the author averaged 0.00038 g/seed or about 2.6 million seeds/kg. Placed on moist filter paper, 13 percent germinated within 15 days. The seeds are dispersed by the wind. Seedlings are infrequent.

Growth and Management.—Proctor's vernonia appears to grow slowly as a seedling and take many years to attain large plant size. Individual stems arising from sprouts grow about 20 cm/year. Although individual stems last only a few years, the plant, renewing itself with new sprouts, appears to live for many years. Propagation techniques have not been published. Complete protection of the Cerro Mariquita site from development, grazing, and fire is critical.

Benefits.—Proctor's vernonia is a pretty plant and certainly contributes to the aesthetics of the area where it grows. It protects the soil and furnishes cover for wildlife.

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***Vernonia sericea* L.C. Rich.** long-shoot
ASTERACEAE

Synonyms: *Lepidaploa phyllostachya* Cass.
Vernonia berteriana DC.
Conya portoricensis Bert. ex DC.
Vernonia arborescens lessingiana Griseb.
Cacalia sericea (L.C. Rich.) Kuntze
Cacalia arborescens lessingiana (Griseb.) Kuntze

John K. Francis

General Description.—Long-shoot, also known as escobilla, huye-que-te-coge, tapa caminos, and yerba socialista, is an upright shrub usually 1 to 1.5 m (occasionally 2 m) in height and 1 cm in basal stem diameter. It usually has a single main stem, although older and previously damaged plants sometimes have multiple stems branching from the root collar or from near the base. The wood of the stems is stiff and hard. The plant is supported by a tap and lateral root system of stiff, orange to tan roots. Smaller roots are tough and flexible. Branches and twigs are slender. The leaves are linear to elliptic, 2.5 to 10 cm long, with an entire edge, and pointed at the tip and somewhat rounded at the base. The inflorescences are elongated scorpioid cymes with leafy bracts and contain lavender to white, sessile flower heads about 6 mm long with 11 to 18 florets. They produce achenes 2 mm long tipped with a brown pappus about 4 mm long (author’s observation, Liogier 1997).

Range.—Long-shoot is native to Cuba, Hispaniola, Puerto Rico, and the Virgin Islands (Liogier 1997). It is not known to have been planted or naturalized elsewhere.

Ecology.—Long-shoot grows on a variety of soil types, mostly of medium to heavy texture with pH’s from 5 to 7 that are derived from sedimentary (including limestone), igneous, and metamorphic parent materials. These are well drained to somewhat poorly drained soils in areas that receive from about 850 to 2200 mm of mean annual precipitation at elevations from near sea level to about 700 m. Long-shoot is moderately intolerant of shade and grows in openings and under the canopy of low basal-area forest. It competes well with forbs and grasses if the vegetation is not too heavy. It is browsed by cattle, but not preferentially, so that it can survive and reproduce in lightly and moderately grazed pastures and range. Long-shoot grows on abandoned agricultural land, secondary forest, stream banks, open remnant forests, roadsides, and fence rows.

Reproduction.—Long-shoot blooms seasonally, probably at the latter part of the rainy season (November through January). The abundant seeds produced are dispersed by wind during the dry season (March and April). A collection of seeds from Puerto Rico weighed an average of 0.000309 g/seed or 3.2 million seeds/kg. Placed on moist filter paper, 69 percent germinated over the course of 2 months, beginning 7 days after sowing.

Growth and Management.—Long-shoot grows between 0.5 and 1 m in the first year from sprouts. The growth rate of seedlings is undoubtedly much slower. Individual stems live about 3 years, but plants sprout and live through a second, perhaps several, cycles of tops. No propagation or management experience has been published. Presumably, conditions for healthy populations can be created by maintaining broken or low basal-area forest stands.

Benefits.—Long-shoot helps protect the soil, adds to the aesthetic beauty of forests, and furnishes cover for wildlife. The species is one of the nectar sources for the butterfly, *Eurema leuce antillarum* Hall (Torres Bauzá 1999).

