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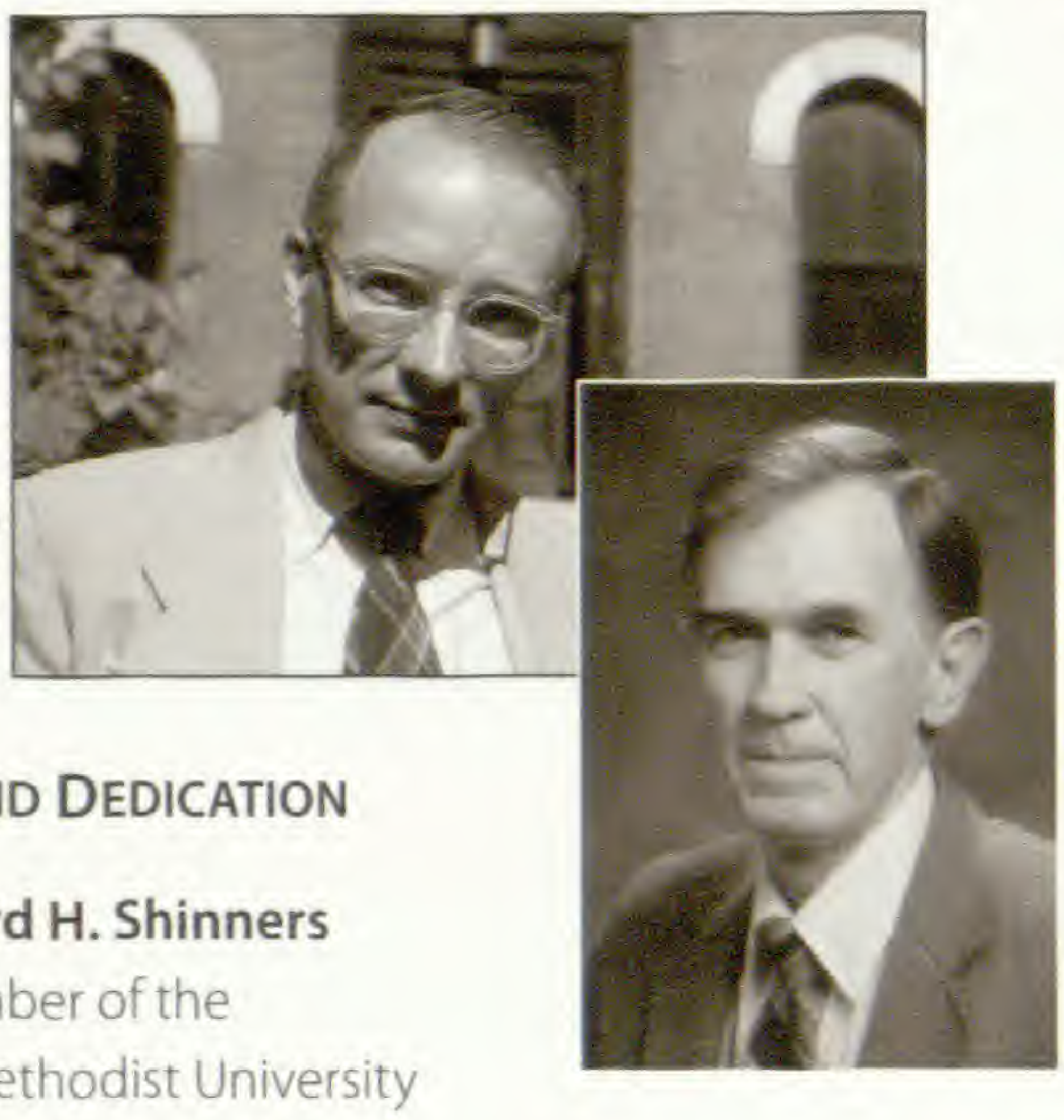

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1700 University Dr.
Fort Worth, Texas 76107-3400, USA
817-332-7432; 817-332-4112 fax
Electronic mail: barney@brit.org; jbrit@brit.org

EDITOR: Barney Lipscomb
ASSISTANT EDITOR: Brooke Byerley

CONTRIBUTING SPANISH EDITOR
Félix Llamas (Universidad of León, León, Spain)

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A NEW *SISYRINCHIUM* (IRIDACEAE) FROM CEDAR GLADES IN NORTHERN ALABAMA

Bruce A. Sorrie

NC Natural Heritage Program and
University of North Carolina Herbarium
North Carolina Botanical Garden
Chapel Hill, North Carolina 27599-3280, U.S.A.
nruce.sorrie@ncdenr.gov

Wesley M. Knapp

Maryland Department of Natural Resources
Wildlife and Heritage Service
P.O. Box 68, Wye Mills, Maryland 21679, U.S.A.
wknapp@dnr.state.md.us

L. Dwayne Estes

Department of Biology &
Center for Field Biology
Austin Peay State University
Clarksville, Tennessee 37044, U.S.A.
estesL@apsu.edu

Daniel D. Spaulding

Anniston Museum of Natural History
P.O. Box 1587
Anniston, Alabama 36202, U.S.A.
dspaulding@annistonmuseum.org

ABSTRACT

Sisyrinchium calciphilum Sorrie is described from a three county area of northwestern Alabama. The new species resembles *S. albidum* and *S. capillare* in possessing paired inflorescences, but is readily distinguished by a suite of characters. It is restricted to limestone cedar glades and semi-open limestone slopes.

RESUMEN

Se describe Sisyrinchium calciphilum Sorrie de un área de tres condados en el noroeste de Alabama. La nueva especie se parece a *S. albidum* y *S. capillare* por tener inflorescencias en pares, pero se distingue fácilmente por un conjunto de caracteres. Está restringida a calizas en claros de cedros y laderas semiabiertas.

Sisyrinchium L. is a taxonomically difficult genus with 37 species in North America north of Mexico. Of these, only *Sisyrinchium albidum* Raf. and *S. capillare* Bicknell have paired inflorescences (Cholewa & Henderson 2002). Each of the inflorescences is subtended by two bracts or spathes, which terminate the unbranched stems. Although this combination of characters is rare in North American *Sisyrinchium*, a third entity shares these character states and is the subject of this paper. We propose *Sisyrinchium calciphilum* Sorrie for this species, which is endemic to limestone glades in northwestern Alabama.

Sisyrinchium calciphilum Sorrie, sp. nov. (**Fig. 1**). Type: ALABAMA: Lawrence Co.: Prairie Grove Glades Preserve, common in moist grassy areas of open limestone cedar glade, 16 Apr 2011, *B. Sorrie, D. Estes, & W. Knapp 12742* (holotype: NCU; isotypes: APSC, GH, MO, UNA, VDB/BRIT).

Plants: perennial, cespitose, 20–42 cm tall. Stems simple, clearly but narrowly winged, 0.7–1.3(–1.5) mm wide, each wing wider than stem core, glabrous, margins entire, stem base purple to pinkish brown. **Leaves:** glabrous, bases not persistent as fibrous tufts. **Inflorescences:** paired one sided cymes, i.e., rhiphidia, each subtended by a pair of spathes, these subtended by a bractlike leaf 41–82 mm long that often obscures inner inflorescence; bractlike leaf and spathes purple tinged, spiculate, spathe keels denticulate, outer spathe of outer pair 12–18 mm, spathes of outer inflorescences averaging 4.4 mm longer than spathes of inner inflorescences, spathe margins hyaline, translucent to purple. **Flowers:** tepals blue with yellow bases, 7–9 mm long, apex weakly emarginate, aristate; filaments connate most of length, egandular; ovary green and glandular-hairy. **Capsules:** fully mature capsules not seen; immature capsules more-or-less globose, 4–5 mm long and wide, pale green, pedicels spreading to ascending, glabrous or with very sparse glandular hairs. **Seeds:** mature seeds not seen.

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Fig. 1. Holotype of *Sisyrinchium calciphilum* Sorrie; *B. Sorrie, D. Estes, & W. Knapp 12742* (holotype, NCU). [digital image]

Additional specimens examined: **ALABAMA. Franklin Co.:** ca. 6 mi E of Russellville, moist open area on Newburg Glade, 28 Apr 1993, *R. Whetstone, D. Spaulding, J. Ballard, & T. Dobson 16395* (JSU). **Lawrence Co.:** S of Wren, Alabama 33 ca. 1.2 mi N of Bankhead National Forest, xeric limestone outcrop, 23 May 1974, *R. Whetstone & T. Atkinson 2823* (JSU); pasture near Mt. Hope and County Road 99, limestone slopes, 27 Apr 1993, *R. Whetstone, D. Spaulding, J. Ballard, & T. Dobson 16436* (JSU); N of Courtland, just S of Wheeler Station Sporting Clays, recently burned oak-hickory flatwoods, 4 May 1996, *R. Whetstone & S. Hruska 17457* (JSU); Prairie Grove Glades Preserve, abundant on thin clay soil over outcrops, flowers blue, 19 Apr 2003, *R. Kral 93898* (AMAL, APSC); 2 mi SE of Speake on Alabama 157, clearing in limestone woods, 23 Apr 1968, *R. Kral 30489* (GA); 1.5 mi SW of Flat Rock, limestone cedar glade, tepals dark purple, 17 Apr 2006, *B. Keener & D. Spaulding 2817* (AMAL, UNA); Bankhead National Forest, off FSR-264, limestone woods, 17 Apr 2005, *D. Spaulding & B. Keener 12252* (AUA,UNA). **Morgan Co.:** disturbed edge of "Crusher Glade" adjacent to dry limestone woods, off County Road 38, 29 Mar 1997, *D. Spaulding, R. Whetstone, J. Ballard, & T. Ballard 9587* (AMAL); Massey, CR-55 near Emmanuel Road, disturbed limestone glade, 13 Apr 2003, *D. Spaulding 11723* (AMAL, UNA); roadside glade on Cedar Plains Road E of Massey, 16 Apr 2011, *B. Sorrie, D. Estes, & W. Knapp 12746* (DUKE, GA, NCSC, NCU, US); East Lacon Road, limestone outcrops on slope in dryish woods, 16 Apr 2011, *B. Sorrie, D. Estes, & W. Knapp 12747* (NCU, NY).

