

The Forgotten Flora of la Frontera

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Abstract—About 1,500 collections from within 100 kilometers of the Arizona border in Sonora yielded noteworthy records for 164 plants including 44 new species (12 non-native) for Sonora and 12 (six non-native) for Mexico, conservation species, and regional endemics. Many common widespread species were poorly collected. Southern range extensions (120 species) were more numerous than northern extensions (20), although nine potentially occur in Arizona. Non-native species dispersed along highways and escaped from cultivation. The Turkish poppy (*Glaucium corniculatum*), established near Agua Prieta, may reach Arizona. African buffelgrass (*Pennisetum ciliare*) and Natal grass (*Melinis repens*) are rapidly expanding into new, higher elevation areas.

Introduction

In northeastern Sonora, grassland and Chihuahuan desertscrub extend across the border from Arizona and New Mexico. Isolated “sky island” mountains support oak woodlands and pine-oak forests in the Apachean Highlands Ecoregion, the northwestern Madrean Archipelago extending northeast of the “mainland” Sierra Madre Occidental. Finger-like northern extensions of foothills thornscrub lie in the northern tributaries of the great Río Yaqui to within 150 km of the border in the complex transition from the New World tropics to the northern temperate zone.

Although Spanish explorers, missionaries, ranchers, and farmers were in northern Sonora for more than 350 years beginning in 1533, few descriptions of the vegetation and botanical specimens were made. The first English description of Sonora appears to have been in Hardy’s (1829) account of his 1825-27 trip through Mexico where he listed cultivated and native plants he observed being used. During the Mexican Boundary Survey of 1848, six botanists including George Thurber, Charles Wright, and Heinrich W. Schott collected plants between Guadalupe Canyon, Agua Prieta, and Santa Cruz just south of the modern Arizona border (Torrey 1859), initiating real botanical exploration in the Sonoran borderlands.

In 1890, Carl Lumholtz led an archeological expedition from Bisbee, Arizona, through Fronteras and other northern Sonoran towns in route to Chihuahua (Lumholtz 1902). Robinson and Fernald (1894) described new species collected by C. V. Hartman and C. E. Lloyd on the trip. Stephen S. White led a group of botanists from the University of Michigan on three expeditions in 1938-1941 to the Río Bavispe Region in northeastern Sonora. He described the vegetation and made about 4,000 collections of 1,200 species, mostly in an area of 1,200 km² in the Sierra del Tigre within the loop of the Río Bavispe (White 1948). As part of his survey of the birds of the pine-oak woodland, Joseph T. Marshall provided lists of the dominant trees in a series of mountain ranges in southern Arizona and northeastern Sonora (Marshall 1957).

Beginning with Howard Gentry, Forrest Shreve, and Ira Wiggins in the 1930s, botanists from the United States rushed southward to the tantalizing tropical deciduous forests of the Río Mayo region of southeastern Sonora, the treasures of the Sierra Madre Occidental in eastern Sonora (Gentry 1942; Martin et al. 1998), or the scenic Sonoran Desert (Shreve and Wiggins 1964). Botanists from Mexico City 2,200 km to the southeast only occasionally visited Sonora. Solis G. (1993) and Fishbein et al. (1995) provided preliminary reports on the flora of the Sierra de los Ajos east of Cananea. In 2001, we began collecting plants in northern Sonora within 100 kilometers of the Arizona border as part of the “Pollinator Monitoring and Education in Mexico” project. In spite of the White collection, we found that even common plants had not been well collected in the Sonoran borderlands. In this paper, we present preliminary results of our floristic survey of the borderlands.

Study Areas and Methods

Between July 2001 and April 2004, botanists from the Arizona-Sonora Desert Museum, Arizona State University (ASU), the University of Arizona (ARIZ), and the Universidad de Sonora (USON) visited the border region on 20 trips. Plant collections were made between Arroyo San Bernardino (109°08’W) east of Agua Prieta and the Sásabe area (111°59’W) within 50-100 kilometers of the Arizona border in the municipios of Agua Prieta, Bacoáchi, Cananea, Cucurpe, Fronteras, Imuris, Magdalena, Naco, Nacozari de García, Nogales, Santa Cruz, Sáric, and Tubutama. Elevations ranged from 630 m at Tubutama to 1,690 m west of Cananea. The vegetation ranged from Chihuahuan (near Agua Prieta) and Sonoran (near Tubutama) desertscrub to desert grassland (Cananea-Naco, Sásabe area), plains grassland (Santa Cruz Valley), oak woodland (Nacozari, Patagonia Mountains, Sierras Las Avispas, and Los Pinitos), and cottonwood-willow riparian forests (Arroyos Planchas de Plata and San Bernardino, Cíbuta-Imuris, Tubutama,). The area is within the Apache Highlands Ecoregion of The Nature Conservancy of

Arizona and the Instituto del Medio Ambiente y el Desarrollo Sustentable del Estado de Sonora (Marshall et al. 2004). Trips were scheduled after spring and summer rains to make general collections of reproductive plants. About 1,500 plants were collected under SEMARNAT permits to Francisco Molina F. and Jesús Sánchez E. and deposited into ARIZ, ASU, USON, and many other herbaria in the United States and Mexico. Most Cactaceae specimens were deposited in to USON in Hermosillo.