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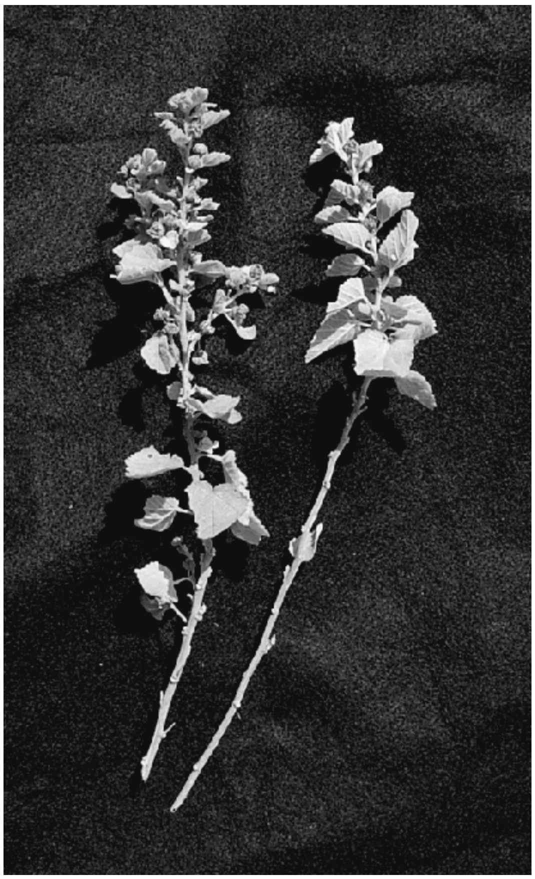
***Waltheria indica* L.** sleepy morning
STERCULIACEAE

Synonyms: *Waltheria americana* L.
Waltheria elliptica Cav.

John K. Francis



General Description.—Sleepy morning is also known as velvet leaf, marsh-mallow, monkey bush, boater bush, leather coat, buff coat, basora prieta, malvavisco, hierba de soldado, guimauve, mauve-gris, moto-branco, hioloa, fulutafu, kafaki, and many other names (Haselwood and Motter 1966, Howard 1989, Liogier 1994, Burkill 2000). It is a short-lived shrub or subshrub sometimes reaching 2 m in height and 2 cm in stem diameter. Sleepy morning develops a weak taproot, robust lateral roots, and abundant fine roots. The roots are brown and flexible. This shrub usually has a single, strong stem emerging from the ground, but frequently branches near the ground. Sleepy morning usually has an upright and somewhat branchy form. However, in some environments, it may grow in a semiprostrate habit. The young stems and leaves are covered with a gray, velvety pubescence. The alternate leaves are narrowly ovate or oblong with a rounded to subcordate base, irregularly serrate edges, and a rounded to acute tip. The petioles are 0.5 to 3.3 cm long and the blades are 2 to 12 cm long and 1 to 7 cm broad. Axillary inflorescences are usually dense glomerules that contain fragrant, yellow to orange flowers. Each 2-mm capsule holds one tiny, black, obovoid seed (Howard 1989, Liogier 1994, Tropilab, Inc. 2001).

Range.—Sleepy morning now grows throughout the tropics and warmer subtropics (Liogier 1994). It apparently naturalized in Hawaii soon after the arrival of nonnative colonists (Haselwood and Motter 1966). Howard (1989) indicates that the species is native to the New World where it occurs from Florida and Texas to Brazil (Dick 2001, Nelson 1996, Texas A & M University 2001).

Ecology.—Sleepy morning grows in disturbed dry and well drained, moist habitat. In Puerto Rico, the species occupies areas that receive from 750 to about 1800 mm of annual precipitation from near sea level to more than 400 m of elevation. The species grows on sites up to 1,220 m in elevation in Hawaii (University of Hawaii 2001). It colonized a wide variety of soils in areas with igneous, metamorphic (including ultramafics) and sedimentary (including limestone) rocks. The species may be found on old fields, construction sites, roadsides, burned forest and grasslands, and stream overflow areas in Puerto Rico. In Florida, it grows in open pinelands, hammocks, and disturbed sites (Long and Lakela 1976). It is intolerant of shade and will not survive under a closed tree canopy and cannot compete with grass in dense swards. It withstands drought, salt spray, and mildly salty soils.

Reproduction.—Sleepy morning plants begin flowering at about 6 months of age and bloom more or less continuously for the rest of their lives. A collection of seeds made in Puerto Rico averaged 0.0013 g/seed or 764,000 seeds/kg.

These seeds were sown without any pretreatment on filter paper and after 16 weeks yielded 13 percent germination. Reproduction is by seeds. The seeds are disbursed by water, agricultural equipment (Sánchez and Uranga 1993), and grazing animals. Seedlings are relatively common in disturbed habitat.