Sisyrinchium albidum was the first of the blue-eyed-grasses with paired inflorescences to be named (Rafinesque 1832). Much later, Bicknell split out *S. capillare* with its wiry, barely winged stems (Bicknell 1899). Since there appeared to be overlapping characters between these two species, some authors declined to recognize *S. capillare* (e.g., Radford et al. 1968) or confounded their habitats and ranges (Cholewa & Henderson 2002). Recent herbarium and field work by the authors show that *S. capillare* occurs strictly in the Atlantic Coastal Plain Physiographic Province whereas *S. albidum* occurs primarily in the Piedmont, Interior Low Plateau, and Interior Highlands Physiographic Provinces, northward to the Great Lakes states; and with populations southward to the Gulf Coastal Plain (Fig. 6). In addition, there are strong morphological differences, notably the slender and nearly wingless stem of *S. capillare* (vs. clearly winged in *S. albidum*), stem with dense fibrous remains of leaves (vs glabrous to only moderately dense), nearly equal spathes (vs. very unequal), and short outermost spathe (vs. long) (Table 1). Note that Table 1 divides *S. albidum* into two groups, east and west of the Appalachian Mountains. These groups appear to differ from each other, notably in stem width and the difference between inner and outer spathe length, but there is much overlap. At this time we are reluctant to recognize any infraspecific taxa and treat *S. albidum* as a widespread, variable species.

Specimens of *S. calciphilum* are quite different from *S. capillare*, where they had been placed due to their slender stems. Stems of *S. calciphilum* are definitely (albeit narrowly) winged, the fibrous remains of leaf bases are absent, the two outer spathes exceed the two inner by a mean of 4.4 mm, spathes and leaflike bracts are strongly purple tinged and spiculate. Corolla color of *S. calciphilum* is medium blue, unlike the pale blue to whitish color of *S. capillare* (Figs. 2 & 3). Moreover, *S. calciphilum* is restricted to high pH limestone glades, whereas *S. capillare* to acidic, fire-maintained longleaf pine savannas (Table 1).

Compared with *S. albidum*, *S. calciphilum* is less strikingly distinct. While a single morphological character may match the eastern or western populations of *S. albidum*, the suite of characters distinguishes *S. calciphilum* (Table 1). Critical differences are: stem width of *S. calciphilum* is similar to that of many plants from east of the Appalachians, but only half as wide as sympatric plants from west of the Appalachians. Stem margins of *S. calciphilum* are smooth, but denticulate (often strongly so) in *S. albidum*. The difference between the two inner and two outer spathe lengths of *S. calciphilum* is on average the same as plants from west of the Appalachians, but almost double that of plants from east of the Appalachians. Corolla color of *S. calciphilum* is medium blue, unlike the pale blue to whitish color of *S. albidum* (Figs. 2 & 4). Coupled with the restricted range and habitat preference, these morphological differences are significant at the species level.

KEY TO *SISYRINCHIUM* WITH PAIRED INFLORESCENCES

1. Stems obviously winged, each wing wider than stem core; outer spathe pair longer than inner by 2.3 mm (average) or more
    2. Stems mostly 1.0–2.5 mm wide, margins denticulate; corolla pale blue to whitish ____ **S. albidum**
    2. Stems mostly 0.7–1.3 mm wide, margins smooth; corolla medium blue ____ **S. calciphilum**
1. Stems not winged or scarcely so, each wing narrower than stem core; outer spathe pair about equal in length to inner pair ____ **S. capillare**

DISTRIBUTION AND HABITAT

Sisyrinchium calciphilum is endemic to three counties in northwestern Alabama (Fig. 5), a region underlain by Mississippian limestone and known to support a number of limestone glades. Associated species include *Carex cherokeensis* Schwein., *Dalea gattingeri* (A. Heller) Barneby, *Forestiera ligustrina* (Michx.) Poir., *Juniperus virginiana* L., *Leavenworthia alabamica* Rollins, *L. crassa* Rollins, *Linum sulcatum* Riddell, *Minuartia patula* (Michx.)

Fig. 2. *Sisyrinchium calciphilum*, Lawrence County, Alabama. Photos Wayne Barger.

Fig. 3. *Sisyrinchium capillare*, Pender County, North Carolina. Photo Bruce Sorrie.

Fig. 4. *Sisyrinchium albidum*, Stanly County, North Carolina. Photo Bruce Sorrie.

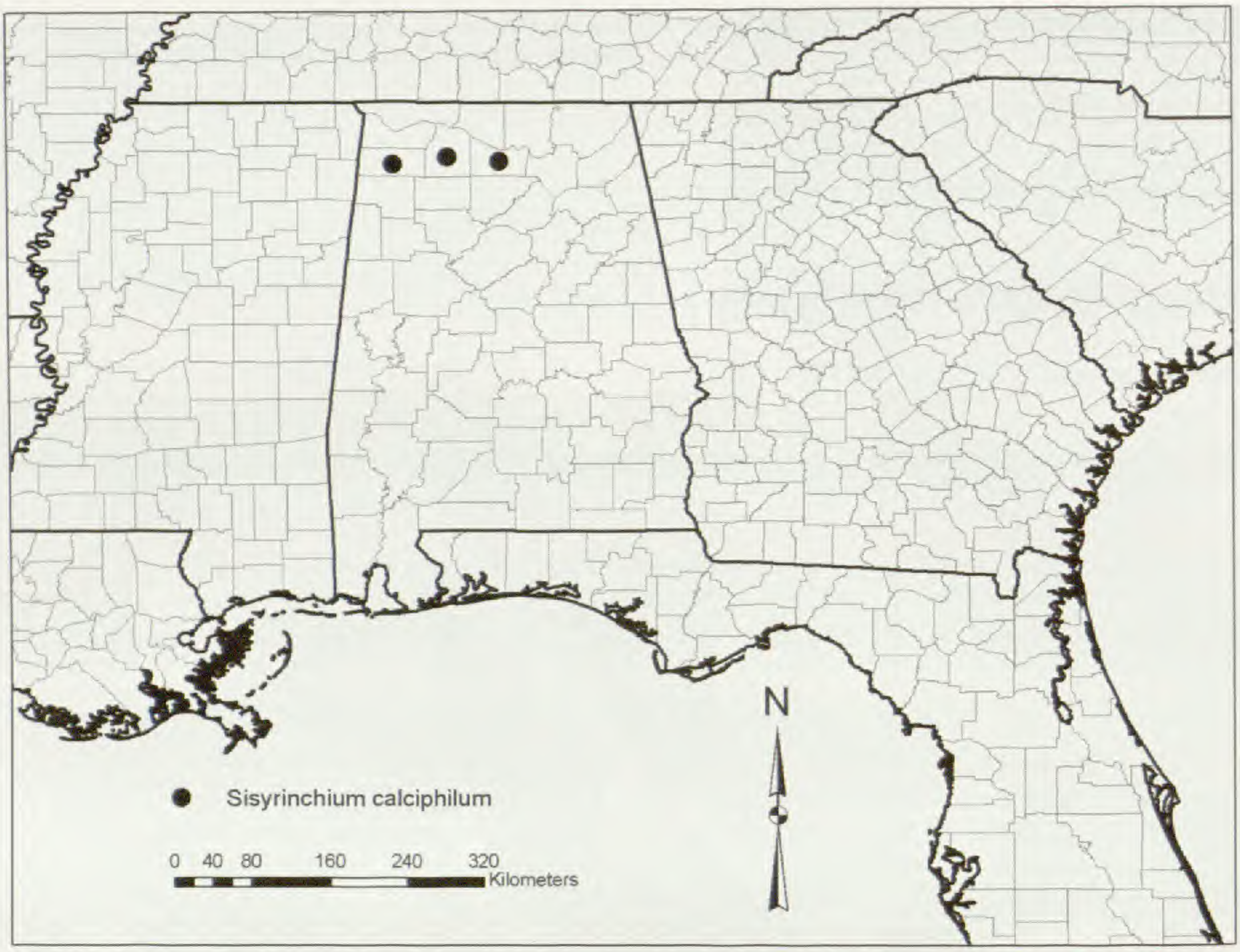

FIG. 5. Range map of *Sisyrinchium calciphilum*.

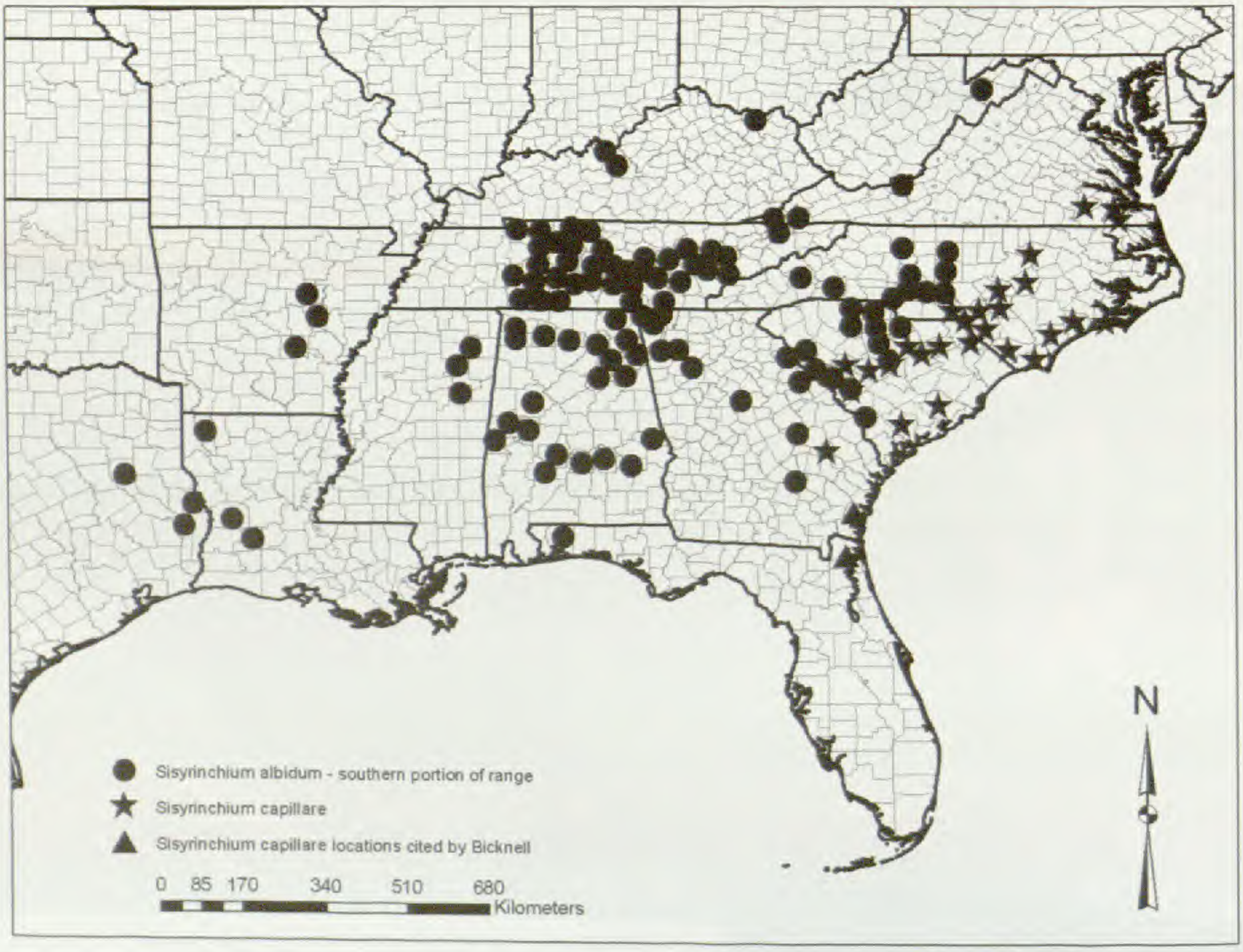

FIG. 6. Range map of *Sisyrinchium capillare* and *S. albidum* (southeastern states only).