Results and Discussion

Plant collections within 100 km of the Sonora border were made for 164 species with few or no previous Sonoran records. Forty-four species, including 12 introduced from the Old World, are new for Sonora. Twelve species including six introduced weeds appear to be the first records for Mexico. Collections of 120 species are southern range extensions of Chihuahuan and Sonoran desertscrub, grassland, Apachean oak woodland, and riparian plants. In contrast, 20 collections reflected northward extensions of Sonoran desertscrub, foothills thornscrub, or “mainland” Madrean oak woodland species. Selected examples of noteworthy Sonoran plant collections are presented in table 1.

An *Anoda* (Malvaceae) southwest of Cananea and a *Flaveria* (Compositae) from east of Agua Prieta appear to be undescribed species (Paul A. Fryxell and B. L. Turner, personal communication, 2002). A few collections were of Arizona-Sonora regional endemics (*Bouteloua eludens* and *Pseudabutilon thurberi*). Some new Sonoran species such as Bartram stonecrop (*Graptopetalum bartramii*), green violet (*Hybanthus verticillatus*), sandpaper oak (*Quercus pungens*), and windmill grass (*Chloris verticillata*) are southward range extensions from southern Arizona. Interestingly, three Chihuahuan Desert species including red cyphomeris (*Cyphomeris gypsophilioides*), *Ruellia parryi*, and a sunflower (*Helianthus laciniatus*) do not occur in Arizona, while *Carlowrightia texana* was recently discovered in the San Pedro Riparian National Conservation Area east of the Huachuca Mountains (Elizabeth Makings, personal communication, 2004).

A few species in the Sonoran borderlands are of conservation concern in Arizona. These include Bartram stonecrop, bigflower blue star (*Amsonia grandiflora*), and the rosewood (*Vauquelinia californica* subsp. *pauciflora*). Our 1995 collection of Gentry indigo bush (*Dalea tentaculoides*) at Cruz del Diablo near Huásabas in eastern Sonora illustrates the importance of borderlands records. It was a southeastern range extension of 250 kilometers from the population in Sycamore Canyon west of Nogales, and was used to support dropping the species as a Candidate species for listing as Threatened under the Endangered Species Act in 1998. However, in 2002 the Center for Biological Diversity petitioned the U.S. Fish and Wildlife Service to list it as Endangered because it was only known from the two Arizona and one Sonora populations. Additional information from the Sonoran portion of its range will be critical in evaluating its' status.

Many of the noteworthy Sonoran collections are common Arizona plants with a few previous collections in Sonora.

These include blackspine, pancake, and Santa Rita prickly pears (*Opuntia macrocentra*, *O. chlorotica*, and *O. santa-rita*), burro grass (*Scleropogon brevifolius*), cliff rose (*Purshia stansburiana*), desert holly (*Acourtia nana*), littleleaf sumac (*Rhus microphylla*), rabbit brush (*Ericameria nauseosa*), soapberry (*Sapindus marginatus*), tarbush (*Flourensia cernua*), turpentine bush (*Ericameria laricifolia*), and many more. New records of Chihuahuan Desert plants in Sonora include dogfennel (*Thymophylla acerosa*), plains flax (*Linum puberulum*), ruda del monte (*Thamnosma texana*), sandpaper bush (*Mortonia sempervirens*), sandpaper oak, Texas shrub senna (*Senna wislizenii*), and twoleaf desert senna (*S. bauhinioides*).