Growth and Management.—Sleepy morning plants in Puerto Rico live for 1 or 2 and occasionally 3 years. Death usually occurs during the dry season. Perennial growth is more likely in continuously moist habitat. Stands of sleepy morning in agricultural plantations can be controlled by cultivation and probably by broadleaf herbicides.

Benefits and Detriments.—In the Turks and Caicos Islands, sleepy morning is used to make an herb tea (Wood 2001). The plant produces a fiber that was formerly used for making cords, sacking, padding, and sandals (Guzmán 1975). Durawhite, an extract of sleepy morning, is used in a commercial cosmetic for its ability to inhibit melanin synthesis and whiten the skin (Janssen Cosmeceutical Care 2001). The plant contains steroid derivatives and alkaloids of the adouetine group that perhaps make it physiologically active. Various extracts are used as standard febrifugal, purgative, emollient, tonic, analgesic, and astringent herbal medicines in Africa (Burkill 2000). In Hawaii, the root is chewed to relieve sore throat (Neal 1965). Stems are used as a chew stick, and extracts of the plant are used as an eye bath and a remedy for hemoptysis in Panama (Agricultural Research Service 2001). Seeds are sold commercially, and the species is cultivated in gardens as a medicinal plant. The plant is browsed by all types of livestock, especially when young (Burkill 2000). Sleepy morning forage in a Mozambique valley during the rainy season contained 6.4 percent crude protein, 0.12 percent phosphorus, and 0.51 percent calcium (Faftine and others 2001). Sleepy morning is considered a weed in much of its range, but it is seldom aggressive enough to be a major problem (Sánchez and Uranga 1993). It is host for a number of insects harmful to agricultural crops (Centro de Desarrollo de Agronegocios 2000, Lastres 2000, Sánchez and Uranga 1993).

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***Wedelia reticulata* DC.** manzanilla de monte
ASTERACEAE

Synonyms: *Seruneum reticulatum* (DC.) Kuntze
Stemmodontia reticulata (DC.) Cook & Collins

John K. Francis

General Description.—Manzanilla de monte is an evergreen shrub to 1.5 m in height and 1.5 cm in basal diameter. Adult plants have few-to-many, slender, brown, brittle, woody stems arising from the root crown. The stems have a 1-mm pith and discernible annual rings. The root system is dominated by stiff and brittle, slender, dark tan-over-green, wide spreading laterals. Also, adventitious roots grow from the bases of branches. Branching is often bifurcate or trifurcate, sometimes forming a tangled structure in older plants. However, foliage tends to concentrate at the periphery of the crown. Leaves are opposite, narrowly oblong ovate to oblong lanceolate, short-pointed at the tip and rounded to subcordate at the base, 3 to 10.5 cm long, with a 0.5- to 1.0-cm petiole and fine serrate edges. The leaves are green to yellow-green. Compound flowers are terminal, solitary, or occasionally in two's or three's. The yellow involucral bracts ("petals") are 4 to 7 mm in length and numerous florets. The fruits are four-sided achenes 3 mm long (author's observations, Liogier 1997).

Range.—Manzanilla de monte is native to Puerto Rico and the island of Hispaniola (Liogier 1997). It is not known to have been planted or naturalized elsewhere.

Ecology.—Manzanilla de monte grows on soils of all textures, pH's from mildly acid to mildly alkaline, over parent materials of igneous, sedimentary (including limestone), and metamorphic (including ultramafic) rocks. Soils are usually rocky or shallow over bedrock. The species grows from near sea level to elevations of 600 m or more in Puerto Rico (Breckon 2001, Francis and others 1998). Annual rainfall ranges from about 900 to 2000 mm. Manzanilla de monte tolerates salt spray and mild salinity in the soil. It is drought tolerant. During drought, the leaves wilt but usually do not fall off. Manzanilla de monte is intolerant of shade. It is open-grown or grows in small openings in low forest. The species is hardy and competes well with grass and herbs of similar height. Well-established stands become clumps and thickets that tend to shade out plants under them.

Reproduction.—Manzanilla de monte blooms and fruits continually. Seed production can be abundant although unknown insects sometimes destroy most of the seeds. Other than short-distance transport by wind, gravity, and water, specific means of dispersal are unknown. Seedlings are relatively uncommon. Suckers at the edge of clumps are common, and plants occasionally layer.

Growth and Management.—Manzanilla de monte is slow growing in natural environments. Sprouts grow 10 to 30 cm/year. Individual stems persist about 4 to 10 years. Through continually suckering and layering, plants can last almost indefinitely.