Table 1. Comparison of *Sisyrinchium albidum, S. capillare,* and *S. calciphilum. Sisyrinchium albidum* has been divided into two populations, east and west of the Appalachian Mountains; these populations without taxonomic status. Measurements are in millimeters, n=25 measurements per species.

Character	*S. calciphilum*	*S. capillare*	*S. albidum* E of Appalachians	*S. albidum* W of Appalachians
Stem width: range; mean	0.7–1.3(–1.5) 1.1	0.6–1.0(–1.2) 0.85	(0.8–)1.0–1.9(–2.2) 1.3	(1.2–)1.5–2.5(–2.8) 1.9
Stem winged	Yes; each wing wider than stem core, rarely equal	No, or barely; each wing narrower than stem core	Yes; each wing wider than or equal to stem core	Yes; each wing much wider than stem core
Stem margins denticulate	No	No	Yes; sometimes no	Yes; rarely no
Old leaf bases fibrous	No; 0/25 plants usually dense	Yes, 25/25 plants, sparse to moderately dense	Variable; 10/25 plants, sparse to moderately dense	Usually not; 4/25 plants,
Stem base and leaf base color	Purple, pinkish brown	Brown, occasionally pinkish brown	Brown, pinkish brown, purple	Purple, pinkish brown, brown
2 outer spathes > 2 inner (mean distance)	4.4	Nearly equal; about 1 mm longer or shorter	2.3	4.4
Outermost spathe length: range; mean	12–18(–20) 15.2	12–17 13.7	12–18(–22) 15.1	15–22(–25) 18.8
Spathes and leaflike bract spiculate	Yes	No	Yes	Yes
Spathes and leaflike bract purple-tinged	Yes	No	Usually; 20/25 plants purplish	Variable; 14/25 plants purplish
Glandular hairs on ovary and base of corolla	Yes	No	Usually; 19/25 with hairs	Variable; 10/25 with hairs
Corolla color	Blue, yellow basally	Pale blue to whitish, yellow basally	Pale blue to whitish, yellow basally	Pale blue to whitish, yellow basally
Habitat	Limestone cedar glades, rocky limestone woodlands	Fire-prone longleaf pine savannas; strictly coastal plain	Openings in rocky oak-hickory-pine forests, granitic outcrops, powerlines	Prairies, oak glades, cedar-glades, openings in rocky oak hickory-pine forests

Mattf.,*Quercus muehlenbergii* Engelm., *Schizachyrium scoparium* (Michx.) Nash, *Schoenolirion croceum* (Michx.) A. Wood, *Scutellaria leonardii* Epling, *Sporobolus neglectus* Nash, and *S. vaginiflorus* (Torr. ex A. Gray) A. Wood. *Sisyrinchium albidum* has also been collected in the same three counties, but is not known to co-occur with *S. calciphilum*.

ACKNOWLEDGMENTS

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Rafinesque, C.S. 1832. *Sisyrinchium albidum*. Atlantic J. 1:17–18.

BOOK REVIEW

Noel H. Holmgren, Patricia K. Holmgren, James L. Reveal, and Collaborators. 2012. **Intermountain Flora, Vascular Plants of the Intermountain West, U.S.A. Volume Two, Part A: Subclasses Magnoliidae–Caryophyllidae.** (ISBN: 978-0-89327-520-4, hbk.). New York Botanical Garden Press, 2900 Southern Blvd., Bronx, New York 10458-5126, U.S.A. (**Orders:** http://www.nybgpress.org, 718-817-8721, fax 718-817-8842). $150.00, 731 pp, color frontispiece, grayscale epilogue, line drawings throughout, 7½" × 10½".

With publication of Volume 2A, the Intermountain Flora Team brings to a successful close a decades-long, multigenerational effort to document the plant life of the colder drylands occupying the large region in the western United States more or less bounded by the Sierra Nevada to the west, the Rocky Mountains to the east, and stretching from central Idaho south to northwestern Arizona. Originally conceived by Bassett Maguire around 1940, the ensuing research became a driving force in the careers of Arthur Holmgren and Arthur Cronquist, as well as the botanists who authored this final volume. Publication of the six volumes in eight big books (most floristicians have difficulty estimating space requirements for their works) took forty years, but time alone is a poor estimate of the scope of the exploration and research that went into the project. The full series treats 3,847 species in 898 genera. For those who do not own these wonderful books, the publisher is currently offering the whole set for $520 (a $640 value). There also are rumors of a planned ninth volume with a comprehensive index and a set of updates and errata.

Volume 2A of the work, which includes the beginning of the dicots in the Cronquistian classification system, treats 147 genera, 611 species, and 301 additional infrataxa in 31 families, including such regionally diverse important groups as the Papaveraceae, Ranunculaceae, Polygonaceae, Caryophyllaceae, Chenopodiaceae, Amaranthaceae, Nyctaginaceae, Montiaceae, and Cactaceae. The presentation is identical to that in earlier volumes, with indented keys and detailed descriptions followed by range/ecology statements and very useful critical notes on taxonomic and other issues (along with copious literature citations). The treatments also include extensive synonyms, with complete citations of types. The numerous plates of line drawings (by several artists), which cover varying numbers of taxa per genus, are uniformly excellent in composition and detail. The drawings of Cactaceae are particularly beautiful. A useful addendum summaries the 6 new combinations, 34 new typifications, and 1 new cytological report included in the volume. Throughout, the contents are encyclopedic and the treatment of any family or genus provides a marvelous introduction to the taxonomy, nomenclature, ecology, and uses for that group.

There is little to criticize in this enormous work. Perhaps some of the more recent volumes are a bit pricey, but sadly that has become the nature of the printed page. The lack of a comprehensive key to dicot families (such keys exist for the remaining major plant groups in other volumes) might be addressed in the proposed follow-up volume, as might a more detailed taxonomic summary of the plants in the series or a discussion of plants of conservation concern in the region (a 70-year study surely can offer a unique perspective on regional patterns of plant endangerment). However, such potential additions in no way diminish the present utility of the volumes. Between the burnt-orange covers of these volumes lies a treasure-trove of information and insights on the vascular plants unequaled for most other regions of the country. The authors, past and present, are to be congratulated on their persistence in seeing this project through to successful completion.—*George Yatskievych, Missouri Botanical Garden, P.O. Box 299, St. Louis, Missouri 63166-0299, U.S.A.*

POLEMONIUM ELUSUM (POLEMONIACEAE), A NEW SPECIES FROM EAST CENTRAL IDAHO, U.S.A.

Joshua J. Irwin

Rocky Mountain Herbarium
Department of Botany, Dept 3165
University of Wyoming
1000 E University Ave.
Laramie, Wyoming 82071, U.S.A.
jirwin1@uwyo.edu

Rebecca Stubbs

Department of Biology, Hensill Hall
San Francisco State University
1600 Holloway Avenue
San Francisco, California 94132, U.S.A.
stubbsrl@sfsu.edu

Ronald L. Hartman

Rocky Mountain Herbarium
Department of Botany, Dept 3165
University of Wyoming
1000 E University Ave.
Laramie, Wyoming 82071, U.S.A.
rhartman@uwyo.edu

ABSTRACT

Botanical inventory of the Salmon-Challis National Forest has led to the discovery of a new species, **Polemonium elusum.** It may be distinguished from congeners by calyx lobes that are green to purplish with whitish, translucent membranes, oblong to spathulate, 0.4–0.7 mm wide connecting them. The presence of the membrane is unique to the genus. It is restricted to nine locations near the Salmon River between Salmon and Challis. In addition to the distinguishing morphometric features, DNA sequence analysis of the ITS1, 5.8s, and ITS2 nuclear ribosomal DNA supports *P. elusum* as a distinct species.

RESUMEN

El inventario botánico del Salmon-Challis National Forest ha permitido el descubrimiento de una nueva especie, **Polemonium elusum.** Puede diferenciarse de sus congéneres por los lóbulos del cáliz que son de verde a purpúreos conectados por membranas blanquecinas translúcidas de oblongas a espatuladas, 0.4–0.7 mm de anchas. La presencia de la membrana es única en el género. Está restringida a nueve localizaciones cerca del río Salmon entre Salmon y Challis. En adición a las características morfométricas diferenciadoras, el análisis de secuencias de ADN del ITS1, 5.8s, y el ADN nuclear ribosómico ITS2 suportan *P. elusum* como una especie distinta.

INTRODUCTION

This finding follows a sequence of slow but steady botanical discoveries in east central Idaho from the 1980s to the present. Important characters differentiating this species of *Polemonium* from others are calyx lobes that are green to purplish with whitish, transulcent membranes, oblong to spathulate, 0.4–0.7 mm wide, connecting them. The presence of the translucent membrane is unique to the genus. Nine localities have been documented. The type locality is at lower Cow Creek where the species is most abundant. Based on both morphological characters and molecular analyses *Polemonium elusum* is distinct.

This species was discovered while conducting a botanical inventory of the Salmon-Challis National Forest during the summer of 2010. This two-year project is one of more than 74 intensive broad-scale floristic inventories conducted by graduate students and staff of the Rocky Mountain Herbarium (Hartman 1992; Hartman et al. 2009; Hartman & Nelson 2011). For examples of published studies see Reif et al. 2009; Kesonie & Hartman 2011, Kuhn et al. 2011.