A suite of Sonoran plants is found in the borderlands of Arizona from the Baboquivari Mountains southwest of Tucson east to the New Mexico border. A few examples are ball moss (*Tillandsia recurvata*), chiltepín (*Capsicum annuum* var. *aviculare*), confituría amarilla (*Lagascea decipiens*), coralbean (*Erythrina flabelliformis*), and feathertree/tepeguaje (*Lysiloma watsonii*). Our collections near the border in Sonora suggest that additional species may be discovered in Arizona. *Carlowrightia texana* (31°18'49"N) and red cyphomeris (31°13'59"N) were 2 and 5 kilometers south of the border (SOB) near Agua Prieta. Willowleaf oak (*Quercus viminea*; 31°08'31"N) was in oak woodland with the closely related Emory oak/bellota (*Quercus emoryi*) in the Sierra Las Avispas 16 km south of the border. Toji (*Struthanthus palmeri*; 22 km SOB; 31°07'06"N), a parasite on kidneywood/palo dulce (*Eysenhardtia orthocarpa*) and Emory oak, was nearby in an area where ball moss covers oaks and ocotillos (*Fouquieria splendens*). Farther west on the road to Sáric, ba'aco (*Phaulothamnus spinescens*; 17.5 km SWOB; 31°10'52"N) and bebelama (*Sideroxylon occidentale*; 27 km SOB; 31°08'59"N) grow with organ pipe cactus/pitahaya (*Stenocereus thurberi*) near La Arizona, the historic ranch for which the State of Arizona was named. Limpiatuna (*Kosteletzkya thurberi*, 45 km SOB; 30°57'21"N), a mallow with a large rose-colored flower, was found in the ciénega at Rancho Agua Caliente 19 km north of Imuris. The Sonoran Desert nopal durasnilla (*Opuntia gosseliniana*) was seen 57 km northwest of Caborca on MEX 2, 55 km southwest of the Arizona border.

Non-native Species

Of special conservation interest are the non-native species discovered in the borderlands. A lily (*Asphodelus fistulosus*) collected in Sonora for the first time north of Cucurpe is a Federal Noxious weed in the United States. A few Turkish poppies (*Glaucium corniculatum*) were first found in Mexico 4.7 km north of Santa Ana, Sonora, on MEX 15 in 1998. This annual has rough, dissected basal leaves, striking flowers with dark red petals grading into orange or yellow at the tips, and elongated, slender t-shaped fruit. In April 2004, thousands of individuals were found in broad roadside drainage areas along MEX 2 east of Agua Prieta. Considering that the border is only 2 km to the north, this attractive weed is to be expected in Arizona.

Other non-native species escape from cultivation. Individual Siberian elms (*Ulmus pumila*) have established in the Río Santa Cruz near Santa Cruz and on roadsides along MEX 2

Table 1—Selected noteworthy plants collected in the Sonoran borderlands in 2001-2003.

Native species new for Sonora

Artemisia pringlei (Compositae)
Carlowrightia texana (Acanthaceae)
Chloris verticillata (Gramineae)
Cyphomeris gypsophiloides (Nyctaginaceae)
Graptopetalum bartramii (Crassulaceae)
Helianthus laciniatus (Compositae)
Hybanthus verticillatus (Violaceae)
Kallstroemia hirsutissima (Zygophyllaceae)
Leersia oryzoides (Gramineae)
Lonicera albiflora (Caprifoliaceae)
Lotus hamatus (Leguminosae)
Lygodesmia ramosissima (Compositae)
Melampodium strigosum (Compositae)
Penstemon linarioides var. *viridus* (Scrophulariaceae)
Ruellia parryi (Acanthaceae)
Quercus pungens (Fagaceae)

Non-native species New for Sonora

Asphodelus fistulosus (Liliaceae)
Choripora tenella (Cruciferae)
Eragrostis echinochloidea (Gramineae)
Fumaria officinalis (Fumariaceae)
Fumaria parviflora (Fumariaceae)
Glaucium corniculatum (Papaveraceae)
Herniaria hirsuta (Caryophyllaceae)
Kochia scoparia (Chenopodiaceae)
Medicago lupulina (Leguminosae)
Sinapsis arvensis (Cruciferae)
Verbascum virgatum (Scrophulariaceae)
Veronica anagallis-aquatica (Scrophulariaceae)

New records of northern species

Acourtia nana (Compositae)
Amsonia grandiflora (Apocynaceae)
Asclepias subverticillata (Asclepiadaceae)
Bahia absinthifolia (Compositae)
Chamaesaracha sordida (Solanaceae)
Cistanthe monandra (Portulacaceae)
Ericameria laricifolia (Compositae)

Ericameria nauseosa (Compositae)
Erioneuron grandiflorum (Gramineae)
Evolvulus sericeus (Convolvulaceae)
Flourensia cernua (Compositae)
Gaillardia pinnatifida (Compositae)
Gomphrena caespitosa (Amaranthaceae)
Hedeoma nanum (Labiatae)
Jatropha macrorhiza (Euphorbiaceae)
Lepidium thurberi (Cruciferae)
Linum puberulum (Linaceae)
Mortonia sempervirens (Celastraceae)
Opuntia chlorotica (Cactaceae)
Opuntia macrocentra (Cactaceae)
Opuntia santa-rita (Cactaceae)
Panicum hallii (Gramineae)
Physaria fendleri (Compositae)
Pseudabutilon thurberi (Malvaceae)
Purshia stansburiana (Rosaceae)
Rhus microphylla (Anacardiaceae)
Salvia subincisa (Labiatae)
Sapindus marginatus (Sapindaceae)
Scleropogon brevifolius (Gramineae)
Senna bauhinoides (Leguminosae)
Sphaeralcea angustifolia (Malvaceae)
Tagetes minuta (Compositae)
Thamnosma texana (Rutaceae)
Thelesperma megapotamicum (Compositae)
Thymophylla acerosa (Compositae)
Vauquelinia californica subsp. *pauciflora* (Rosaceae)