Benefits.—Manzanilla de monte contributes to the aesthetics of natural areas where it grows, helps protect the soil, and furnishes cover and possibly food for wildlife. Although somewhat rough in appearance during dry periods, it has pretty flowers and should make a fine ornamental for natural landscaping, especially in coastal areas and rocky terrain.

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Ziziphus obtusifolia (Hook. ex Torr. & Gray) Gray graythorn

RHAMNACEAE

Synonyms: *Condalia obtusifolia* (Hook.) Weberbauer
Condalia lycioides (Gray) Weberbauer
Zizyphus lycioides Gray

James E. Nellessen

General Description.—Graythorn is also known as lote bush, southwestern condalia, prairie bush, or thornbush. This shrub reaches heights of 2 to 3 m but is often shorter. Stems are grayish green due to a whitish or grayish wax-like bloom, which helps to distinguish *Ziziphus* from *Condalia*. The stems are robust, grooved, highly branched, although terminal branches are short, and bear stout spine-tips. The stem branching pattern gives this shrub an irregular shape. Side branches tend to come out at right angles from the main axis. The leaves are alternate, simple, generally less than 2.5 cm long, range from 0.4 to 0.7 cm in width, are ovate, oblong, or elliptic with three main veins. Leaf shape is variable which has lead to some confusion in identification. Leaves are dropped during dry periods (Carter 1997, Correll and Johnston 1979, Great Plains Flora Association 1986, Kearney and others 1951, Martin and Hutchins 1980-81).

Taxonomy.—This shrub has a somewhat complicated proliferation of taxonomic names. Two varieties are recognized: *Ziziphus obtusifolia* var. *canescens* (Gray) M.C. Johnston; and the typical variety *Z. obtusifolia* var. *obtusifolia*. Synonyms for variety *canescens* are: *Condalia lycioides* (Gray) Weberb. var. *canescens* (Gray) Trel.; *Zizyphus lycioides* Gray var. *canescens* Gray; and *Condaliopsis lycioides* var. *canescens* (Gray) Suess. Synonyms for variety *obtusifolia* are: *Condalia lycioides* (Gray) Weberb., including var. *lycioides*; *Condalia obtusifolia* (Hook. ex Torr. & Gray) Weberb.; *Zizyphus lycioides* Gray; and *Condaliopsis lycioides* (Gray) Suess. (Allred 2002, Kartesz 1994).

Range.—This species occurs from just a few counties in southwestern Oklahoma (McCoy 1981), portions of central and western Texas, through southern New Mexico to northwestern Arizona and southeastern California and south well into Mexico. It occurs at a wide elevational range from about 300 m to 1,525 m. Populations in the more western portions of its range are variety *canescens* (Kearney and others 1951).

Ecology.—Graythorn will grow in a variety of situations from silty and sandy floodplains and washes to gravelly slopes and plains in desert grasslands and scrublands. This species tends to be diffusely distributed within its local habitat, but may also form thickets. This species is considered a characteristic component of Chihuahuan desert scrub and a diagnostic climax indicator species of desert grassland (Dick-Peddie 1993). In a northern Texas study, although graythorn had a minimal influence on overall grass cover, there appeared to be differences in species distributions around graythorn bushes (Foster and others 1984). Buffalo grass [*Buchloe dactyloides* (Nutt.) Engelm.] was more abundant near graythorn than in shrub free zones, while Texas winter- or needlegrass (*Stipa leucotricha* Trin. & Rupr.) cover and standing crop was greater away from graythorn. A study conducted in a savanna parkland habitat in southern Texas showed that graythorn is a deciduous shrub with an average leaf lifespan measured at 66 days (Nelson and others 2002). Supplemental watering had no detectable effect on leaf longevity. Root infection with symbiotic strains of *Frankia* and *Rhizobium* did not occur on four species of Rhamnaceae from southern Texas, including graythorn, when planted in pots in the laboratory, in a 1:1 native soil (with symbionts) to vermiculite substrate (Zitzer and others 1996).