Polemonium elusum J.J. Irwin & R.L. Hartman, sp. nov. (**Fig. 1**). Type: U.S.A. IDAHO. Lemhi Co.: Lemhi Range, lower Cow Creek, 7 air km (4.4 air mi) NE of Ellis, 44.7402°N, 113.9935°W (NAD83), elev. 1440 m, 15 Jun 2011, *Hartman, Irwin, & E.E. Stewart 91587* (holotype: RM; isotypes: BRY, CIC, COLO, F, GH, ID, IDS, JEPS, MO, MONT, NY, RSA, SFSU, US, WS, WTU.

Polemonium elusum J.J. Irwin & R.L. Hartman; differens a ceterus speciebus e *Polemonium* in calyce lobis connexus a membrana translucens.

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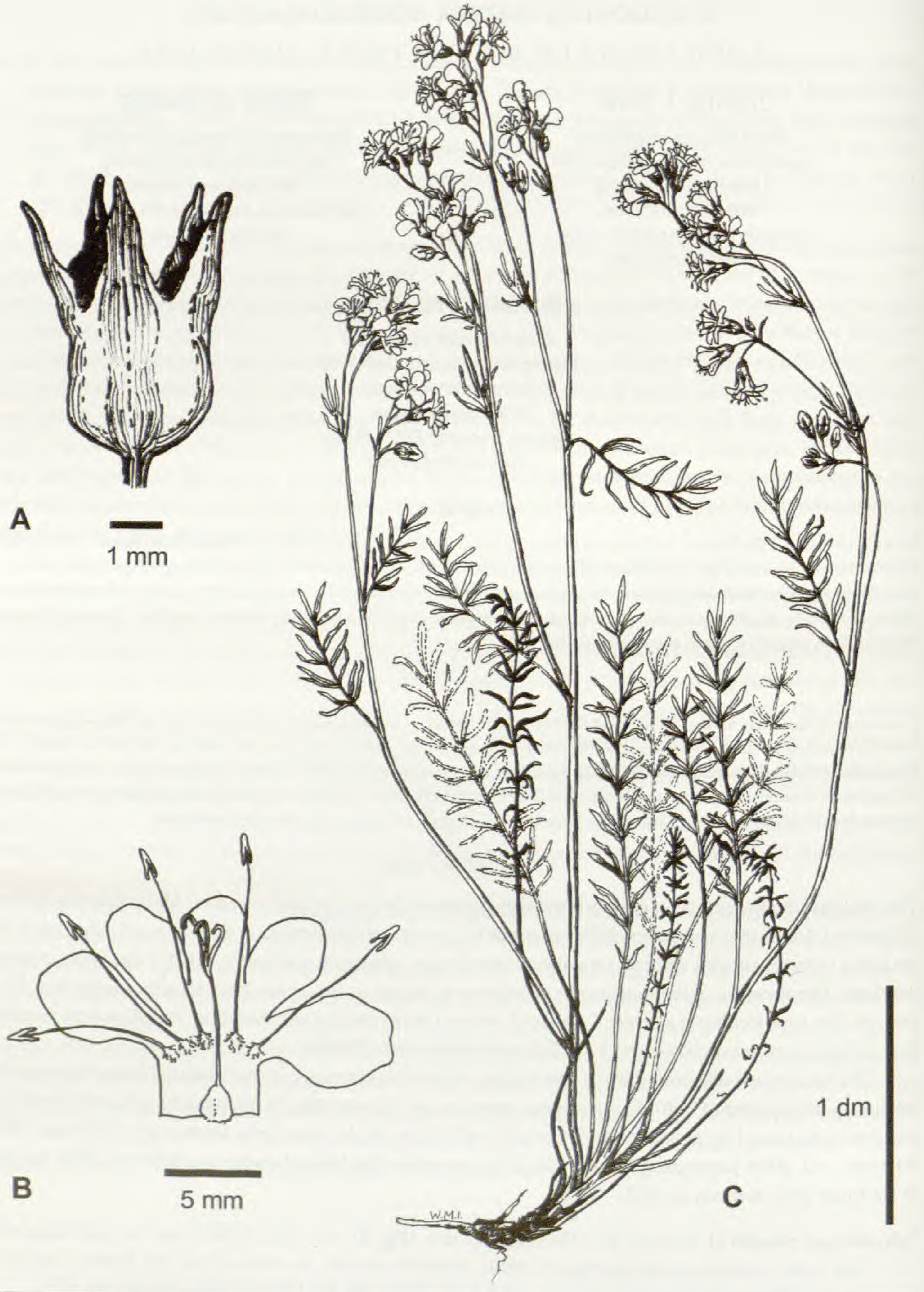

Fig. 1. Illustrations of *Polemonium elusum*, showing: **A.** calyx, **B.** longitudinal dissection of a flower, and **C.** entire plant.

Perennial herbs, caespitose, glabrous to pubescent with trichomes sparse to moderately dense, minute, flaccid to erect, often glandular trichomes, not odiferous; branches subterranean, 3–15. **Stems** 20–50 cm tall. **Leaves** mostly basal and the bases sheathing to scattered along stem, 5–20, 10–30 cm long proximally to 2 cm distally, 1.5–3(–4) wide; petioles 2–7(–11) cm long; pinnae 12–24, mostly 2-parted, alternate or paired and thus appearing whorled, narrowly to broadly elliptic or spatulate, occasionally obovate, 4–28 mm long, 1–3.5 mm wide. **Inflorescences** a thyrse, often diffuse; branches 2–5, 5–11 cm long, strict; flowers 15–60, congested distally; pedicels 5–6 mm long. **Flowers** 5-merous; perianth regular; calyx fused at base, campanulate; lobes lanceolate, green to purplish in part, 4.4–8 mm long, diverging at a 35–40 degree angle; connective membrane in bud, flower, and fruits translucent, whitish, oblong to spatulate, 0.4–0.7 mm wide; sinuses rounded; corolla light blue to white, campanulate, 10–13 mm long, tube 4–5.2 mm long; lobes 5–7.8 mm long, spatulate to obovate; apex rounded, minutely apiculate; stamens usually exserted; filaments attached 2–3 mm above base, at which point minutely and densely tomentose for 0.8–1 mm; anthers basifixed, narrowly to broadly sagittate, broadly elliptic to orbicular following dehiscence, 1.4–1.8 mm long; ovary greenish, broadly ovoid, 2 mm long, with 5 raised nerves at least in part; placentation axile, chambers 3; styles 6.5–8 mm long; branches flattened, 2.5–3.2 mm long; stigma glandular over adaxial surface. **Fruit** globose, tricarpellate, 4.5–5 mm long, split for 60–70 percent of length. **Seeds** brown, trigonous, the abaxial surface rounded, the edges acute, 2.4–2.8 mm long; surface minutely wavy, not mucilaginous.

PARATYPES: **U.S.A. IDAHO. Lemhi Co.:** Salmon National Forest, Lemhi Range, dry gulch on the north side of Cow Creek, immediately upstream of Black Canyon, 9.5 air km (5.9 air mi) ENE of Ellis, 44.7379°N, 113.9484°W (NAD83), elev. 1,692 m, 17 Jun 2010, *Irwin 1096* (RM); Cow Creek between national forest boundary and the confluence with North Fork Cow Creek, 33.6 air km (20.9 air mi) NE of Challis, 8.8 air km (5.5 air mi) NE of Ellis, 44.7393°N, 113.9605°W (NAD83), elev. 1,600 m, 15 Jun 2011, *Irwin 5038* (RM, SFSU); Salmon River canyon between Salmon and Ellis, slopes above an unnamed wash between Cronks Canyon and Cow Creek, 4.7 air km (2.9 air mi) NE of Ellis, 44.7197°N, 114.006°W (NAD83), elev. 1,493 m, 16 Jun 2011, *Irwin 5148* (RM, SFSU); mountain slopes 0.6 air km S of lower Cow Creek, 6.7 air km NE of Ellis, 44.7308°N, 113.9836°W (NAD83), elev. 1,928m, 24 Jun 2012, *Irwin 8563* (RM); summit of unnamed mountain east of Cronks Canyon, 6.2 air km ENE of Ellis, 44.7069°N, 113.9738°W (NAD83), elev. 2,560 m, 24 Jun 2012, *Irwin 8570* (RM). **Custer Co.:** Challis National Forest, Pahsimeroi Mountains, upper Gerry Gulch, NW of point 7686, 12.2 air km (7.6 air mi) SW of Ellis, 44.5935°N, 114.1206°W (NAD83), elev. 2,027 m, 24 Jun 2011, *Irwin 5493* (RM); near the creek at upper Gerry Gulch, 11.6 air km (7.2 air mi) SW of Ellis, 44.5976°N, 114.1137°W (NAD83), elev. 2,023 m, 24 Jun 2011, *Irwin 5496* (RM, SFSU); Salmon River Mountains, along Ellis Creek approximately 0.6 air km downstream of Cherry Creek, 5.3 air km WNW of Ellis, 44.6998°N, 114.1141°W (NAD83), elev. 1,582 m, 17 Jun 2012, *Irwin 8452* (RM).

Etymology.—The epithet was chosen as this species has eluded discovery for well over a century, this despite sporadic botanical forays to the region.

Distribution and ecology.—*Polemonium elusum* is known from the mountains and foothills surrounding the town of Ellis, in east central Idaho (Fig. 2). Populations occur from 1440 to 2560 m in elevation, where vegetation transitions from sagebrush and mountain mahogany to Douglas-fir woodland, depending on slope and aspect. Within this range of vegetation, it was found in a variety of microhabitats, thus the species appears to be an ecological generalist. Microhabitats in which plants are found include the margins of talus fields, dry Douglas-fir woodland, outer riparian margins, and shaded rock outcrops. Plants occur in stable but loose, coarse textured colluvial soils. All populations were found on various geologic units of the Challis volcanics group (Zientek et al. 2005) and were most abundant from lower Cow Creek southward across the adjacent unnamed mountain.

The initial discovery was made by Irwin on Cow Creek in mid-June 2010. This locality was surveyed as potential habitat for *Cryptantha salmonensis* Payson, *Astragalus amblytropis* Barneby, and *Oxytropis besseyi* (Rydb.) Blank. var. *salmonensis* Payson. None of these endemics was encountered, but *Polemonium elusum* was found growing under more mesic conditions than would be expected for the aforementioned taxa. Further inventory has shown that populations of *P. pulcherrimum* var. *pulcherrimum* surround the distribution of *P. elusum*. These species have several similarities, including overlapping elevation ranges, dry habitats, and a similar architecture of the corolla and the inflorescence. Additionally, *P. viscosum* has been observed as low as 1770 m elev. in deep canyons above the Salmon River to the north and south of *P. elusum*. However, these congeners have not been found growing sympatrically.