Southern species near Arizona border

Acacia occidentalis (Leguminosae)
Havardia mexicana (Leguminosae)
Kosteletzkya thurberi (Malvaceae)
Opuntia gosseliniana (Cactaceae)
Phaulothamnus spinescens (Phytolaccaceae)
Quercus viminea (Fagaceae)
Sideroxylon occidentale (Sapotaceae)
Struthanthus palmeri (Loranthaceae)
Tephrosia leucantha (Leguminosae)

and SON 117 in the Agua Prieta area. Honey locust (*Gleditzia triacanthos*), a large spiny legume with dense foliage native to the Southeastern United States, is a common shade tree near Lochiel, Arizona, and in Santa Cruz, Sonora. Scattered honey locusts in the Río Santa Cruz near Santa Cruz appear to be from the town trees and not from Lochiel as claimed by Solis et al. (2002). The Asian tree of heaven (*Ailanthus altissima*) was widely planted as an ornamental in the 1800s, especially in rural and mining towns. In Santa Cruz, it is locally called “nogal,” reflecting the similarity of the leaves with the Arizona walnut/nogal (*Juglans major*). Colonies of plants were seen in several places in the Río Santa Cruz both near and away from houses and ruins. Although this tree reproduces profusely with root sprouts, hundreds of seedlings were found on roadcuts.

Jujube/dátil chino (*Ziziphus jujuba*) is an ornamental tree with an edible fruit that was widely planted by Chinese immigrants. Although no Chinese presently live in San Lázaro and Santa Cruz, dátil chino is still appreciated by the mestizo residents. A stand of trees was found along MEX 2 east of Agua Prieta in an area without houses or ruins nearby. In the old mining town of Bisbee, Arizona, fennel (*Foeniculum vulgare*) is a European plant used for food and medicine that is well established in disturbed areas along streets. A collection of this plant in a similar weedy urban setting in Agua Prieta is the first record for Sonora.

Two non-native grasses are of special concern in the Sonoran borderlands. Buffelgrass/zacate buffel (*Pennisetum ciliare*) is a robust, shrub-like African grass that has been actively planted

in Sonora for cattle forage. However, in Arizona and Texas, it is perceived as a threat because it introduces fire as an ecological process into fire-intolerant Sonoran and Chihuahuan desertscrub. Beetle et al. (1991) mapped it in most of central and southern Sonora in areas with 300 mm/yr or less rainfall. Their highest elevation observation for buffelgrass was 1,280 m west of Cumpas (Rogelis Alcaraz, personal communication, 2004). Recently it was seen at 1,420 m elevation in oak woodland on the Sierra de Mazatán 70 km east of Hermosillo (Jesús Sánchez E., personal communication, 2004). Our collections suggest that this savanna grass is expanding its range upward to at least 1,320 m in northern and northeastern Sonora elevation, and include the first records for the municipios of Agua Prieta, Fronteras, Imuris, and Nacozari de García; it probably also occurs in the municipios of Cananea and Naco. Noteworthy localities for buffelgrass record were in desert grassland 9.9 km north on MEX 15 (916 m) and 15 km northeast on MEX 2 (1,310 m elevation) of Imuris and in Chihuahuan desertscrub 18.3 km east on MEX 2 and 36 km south on SON 117 of Agua Prieta (1,139-1,320 m elevation).

Natal grass/zacate rosado (*Melinis repens*) is a South African species that is widespread in Sonora but reaches higher elevations than buffelgrass (Beetle et al. 1991). Our collections were the first records for the municipios de Nacozari de García and Tubutama; we expect more records for the municipios de Cananea, Fronteras, Naco, Santa Cruz, and Sáric. This species has begun to increase rapidly in the last few years. In the last six years we have noticed dramatic increases in this grass in northern Sonora south of Nogales and northeast of Imuris, as well as in easternmost Sonora in the near Yécora. At higher elevations it is replacing native grasses in desert grasslands. At 15 km northeast of Imuris on MEX 2, it is invading a unique grassland with feathertrees dominants on a south-facing slope at 1,310 m elevation. In the Guadalupe Tayopa-Tepoca area in the Municipio de Yécora, Natal grass now dominates disturbed openings in tropical deciduous forest.

In conclusion, the flora of the Sonoran borderlands is very diverse and reflects complex transitions between temperate desertscrub, grassland, and oak woodland and tropical vegetation to the south. Additional collections in the area will continue to yield many range extensions, State records for Sonora, national records for Mexico and track threats from aggressive non-native species.

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