Reproduction.—Flowers of graythorn are small, inconspicuous, and occur in axillary cymes of two to seven flowers. The five-petalled flowers are greenish yellow. Graythorn may bloom at various times during the growing season, from May through September, depending on the availability of moisture. The fruit is a dark blue to black globose drupe, 6 to 10 mm long, covered with a whitish bloom, and matures from July into early October. Seeds are nondormant, but the seed coats are impermeable to water, hence are classified as physically dormant (Baskin and Baskin 2001). Physically dormant seeds need some type of scarification of the seed coat to initiate water penetration and germination. Optimal germination occurs at 25 °C. Both light and prechilling maximized the percent germination (Speer and Wright 1981, Young and Young 1992). Graythorn seeds from the lower Rio Grande valley in southern Texas did not need pretreatment for germination (Vora 1989).

Growth and Management.—Graythorn stem regeneration generally occurs just below the cut or removed portion. When stems are removed to the ground line, regeneration will occur from the root crown, and stems can be regenerated from roots, but generally only when the root crown itself is removed (Flinn and others 1992). Graythorn may demonstrate rapid growth when resprouting from cut stumps or during periods of good moisture but is generally a slow growing shrub. Although this species may on occasion become locally dense and form thickets, it is generally a species that is diffusely distributed within its habitat, such that management should not be a problem.

Benefits.—The fruits are readily eaten by birds such as Gambel's quail and white-winged doves. Graythorn was among several shrubs in a northern Mexico study testing the preferred browse composition and digestibility of foliage. Graythorn was grouped with species having a high crude protein content, lower cell wall content, and smoother or waxy leaf surfaces with the absence of trichomes. Range goats and white-tailed deer included graythorn as an important part of their diets (Ramirez and others 1997). In another nutrient study in northern Mexico (Ramirez and others 2001) graythorn was among several shrubs studied for seasonal mineral levels. General mineral concentrations were higher in the spring and summer, but only calcium, magnesium, potassium, and iron were at levels to meet adult goat requirements during all seasons. Phosphorus was low in all seasons except the spring. Native Americans have used the plant for medicinal purposes. Pima Indians have steeped the roots in water and applied them to sore eyes. Seri Indians have powdered the roots for application to skin and scalp sores. Solutions made from roots also served as a soap substitute (Bowers and Wignall 1993, Epple 1995, Kearney and others 1951).

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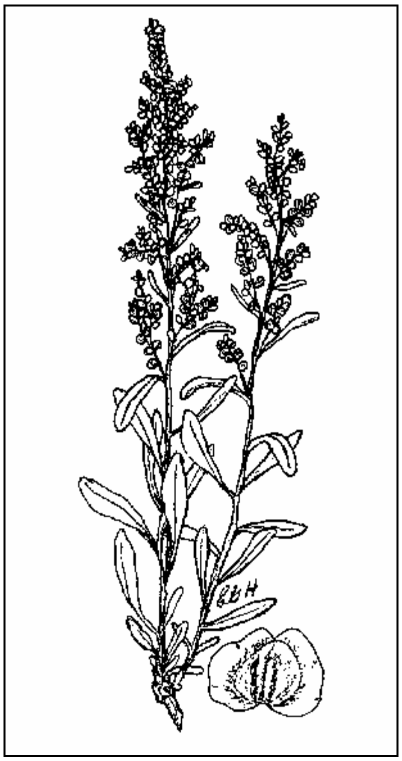
Zuckia brandegei **(Gray) Welsh & Stutz ex Welsh** siltbush
CHENOPODIACEAE

Synonyms: *Grayia brandegei* Gray var. *brandegei*
Grayia brandegei Gray var. *plummeri* Stutz & Sanderson
Zuckia arizonica Standley

Nancy L. Shaw, Rosemary L. Pendleton, and Emerenciana G. Hurd



General Description.—Siltbush or spineless hopsage is a deciduous shrub or subshrub ranging from 0.1 to 0.8 m in height (Goodrich and Neese 1986). Stems of the current year are thornless and ascending to erect, branching from a persistent, woody base. Leaves are alternate, gray-scurfy and entire to lobed. Overwintering leaf buds are prominent, axillary, and globose (Welsh and others 1987). There are three varieties (Welsh 2000). Diploid (2x = 18) *G. brandegei* (Gray) Welsh & Stutz var. *brandegei* is small with narrow, linear leaves. Tetraploid (4x = 36) *G. b.* (Gray) Welsh & Stutz var. *plummeri* (Stutz & Sanderson) Dorn (Plummer's siltbush) is larger with ovate to lanceolate leaves. Utricles of both varieties are obcompressed and vertical with two-winged samara-like bracts (see illustration). Utricles of the third variety, *G. b*. (Gray) Welsh & Stutz var. *arizonica* (Standley) Welsh (Arizona siltbush), are dorsiventrally compressed and mostly horizontal with six-keeled bracts. Flowers of all three varieties develop in small clusters in bract axils. Staminate flowers consist of four or five stamens and a four- or five-lobed perianth. Pistillate flowers contain a single pistil enveloped by two united bracts. Embryos are well developed.