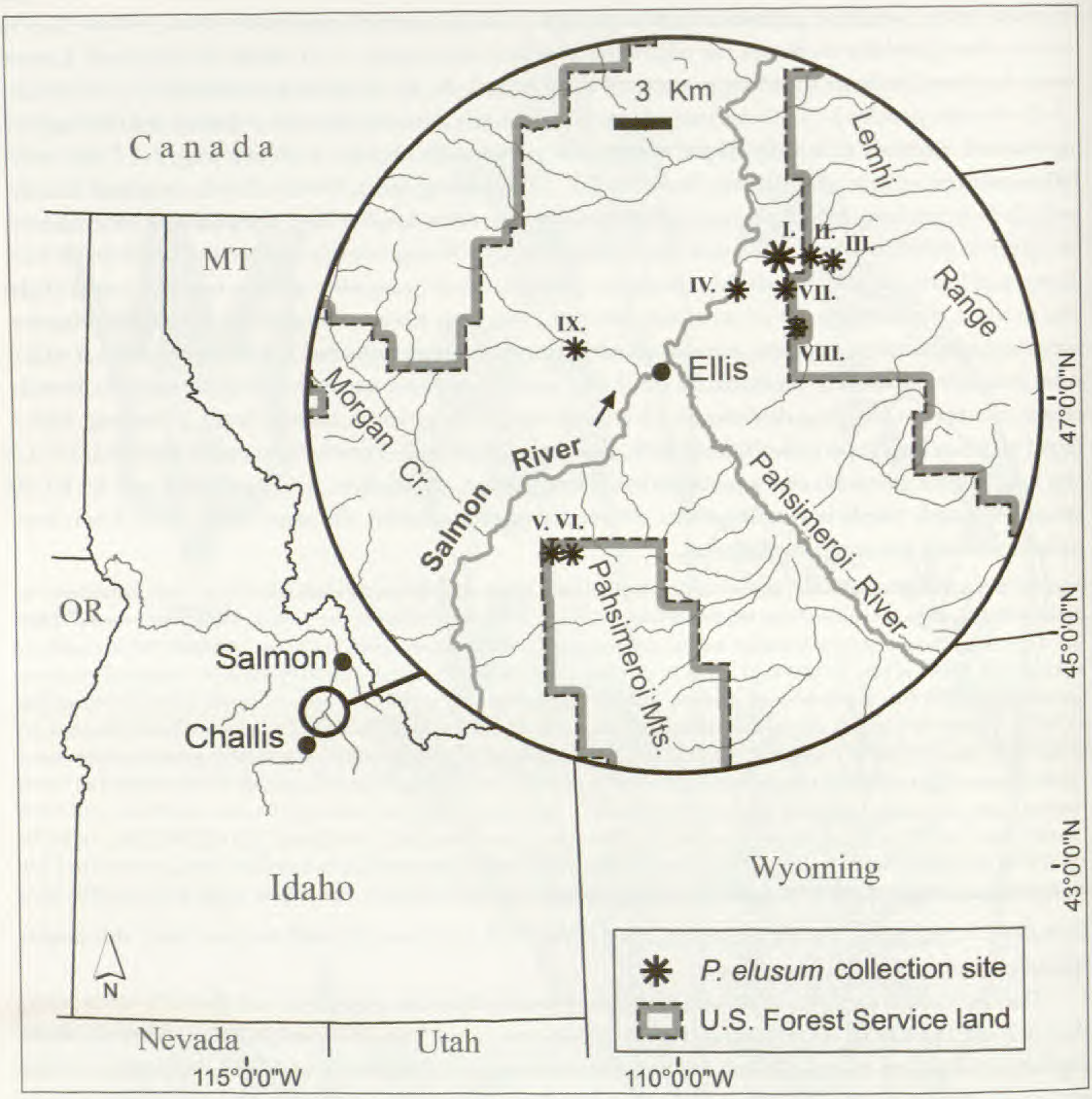

Fig. 2. Distribution of *Polemonium elusum*. Sites are as follows: **I.** type locality on lower Cow Creek, and collections from **II.** middle Cow Creek, **III.** dry gulch off Cow Creek upstream of Black Canyon, **IV.** unnamed gulch near Cronks Canyon, **V.** upper Gerry Gulch, **VI.** upper Gerry Gulch near creek, **VII.** slopes south of Cow Creek, **VIII.** unnamed summit ridge south of Cow Creek, and **IX.** Ellis Creek.

Phenology.—Flowering begins in late-May at more xeric, low elevation sites, continuing through mid-July at higher, cooler sites; fruiting from mid-June through August.

Conservation.—Perhaps the greatest threat to the existence of *Polemonium elusum* is the small total population size and its narrow distribution. The known populations total about 1,300 plants, occupying eight km^2. Other probable threats include herbivory by ungulates and habitat invasion by exotic weeds. Interestingly, the population at Gerry Gulch occurs at a location where the vegetation is significantly impacted by cattle. Herbivory by white-tailed deer has been shown to be a significant factor for population survival in *Polemonium vanbruntiae* Britton (Bermingham 2010). If herbivory by cattle and wildlife affects the survival of *P. elusum*, then the maintenance of ungulate populations below certain levels may be required.

Other aspects of the biology of this taxon are unknown. However, *Polemonium vanbruntiae* is self compatible (Hill et al. 2008). Because reproductive and life history traits influence the survivorship of plant populations, further research on *P. elusum* is necessary in order to develop a more effective conservation strategy.

Molecular analysis.—Sequence data from 28 taxa were analyzed. The 46 vouchers used in this phylogenetic study are listed in Appendix 1. Twenty-six of these were accessions from GenBank. *Leptosiphon, Linanthus,* and *Phlox* were used as outgroups because they have been proposed as genera closely related to *Polemonium* (Porter 1997; Johnson et al. 2008; Hankamp 2011).

Field collections of fresh plant material were preserved in silica gel and voucher specimens are deposited in the herbarium at San Francisco State University (Table 1). DNA extracted from herbarium sheets follow the same process. Extraction protocols are described in DNeasy (2004). The ITS1, 5.8S, and ITS2 regions were amplified using primers ITS4 and ITSLEU (White et al. 1990). Both regions were duplicated using standard Polymerase Chain Reaction (PCR) in 25 μl volume reactions. Excess nucleotides and primers remaining in the samples from the PCR were removed using ExoSAP-it kit.

An Applied Biosystems 3100 Genetic Analyzer was used for the capillary electrophoresis of all samples. Fragments were sequenced using BigDye following the manufacturer's protocols. Precipitation was with EDTA/Ethanol/Sodium acetate, and the remaining cycle sequence products were resuspended in Hi-Di before being denatured. Fragments were visualized using an Applied Biosystems PRISM 3100 Genetic Analyzer. Run modules were conducted using liquid polymer POP-6 or POP-7. Sequence files were base-called using Sequencing Analysis 5.1 (Applied Biosystems 2003), and the forward and reverse reads were formed into a consensus sequence using Sequencher 4.8 (Gene Codes Corporation 2007). The consensus sequence contig was loaded into MacClade 4.08X (Maddison & Maddison 2005) to visually confirm the coherence of the bases, and into ClustalX Version 2 (Larkin et al. 2007) for a complete alignment. The nexus file was analyzed in PAUP 4.0a112 (Swofford 2002), Mr. Bayes 3.1.2 (Ronquist & Huelsenbeck 2003), and GARLI 0.951-GUI (Zwickl 2006).

RESULTS

This ITS data set included 46 samples with a total of 706 characters, 163 of these were variable. Of the variable characters, 61 were parsimony informative. Bootstrap analyses were performed in PAUP 4.0a112 (Swofford 2002) using a heurist search with 100 repetitions and number of trees increasing by 100. Trees were also analyzed using maximum likelihood and Bayesian analysis.

For statistical selection of the best fit model, jModelTest (Posada 2008) was used. The -lnL using jModelTest was 2412.83. The results indicated GTR+I+G, and these parameters were employed. Bootstrapping was tested with GARLI and Bayesian analysis provided numbers for branch support.

DISCUSSION

Molecular analysis of the ITS region of *Polemonium* weakly suggests *P. elusum* is sister to *P. mexicanum*, *P. pauciflorum*, *P. grandiflorum*, and *P. carneum* (Fig. 3). This is the best inference from the maximum likelihood tree but it is not statistically supported by either bootstrap (56%) or Bayesian (0.84) values. A few conclusions can be drawn from these results. First, the four species that are most closely related to *P. elusum* are all included in Grant's (1959) sect. *Polemonium* and *P. elusum* also fits into this section. Worley et al. (2009) further divided Grant's sect. *Polemonium* into three species complexes, and except for *P. mexicanum*, the other three species are all included in the *P. pauciflorum* complex. This species complex includes plants that are erect to decumbent. The inflorescences are panicle-like cymes or the flowers are arranged in groups of one to three. *Polemonium elusum* meets these criteria.

Second, under Wherry's (1942) classification, *P. pauciflorum*, *P. grandiflorum*, and *P. carneum* all fall under the large flowered section *Eupolemonium*. Once more, *P. elusum* fits the criteria to be included in this section. These species all have overlapping elevation ranges and low montane habitats but occupy different regions of North America. Although there is not much statistical support for this grouping, morphometric features help validate the placement of *Polemonium elusum* with this group.

Polemonium elusum is congruent with the rest of the genus in its campanulate corolla, habit, compound leaves, stamen attachment, pubescent filaments, and brown seeds. This species notably differs in the calyx

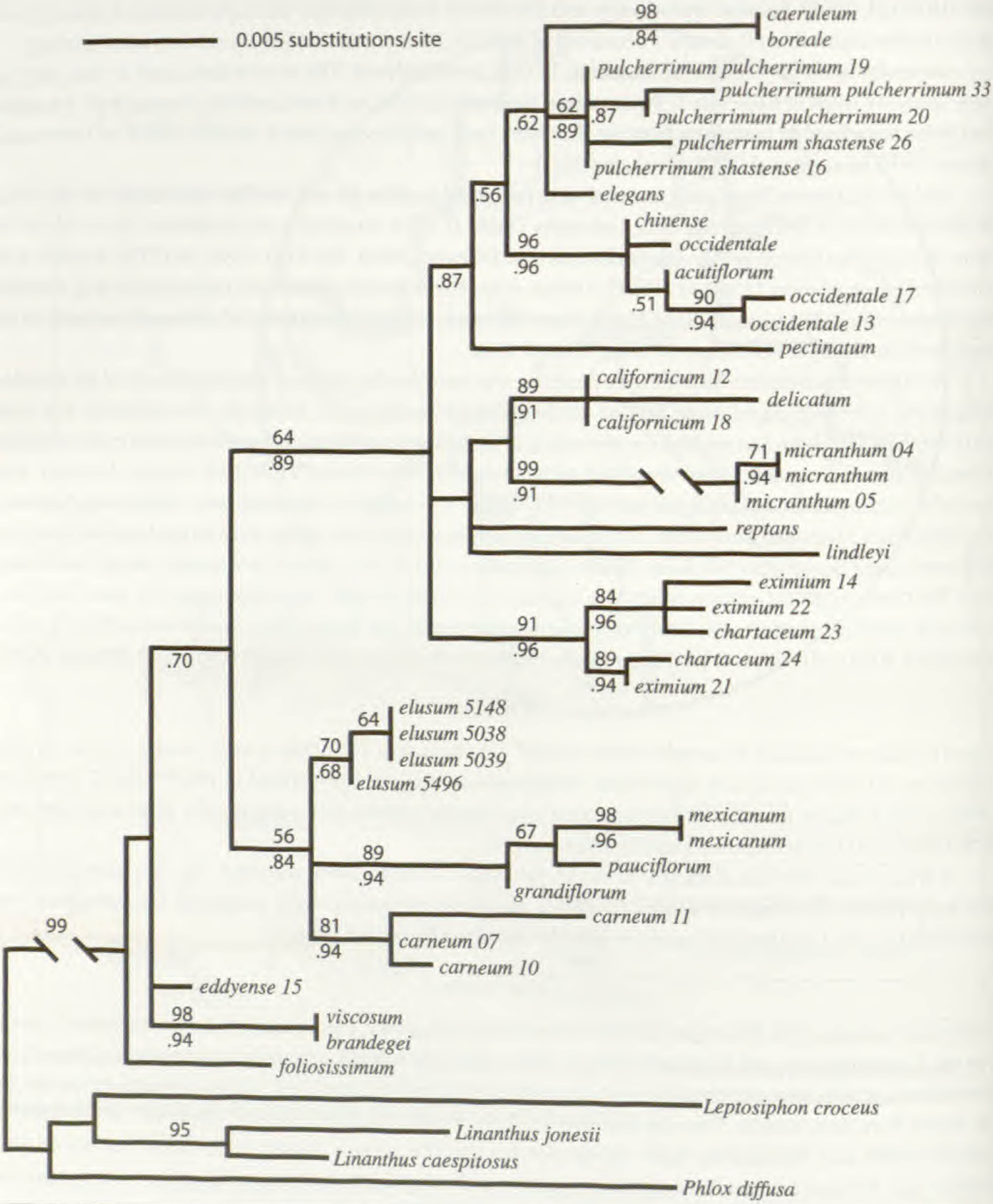

FIG. 3. Maximum likelihood tree for nrITS dataset with GARLI bootstrap values (above branch) and Bayesian posterior probabilities (below branch). -lnL=2412.83.

membrane and leaf structure. In the calyx, a translucent membrane connects the lobes in P. elusum (Fig. 1. A.). A translucent membrane between calyx lobes is exhibited in all of the temperate Polemoniaceae except for *Polemonium*, therefore this is the only species in the genus that is consistent in this attribute with the other genera in the family. This distinction of the calyx tube being translucent between lobes is visible in bud, at anthesis, and also in fruiting. Furthermore, unlike most of the other genera with translucent membranes, in this species the membrane does not rupture in fruit.

Another distinctive feature of *Polemonium elusum* is the leaf structure. The leaf structure and size of *P. elusum* falls on a spectrum between the low and high elevation *Polemoniums*. Though *P. elusum* is not an alpine species, the leaf structure is similar to high elevation *Polemoniums* such as *P. eximium* and *P. viscosum*. As seen in the alpine species, the leaflets in *P. elusum* are deeply lobed, but unlike high elevation *Polemoniums* that have leaflets that are 3–5-lobed, in *P. elusum* the leaves are mostly 2-lobed. Additionally, the compound leaves of alpine species are less than 9 mm wide while in *P. elusum* the leaves grow up to 30 mm wide. Similarly larger leaves are seen in lower elevation *Polemoniums*, like those of *P. caeruleum* and *P. carneum*, but the leaflets in these species are entire and not lobed.

APPENDIX 1

Voucher specimen for the 46 populations of 29 taxa from which nrITS region sequences were obtained. All samples without GenBank accession numbers were placed in silica gel in the field by Stubbs. Material of *P. elusum* was from dried specimens collected by Irwin.

Taxon	Voucher/GenBank #
P. acutiflorum	de Nevers 2073 / DQ320767
P. boreale	Cody 26927 / DQ320769
P. brandegei	Worley 006 / DQ320771
P. caeruleum	McNeal 3530, BRY / EU628253
P. californicum	Stubbs 18, SFSU
P. californicum	Stubbs 18, SFSU
P. carneum	Stubbs 07, SFSU
P. carneum	Stubbs 10, SFSU
P. carneum	Stubbs 11, SFSU
P. chartaceum	Stubbs 24, SFSU
P. chartaceum	Stubbs 23, SFSU
P. chinense	Ting-nong 1543 / DQ32078
P. eddyense comb. nov.	Stubbs 15, SFSU
P. elegans	Worley 18 / DQ320783
P. elusum	Irwin 5038, RM
P. elusum	Irwin 5039, RM
P. elusum	Irwin 5148, RM
P. elusum	Irwin 5496, RM
P. eximium	Stubbs 14, SFSU
P. eximium	Stubbs 21, SFSU
P. eximium	Stubbs 22, SFSU
P. foliosissimum	Halse 4261 / DQ320787
P. grandiflorum	Zamudio 7469 / DQ320788
P. mexicanum	Koch 75399 / DQ320789
P. micranthum	Stubbs 04, SFSU
P. micranthum	Stubbs 05, SFSU
P. micranthum	Taylor 12548 / DQ320791
P. occidentale	Stubbs 17, SFSU
P. occidentale	Timme 015 / DQ320793
P. occidentale	Stubbs 13, SFSU
P. pauciflorum	LeBuhn s.n. / DQ320794
P. pectinatum	Worley 001 / DQ320796
P. pulcherrimum var. delicatum	de Geofroy 127 / DQ320797
P. pulcherrimum var. lindleyi	Grimes 2159 / DQ320801
P. pulcherrimum var. pulcherrimum	Stubbs 19, SFSU
P. pulcherrimum var. pulcherrimum	Stubbs 33, SFSU
P. pulcherrimum var. pulcherrimum	Stubbs 20, SFSU
P. pulcherrimum var. shastense	Stubbs 16, SFSU
P. pulcherrimum var. shastense	Stubbs 26, SFSU
P. reptans	Keil 6266 / DQ320805
P. viscosum	Worley 004 / DQ320806
Leptosiphon croceus	Hankamp 043, SFSU
Linanthus caespitosus	Wilken 13982, SFSU/AF119443
Linanthus jonesii	Owings 047, SFSU/AF119430
Phlox diffusa	Peterson 97-110, SFSU/AF119444

ACKNOWLEDGMENTS

We would like to thank Teresa Prendusi and Bruce Smith for their support of the floristic inventory, thus making this discovery possible. Lucinda Haggas coordinated our logistical needs during summer field work. Bob Patterson and Dieter Wilken provided helpful suggestions regarding the manuscript. Wendy Irwin graciously provided Figure 1.

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NEOTYPIFICATION OF *AMORPHA ROEMERIANA* (FABACEAE: AMORPHEAE)

Shannon C.K. Straub[1] and James L. Reveal

L.H. Bailey Hortorium, Department of Plant Biology, 412 Mann Library Building
Cornell University, Ithaca, New York 14853, U.S.A.
ss463@cornell.edu; jlr326@cornell.edu

ABSTRACT

A neotype (*W.R. Carr et al 27810*, TEX) is designated for *Amorpha roemeriana* Scheele (Fabaceae: Amorpheae) to preserve the current application of the name for a relatively rare species of the Edwards Plateau of central Texas and Coahuila, Mexico.

RESUMEN

Se designa un neotipo (*WR Carr et al 27810*, TEX) para *Amorpha roemeriana* Scheele (Fabaceae: Amorpheae) para preservar la aplicación actual del nombre de una especies poco común en el Edwards Plateau del centro de Texas y Coahuila, México.

In the process of preparing a treatment of *Amorpha* L. for a forthcoming volume of *Flora of North America*, we attempted to locate original material of *Amorpha roemeriana* Scheele, a relatively rare species found primarily on the Edwards Plateau of Bandera, Bexar, Blanco, Comal, Gillespie, Hays, Kendall, Kerr, Kinney, Medina, Travis, and Uvalde counties of central Texas (Turner et al. 2003: 306), with disjunct populations in Coahuila, Mexico, that scarcely differ from the Texas populations. The type was collected by Carl Ferdinand von Roemer (1818–1891) "In margine rivulorum prope, Austin" during his 1845–1846 visit to Texas where he concentrated on geology (Simonds 1902). Upon his return to Europe, Roemer wrote several books and articles on his visit parleying these activities eventually into a professorship in geology at the University of Breslau. Roemer's plant specimens were given to George Heinrich Adolf Scheele (1808–1864) who accounted for several new Texas species (Scheele 1848) gathered by Roemer and, independently, by Ferdinand Jacob Lindheimer (1801–1879), including *A. roemeriana* which was reported to have been collected, in flower, in April of 1846. Roemer (1849: 429) himself stated that the plant was found "Bei Austin am Bachrande," and the "Blüthen sehr wohlriechend, violet."

Scheele's types were housed at Berlin, but as noted by Wilbur (1975), no one has reported, in the literature at least, the existence of any original material of *Amorpha roemeriana*. We attempted to locate a specimen at the Roemer-und Pelizaeus-Museum in Hildesheim, Germany, which at one time contained specimens gathered by Ferdinand Roemer (the Museum is named for his brother, Hermann Roemer [1816–1894]), only to be informed that the plant collection was sent to Berlin in the early 1900s. Nonetheless, there is no record at the Museum that there was a specimen of *Amorpha* from Austin, Texas, gathered in 1846.