Range.—Siltbush is a narrowly distributed edaphic endemic, largely restricted to the Colorado River drainage. *G. b.* var. *brandegei* occurs primarily in south-central Utah and northeastern Arizona. *G. b.* var. *plummeri* grows in isolated populations in northeastern Utah, south-central Wyoming, western Colorado, and northwestern New Mexico. *G. b*. var. *arizonica* occurs in scattered populations from northern Arizona to northeastern Utah (Goodrich and Neese 1986, Shaw and others 2001, Welsh and others 1987).

Ecology.—Siltbush grows in isolated monotypic populations on shale outcrops in desert shrub and lower juniper communities at elevations of 1,280 to 2,240 m (Goodrich and Neese 1986). Soils on these outcrops are poorly developed, fine textured, and characterized by moderate levels of soluble salts, and high levels of exchangeable sodium and potassium. Micronutrient levels are generally high. Siltbush tissues accumulate sodium and magnesium, but potassium levels and the calcium and magnesium ratio are low (Pendleton and others 1996).

Reproduction.—All siltbush varieties are monoecious and heterodichogamous (Pendleton and others 1988) with individual plants either protogynous (producing pistillate, then staminate flowers) or protandrous (producing staminate, then pistillate flowers). Flowering occurs in late spring or summer and fruits ripen in mid to late summer or fall (Pendleton and others 1988). Protogynous plants generally produce more seed, but protandrous plants may be equally productive in years when precipitation is high and seed predation is low (Pendleton and others 2000). Wind and gravity disperse the fruits over time; some fruits generally remain on the plant until late winter. There are about 625,000 seeds/kg (Pendleton and others 2000). Germination experiments conducted with seeds of *Z. b.* var. *brandegei* and *Z. b*. var. *plummeri* showed that seeds of warm winter populations germinated over a wide range of constant temperatures (15 to 30 ^{o}C) (Meyer and Pendleton 1990). Seeds of cold-winter populations were dormant at fall and winter temperatures and required exposure to overwinter chilling to promote germination. Germination generally increased with duration of wet prechilling at 1 ^{o}C for up to 8 weeks, dry afterripening for up to 14 months, or bract removal (Meyer and Pendleton 1990). Germination is epigeal.

Growth and Management.—Few data are available. Siltbush is a stress-tolerant species capable of establishing on steep, eroded sites where the combination of salinity, aridity, and fine soils preclude establishment of other species (Pendleton and others 1996). Seedling growth rate and palatability of mature plants are moderate (personal communication with Steve Monsen, USDA-FS-RMRS, Provo, UT, and Howard Stutz, Brigham Young University, Provo, UT). Plants may attract rodents, other small animals, and deer.

Benefits.—Siltbush is a potential revegetation and soil stabilization species for disturbances resulting from mining and other human activities on sites where it is native. Few other species will grow on these outcrops (Pendleton and others 1996).

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Glossary of Technical Terms Used in this Volume

Achene—an indehiscent one-seeded fruit type common in Asteraceae.
Alfisols—order of moderately leached soils, developed under forests, with relatively high native fertility, and having well developed subsurface horizons with clay accumulation.
Allele—one of an array of genes possible at a certain position (locus) on a given chromosome.
Allelopathy—the negative influence of plants on each other generally understood to arise from released metabolic products.
Alpine—sites in mountains above the timberline or vegetation characteristic of those areas.
Anthesis—the time at which a flower comes into full bloom.
Arborescent—having a treelike habit.
Aridisols—order of soils of arid regions that contain free $CaCO_3$ and have at least some subsurface horizon development.
Aril—an appendage or outer covering of some seeds, often fleshy or pulpy.
Armed—having spines or thorns.
Awn—bristle-like appendage of a flower and fruit usually seen in grasses.
Axillary—borne in the axils (or inside the angles of attachment) of leaves.
Beach strand—narrow strip of vegetation between a beach and inland formations.
Berry—fleshy fruit containing one or usually more seeds.
Biomass—the dry weight of the plants and animals (usually just plants in vegetation studies) in a unit area.
Bonsai—a tree or shrub grown in miniature form through cultural practices; the term is sometimes used for naturally miniature trees or shrubs.
Bract—modified leaves associated with flowers.
Calyx—the whorl of green leaf- or bract-like sepals.
Campanulate—bell shaped.
Canescent—hoary, gray-colored pubescence.
Canopy—the more or less continuous cover of tree crowns in a forest.
Capsule—a fruit arising from a multicarpellate ovary that usually dries and splits open.
Cartaceous—papery texture (usually used to describe leaves).
Catkin—a drooping elongated inflorescence of unisexual flowers typical of willows.
Cespitose shrubs—very short shrubs with a cushion-like habit.
Chaining—dragging a heavy chain between two bulldozers to kill unwanted brush and small trees and to scarify the soil.
Clambering—habit of growing over obstacles or into low vegetation without tendrils or other specialized climbing structures.
Claviculate—club shaped.
Clearcut—silvicultural harvesting method in which all the trees are removed at one time and usually unwanted material is felled as well.
Climax—terminal stage of ecological succession in which the vegetation association remains stable over a relatively long period.
Codominant—a crown class in a tree or shrub canopy in which a plant shares the main canopy level with many other individuals of similar height.
Colluvium (colluvial soil)—fractured rock and soil accumulated at the foot of a slope or the soil developed from it.
Coppice—reproduce by sprouts after being cut or damaged.
Cordate—heart shaped.
Coriaceous—thickened and leathery.
Corolla—the whorl or aggregate of the petals of a flower.
Corymb—a flat-topped inflorescence in which the outer flowers open first.
Crenate—margin with rounded, broad teeth.
Cyme—a more or less flat-topped inflorescence in which the central flowers open first
d.b.h.—stem diameter at breast (1.37 m above the ground) height.
Decumbent—branching habit that is flattened, growing along the ground with ends turned up.
Dioecious—having staminate (male) and pistillate (female) flowers on different plants.
Diploid—having two sets of chromosomes in a somatic nuclei.

Disjunct population—a population isolated from the main part of the range.
Diurnal—occurring (blooming) during the day.
Dominant—a crown class in forest or shrub canopy in which the individual is taller than the general canopy level; may also refer to species with a preponderance of numbers or biomass.
Drupe—fleshy, one-seeded fruit whose seed is encased in a stony endocarp.
Ecotone—a zone of transition between adjacent plant communities.
Ecotype—a population within a species that is genetically adapted to a certain habitat distinct from that which is general for the species.
Edaphic—pertaining to the soil and its ecological relationships.
Endosperm—starchy or oily tissue in many seeds.
Entire—without teeth or indentations on the margin.
Epigeal—germination and emergence in which the cotyledons raise above the soil surface.
Escapes—introduced populations now established and competing in the wild and spreading beyond the original point of introduction.
Excessively drained soil—water runs off, infiltrates, or evaporates rapidly so that the soil tends to be droughty even with ample rainfall.
Floret—individual, usually minute, flower of a compound flower.
Fruticose—being woody or shrub-like.
Galleries—small patches of vegetation (usually trees or shrubs) in protected locations distinct from surrounding vegetation.
Germinative capacity—the percentage of seeds that germinate during the normal period of germination.
Glabrous—not hairy; hairless or nearly so.
Glaucous—with a waxy bloom or whitish substance that rubs off.
Habit—the growth form or appearance of a plant.
Head—a compact, multiple inflorescence, often disk-shaped.
Hammock—a fertile area in Florida and Southeastern United States that is elevated above the surrounding terrain.
Hypanthium—a floral tube formed by the fusion of the basal portions of the sepals, petals, and stamens from which the rest of the floral parts arise.
Hypogeal—germination and emergence in which the cotyledons remain below the soil surface.
Inceptisols—order of soils that are young, frequently rocky, and have a poorly developed profile.
Intermediate—a crown class of tree or shrub canopies in which the individual plant crown is within and does not quite rise to the level of the top of the canopy.
Lanate—soft, woolly pubescence.
Layering—rooting at a point on a stem where the stem comes in contact with the soil or with artificial treatment called air layering.
Legume—one to multiple-seeded fruit (pod) common in the Fabaceae family.
Lenticels—lenticular or diamond-shaped dots, pits, or corky protrusions on stems.
Litter—organic debris on the surface of the soil or the uppermost layer of the forest floor organic horizon.
Maceration—the process of soaking and gently grinding fruits to remove the pulp from seeds.
Mesic—moist soil or environment; neither excessively wet nor dry.
Mine spoil—dirt and rock left after a mining operation.
Monoecious—having staminate (male) and pistillate (female) flowers on the same plant.
Naturalized—naturally reproduced progeny of horticultural plants or wildland plantings outside their native range.
Nerve—vein, usually used in relation to leaves.
Nut—a one-seeded fruit enclosed in an involucre (diminutive=nutlet).
Old growth forest—characterized by old, usually large, and often decadent trees.
Open forest—a forest characterized by low basal area, a large amount of space between crowns, and a lot of sunlight reaching the forest floor.
Open-grown—growing without significant competition from plants of similar size or taller.
Panicle—an inflorescence with indeterminate branching, the primary axis bearing branched secondary axes and pedicellate flowers.
Pappus—hairs attached to small seeds that together function as a wing.
Perfect flower—a flower with both stamens (male parts) and carpels (female parts).
Pericarp—the wall of a ripened ovary (fruit).