The detailed description written by Scheele provides the characters necessary to distinguish *Amorpha roemeriana* from *A. fruticosa*, the most widespread species of the genus and the only one co-occurring with *A. roemeriana*. The inclusion of the swollen mucro, glandular punctuate leaflets, petiolules bearing purplish glands, and glandular vexillum in the description clearly point to *A. roemeriana* as that name is applied currently (Schneider 1907; Rydberg 1919; Palmer 1931; Wilbur 1975; Isley 1998), and contrast with the long, slender mucro, commonly eglandular leaflets, eglandular or inconspicuously glandular petiolules, and generally eglandular vexillum of *A. fruticosa*. Confirming the assumption that the name as currently applied is correct could be only accomplished by examining type specimen material. Being unable to locate any original material, we are here designating a neotype to maintain the current concept of *A. roemeriana*, which we believe to be consistent with the original description. With the able assistance of William R. Carr of the Nature Conservancy of Texas and Dr. Thomas Wendt of the University of Texas, to whom we are grateful, a suitable collection was obtained.

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[1] **Current address: Department of Botany and Plant Pathology, 2082 Cordley Hall, Oregon State University, Corvallis, Oregon 97331, U.S.A.**

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Amorpha roemeriana Scheele, Linnaea 21:461. 1848. Type: UNITED STATES. Texas. Hays Co.: Ashe juniper woodland on extremely shallow stony clay loam on top of N- to NW-facing bluff of Fredericksburg Limestone ca. 40–50 ft above the S bank of Blanco River, NW corner of Falls Ranch, ca. 4.5 air mi W of the junction of State Route 150 and Ranch Road 2770 near Mountain City, ca. 2.8 air mi SSE of the junction of State Route 150 and Ranch Road 3237 at Hays City, at N30°00'37.5", W097°58'01.1", Mountain City Quadrangle, elev. 740–750 ft, 15 May 2009, *W.R. Carr, B. Johnson & T. Wendt 27810* (neotype, designated here: TEX; isoneotypes: ARIZ, BH, BRY, CAS, HUH, K, MEXU, MICH, MO, NCU, NY, OKLA, RSA, US).

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SYSTEMATICS OF *LINDLEYA* (ROSACEAE: MALOIDEAE)

James Henrickson

Plant Resources Center
University of Texas, Austin, Texas 78712, U.S.A.
henrickson@mail.utexas.edu

ABSTRACT

The genus *Lindleya* consists of a single species *L. mespiloides* Kunth in H.B.K. It is endemic to three arid regions in México: from southeastern Chihuahua, south to central San Luis Potosí and southwestern Tamaulipas; in Hidalgo-Querétaro; and Puebla-Oaxaca with outlying collections from northwest Guerrero. The genus has a complex taxonomic history involving multiple uses of the generic name; the generic name *Lindleya* Kunth is conserved. Data on leaf, flower, and fruit structure are provided. The taxon is quite uniform in floral and fruit-seed characteristics throughout its range, though it shows differences in leaf shape, leaf and sepal size with leaf sizes reflecting habitat. The genus is distinguished by its large flowers with asymmetrical petals, ±20, large, often folded anthers, its superior, perigynous ovary with 5 connate carpels, and its globose, loculicidally dehiscent woody capsules containing narrowly winged seeds. Comparisons are made between *Lindleya* and its nearest relative *Vauquelinia*. Molecular data supporting its relationship at the base of the tribe Pyreae (ex subfamily Maloideae) is discussed along with a call for further modifications of the classification of the Rosaceae.

RESUMEN

El género *Lindleya* tiene una sola especie *L. mespiloides* Kunth in H.B.K. Es endémica de tres regiones áridas de México: del sureste de Chihuahua, hacia el sur hasta la parte central de San Luis Potosí y suroeste de Tamaulipas; en Hidalgo-Querétaro; y Puebla-Oaxaca con colecciones distantes en el noroeste de Guerrero. El género tiene una historia taxonómica compleja que implica múltiples usos del nombre genérico; El nombre genérico *Lindleya* Kunth está conservado. Se aportan datos de la estructura de la hoja, la flor y el fruto. El taxon es bastante uniforme en las características florales, de frutos y de semillas en todo su rango, aunque muestran diferencias en forma de la hoja, tamaño de hojas y sépalos con tamaños de hoja que reflejan el hábitat. El género se distingue por sus flores grandes con pétalos asimétricos, ±20 anteras grandes a menudo dobladas, su vario súpero perigino con cinco carpelos connados, y sus cápsulas globosas, leñosas, dehiscentes, loculicidas, que contienen semillas estrechamente aladas. Se hacen comparaciones entre *Lindleya* y pariente más próximo *Vauquelinia*. Se discuten los datos moleculares que soportan su relación en la base de la tribu Pyreae (ex subfamilia Maloideae) junto con una llamada a otras modificaciones de la clasificación de las Rosaceae.

INTRODUCTION

The monotypic genus *Lindleya* (Rosaceae) consists of sclerophyllous, evergreen shrubs with conspicuous white flowers and distinctive, woody, 5-carpelled capsular fruit. It is native to the arid and semi-arid chaparral or matorral of Mexico, with populations known from Puebla-Oaxaca, Hidalgo-Querétaro and the mountains of the Sierra Madre Oriental and the Chihuahuan Desert from San Luis Potosí, Tamaulipas, Nuevo León, Coahuila and eastern parts of Zacatecas, Durango and Chihuahua.

The genus has a complex but interesting taxonomic history that is reviewed below. Data on vegetative and reproductive features are presented and illustrated along with a formal taxonomic treatment and distribution maps. The most interesting aspect of *Lindleya* is its place in the phylogeny of the Rosaceae. With its five-carpeled capsular fruit, its placement within the family has been problematic.

MATERIALS AND METHODS

The study is based on empirical observations from field-collected and herbarium material as well as extensive field studies. Herbarium specimens were borrowed from A, GH, MO, MICH, NY, TEX-LL and US. Additional data was obtained from collections from ARIZ, ASU, CAS, DS, ENCB, MEXU, RSA, POM during visits to those herbaria. Anatomical studies incorporated standard paraffin techniques (Johansen 1940) for production of serial sections of leaves and flowers. All plant measurements were made from dried material unless otherwise noted.

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TAXONOMIC HISTORY

Taxonomic History.—The genus *Lindleya* was named by Kunth (1824) in the sixth volume of Humboldt and Bonpland's *Nova Genera et Species Plantarum* [5 Jan 1824-pertinent dates from International Plant Name Index (www.ipni.org) and Taxonomic Literature II (Stafleu & Cowan 1976–1988)] with a complete description. An illustration of the sole species, *Lindleya mespiloides* Kunth, was published in Apr 1824 (fig. 562). The genus was named for the then young John Lindley (1799–1865), British botanist, student of the Rosaceae and Orchidaceae, who went on to be professor of botany at the University College London (1829–1860).

However, prior to this, the name *Lindleya* had been used as a generic name several times. The first use of *Lindleya* as a genus name was by Nees von Essenbeck (1821), in a paper (21 May 1821) determining specimens from the Brazilian collections of Spix and Martinus. His *Lindleya* was a genus in the Theaceae, which Index Kewensis states is based on a species *Lindleya fruticosa* Nees (=*Laplacea semiserrata* Cambess.). Nees' *Lindleya*, however, is a homotypic synonym of a slightly older *Wilkstroemia* Schrader (5 May 1821) and thus is a superfluous name. Kunth in Humboldt, Bonpland *loc. cit.* (25 Feb. 1822) recognized this genus as *Laplacea* Kunth.

Kunth himself had previously used the generic name *Lindleya* twice. His first use was on plates of two species that were published in volume five of *Nova Genera et Species Plantarum*. According to Taxonomic Literature II, the fascicle of plates bearing the name *Lindleya* (plates 479–480) were published on 25 Feb. 1822, while the text, (vol. 5: 361–367) was not published until 24 March 1823, however, in the text, the species were placed in the genus *Casearia* (Flacortiaceae). The use of generic name *Lindleya* on the plates has been considered as a *nomen nudum* by Index Kewensis and Index Nominum Genericorum database and I.P.N.I. But the International Code of Botanical Nomenclature (McNeil et al. 2006) Art. 42.3 considers an illustration with analysis (i.e., with separate figures showing details to aid with identification) as being acceptable in place of a written description or diagnosis for a species description. But Art. 42.1, 42.2 notes that this can apply only if the genus is monotypic. As there were two species illustrated, the use of *Lindleya* here can be considered as a *nomen inval.*

Kunth (1822) again used a *Lindleya* in his brief treatise on Malvaceae, Büttneriaceae and Tiliaceae (20 Apr, page 10) listing "Lindleya nob." ("nob." indicating nobilis, or himself; see ICBN recom. 46D) between *Theobroma* Linn. and *Guazuma* Plum., in Sectio [subfamily] II "Büttneriaceae verae" of Büttneriaceae (once Sterculiaceae, now Malvaceae s.l.). This is purely a listing of a known or proposed name and again is a *nomen inval.*, without description given, implied or cited.

Rydberg (1908a) in his Notes on Rosaceae preceding his North America Flora treatment (Rydberg 1908b) listed the previous use of *Lindleya* by Kunth and Nees (as noted in Index Kewensis) and offered a new generic name *Lindleyella* for the Rosaceaous genus, and described a second species *L. schiedeana* Rydb., characterized by more obovate leaf blades and longer, more obovate petals. In 1940 Fedde, for some reason, rejected the earlier *Lindleyella* of Rydberg (1908), in favor of a later described *Lindleyella* Schlechter (1914), a genus of Orchidaceae with five species that were named from 1914 to 1924, and substituted a new name, *Neolindleyella* Fedde for Rydberg's genus. As to why Fedde would choose a younger name (*Lindleyella* of Schlechter 1914) against an older name (*Lindleyella* of Rydberg 1908) is unknown as it goes against the rules of priority, which he so strongly espoused. Fedde's work on botanical nomenclature had become such a disruption on nomenclatural stability that the provision for conservation of generic names was enacted during the Vienna Congress in 1905 (Briquet 1906).

In 1930, at the fifth International Botanical Congress (Briquet 1935), the rule concerning homonyms was altered. Prior to that time, a later homonym could be accepted as a valid name if the earlier name had become a synonym and was not being used. The fifth congress maintained strict nomenclatural priority and rejected later homonyms with the understanding that all well known generic homonyms, as far as possible, should be conserved.