pH—a measure of soil acidity or alkalinity; values above 7.0 are alkaline and values below are acid.
Phenotype—a plant as it exists; the product of the interaction of genetics and environment.
Pioneer—shrub or other plant that establishes on or has the ability to colonize newly disturbed habitat.
Pith—spongy central cylinder of parenchyma tissue in stems.
Ploidy—the degree of repetition of the basic chromosome number.
Poorly drained soil—water runs off or evaporates so slowly that the soil remains wet for a large part of the year.
Provenance—the original geographic source of a plant's genetic material.
Puberulent—covered with soft, very fine hairs.
Raceme—an inflorescence with indeterminate single axis and pedicellate flowers.
Rachis—the axis of a pinnately compound leaf.
Remnant (forest)—lightly to moderately disturbed pieces or stands of the original forest.
Reticulate—with a net-like structure.
Rhizome—modified underground stem.
Riparian vegetation—plant associations and stand types growing along streams.
Samara—a one-seeded, winged fruit.
Savannah—tropical or subtropical grassland with scattered trees; usually maintained by periodic fires.
Scabrous—covered with scattered, short, stiff hairs.
Scandent—vine-like habit.
Scarify—to perforate or make a seed coat permeable by mechanical or chemical means.
Scrub—vegetation consisting of shrubs and sometimes trees stunted because of poor site conditions.
Secondary forest—forest that has grown up after clearing or lesser disturbance.
Selfing—pollination of a plant with its own pollen.
Seral—transitional as a site or vegetation association moves toward a climax state.
Serrulate—finely serrate.
Sessile—connected directly to the stem or other structure without a stalk.
Shade intolerant—requiring full or nearly full sunlight to survive, grow and reproduce.
Shade tolerant—the ability to survive, grow, and reproduce in the shade of taller vegetation, as under a tree canopy.
Skeletal soil—substrate in which stones form the structure of the soil with sand, silt, and clay filling the voids between.
Slash—the cut stems and limbs of trees and brush, or to cut unwanted trees and brush leaving it in place.
Soil texture—classes defining the proportion of sand, silt, and clay making up a soil.
Spike—indeterminate inflorescence of sessile flowers arranged linearly along a central axis.
Stamen—male or pollen-producing part of the flower.
Stipule—a small leaf-like structure found at the base of some leaf petioles, usually present in pairs.
Stolon—a stem or shoot that bends to the ground and takes root after contact.
Stratify—breaking the physiological dormancy of certain seeds with a period of cold or warm incubation.
Succulent—class of plants with fleshy leaves and usually stems that store water in their tissues and usually have special metabolic pathways (crassulan acid metabolism).
Sucker—root sprouts or to reproduce by root sprouts; sometimes used to mean an epichormic branch.
Suffruticose—perennial plant with stems that are woody near their base.
Suppress—inhibit the growth (and often eventually kill) by shading and competition for water and nutrients.
Synonym—an equivalent but superseded species name.
Testa—the outer coat of a seed.
Ultisols—a family of highly weathered soils found in subtropical and tropical environments.
Ultramafic rocks—metamorphic rocks (including serpentine) characterized by low percentages of silica and elevated percentages of iron and magnesium.
Variety—a subdivision of a species that has one or more inherited morphological characteristics.
Well-drained soil—water runs off, infiltrates, or evaporates readily but not rapidly.
Xeric garden—a garden planted with drought-resistant vegetation that is not irrigated.

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