To this end, a systematic search was made to validate later homonyms via generic conservation (Rehder et al. 1935). The task was assigned to various botanists each responsible for genera based on alphabetical groupings. Genera beginning with the letters L through P were assigned to Dr. Rudolf Mansfield of the Botanical

Museum of Berlin. Through his work, *Lindleya* Nees was rejected in favor of *Laplacea* H.B.K. (nom. cons.). Kunth's use of *Lindleya* as a replacement name for *Casearia* was considered a *nomen nudum*, and *Lindleya* of Kunth in Humboldt and Bonpland (1824) was conserved against *Lindleyella* Rydb. (Green 1940). Thus the correct name for the genus, under the present rules, following that round of conservation, would be *Lindleya* H.B.K., or following those who object to the H.B.K. designation, *Lindleya* Kunth in Humboldt & Bonpland (*nom. cons.*) or just *Lindleya* Kunth following ICBN 2006, Art. 46, ex. 9, note 1 (McNeill et al. 2006).

Of interest, in 1858, J. Agardh, in his *Theoria Systematis Plantarum*, placed *Lindleya* in its own family Lindleyaceae J. Agardh. In the same paper, he also recognized Cercocarpaceae J. Agardh, Coleogynaceae J. Agardh, and many other new families of dicotyledoneae.

MORPHOLOGY AND ANATOMY

Growth habit.—The species is a multi- to few-stemmed shrub (Fig. 1A). In more mesic habitats, the main branches are ascending and the plant forms an obovoid-spreading shrub to 2–4(–5) m tall with the uppermost branches either ascending or arching outward. In dry habitats the plants form more rounded, densely and divaricately branched shrubs to 1.3 m tall and wide. These arid-land shrubs may be misshapen due to browsing by goats, or somewhat thorny due to the placement of dried lateral stems.

Stems.—Stems are heteroblastic. Young long-shoot stems are initially maroon, glabrous, with internodes 7–15 mm long. They develop a single band of vascular tissue and dense strands of primary phloem fibers. The cortex and pith cells both develop thickened walls. Secondary growth initiates soon after stem development. Short-shoots develop from the nodes. As they mature they may develop into variously branched short-shoot systems to 1–5(–7) cm long with internodes 0.4–1.5(–5) mm long. The epidermis of young stems is soon replaced by a light gray periderm. Older branches have a smooth gray periderm marked by distinctive horizontal lenticles (Fig. 1D).

Stipules.—Paired yellow-green stipules occur at each long- and short-shoot node at the margins of the canaliculate petioles. They are typically acicular, 0.4–0.9(–2.2) mm long and are bordered on two sides by well-spaced or crowded, distinct, reddish-maroon multicellular glands to 0.2–0.3 mm long (Fig. 3A). When shorter, the crowded glands, which decrease in size acropetally, make the stipules appear more deltate. When longer, the stipules are very slender, acicular with well spaced marginal glands. The stipules mark the separation of the broadened leaf base from the canaliculate petiole and occur just below the zone of leaf abscission. The petioles receive three traces from the stem.

Leaves.—Leaves range from leptophylls, 8 mm long 2.5 mm wide to mesophylls 55 mm long and 17 mm wide (Fig. 2B–Q). The lamina range from narrowly oblanceolate, narrowly obovate to obovate. The apices range from narrowly acute, obtuse, rounded, to retuse often with an acuminate to mucronate tip. Any one plant may have some leaves with acute tips, other leaves with rounded tips. They are cuneate at the base with the margins forming decurrent narrow wings along the short, canaliculate, yellowish petioles. The margins are crenate; the crenations are gland tipped, with rounded distal and proximal margins. The crenations are usually uniform in distribution, but are more widely separated along the lower blade margins. The leaf blades are glabrous throughout. The marginal dark red-maroon glands are compressed ovoid, sessile, the marginal ones ascending towards the tip, the distal ones erect, 210–290(–350) µm long, to 100–120(–160) µm wide at the broad base. The gland's marginal cells are anticlinally elongated. The glands fall from older leaves.

The dorsi-ventral leaf blades are generally ascending, with the adaxial surface slightly concave (Fig. 1B). The blades range from 220–360(–430) µm in trans-section thickness and are 350–400(–430) µm thick at the midvein. The midvein is raised on both the adaxial and abaxial surface proximally, but only on the abaxial surface in the mid section and distally, except in the thickest blades where the midvein is not raised (Fig. 2A). The adaxial epidermis usually consists of large polyhedral cells that undergo a periclinal division, producing a narrow external cell with rather dense cytoplasm and a much larger internal water-storage cell. The outermost wall of the upper epidermal cell is about 5.5–7 µm thick, with the cuticle 4–5.6 µm in thickness. The abaxial epidermis has similar structure under vascular bundles, but in the intervascular area they consist of a mix of

Fig. 1. Photographs of *Lindleya mespeloides*. **A.** Growth habit of shrub ca. 2.5 m tall (lower branches have been removed by goats). **B.** Young stem showing ascending orientation of leaves. **C.** Flowering branch, showing density of flowers. **D.** Trunk of stem about 11 cm in diameter showing smooth gray bark with conspicuous lenticels. **E.** Flower bud showing bract, pedicel, sepals with bordering glands. **F.** Mature flower, face view, showing oblique, white petals, 20 stamens and central ovary. **G.** Mature flower, lateral view, showing ascending disposition of stamens. A, B, D from near Iturbide, Nuevo León, México (*Henrickson 22112*, TEX), C, F, G from near 18 de Marzo, Nuevo León, México (*Henrickson 22118*, TEX). Scale in B = 5 cm, in C = 10 cm, in E = 5 mm, in F & G = 1 cm.

epidermal and guard cells and the structure is difficult to sort out. The epidermal cells are larger and have a smaller external cell, but the guard cells do not. The adaxial leaf mesophyll consists of 2(–3) layers of crowded palisade cells. A palisade-type cell orientation may or may not occur in the abaxial mesophyll, but cells are not as dense. The primary, secondary, and usually tertiary veins have vascular cambia. A mass of support cells develops adaxial to the phloem. In some leaves these consist entirely of collenchyma cells, in others collenchyma mixed with fibers, and in the primary and secondary veins consist of masses of lignified fibers. Usually a collenchymous bundle-sheath extension occurs both above and below the primary-secondary-tertiary veins and sometimes bundle sheath extensions continue to the fourth and fifth order veins (seen throughout the

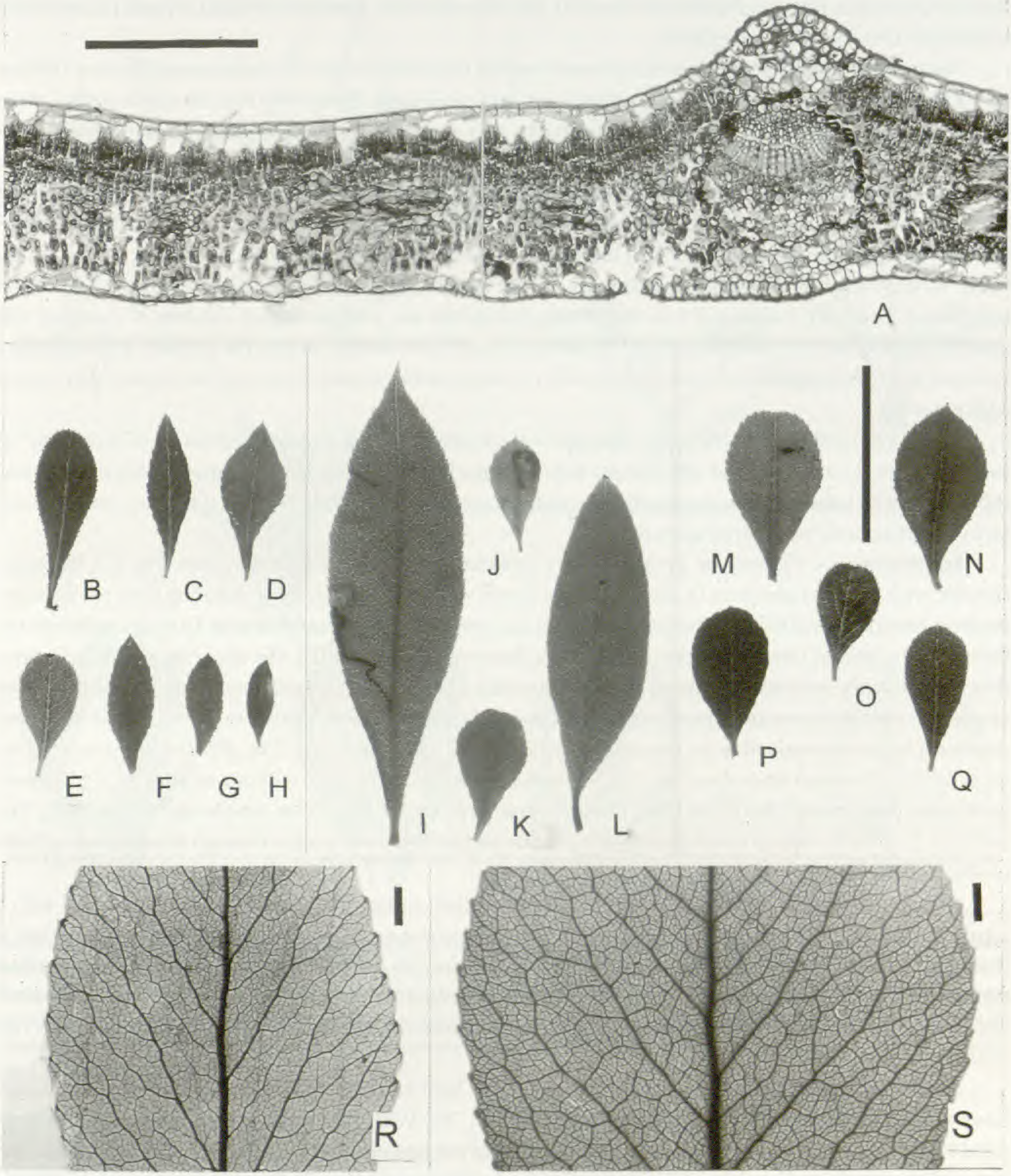


Fig. 2. Leaf structure of *Lindleya mespeloides*. **A.** Transverse section of leaf showing bi-layered upper epidermis, palisade and lower palisade-like spongy mesophyll. Note midvein is raised on adaxial (upper) leaf surface. **B–Q.** Photographs of wetted leaves showing variation of size and leaf shape from specimens from Coahuila-Nuevo Leon (B–H), Hidalgo (I–L), and Puebla-Oaxaca (M–Q). **B.** *Henrickson 22056* (TEX)-NL, **C.** *Henrickson 6225* (TEX)-Coah. **D.** *Johnston et al. 11465* (LL)-Dgo. **E.** *Steward 294* (GH)-Coah. **F.** *Steward 378* (GH)-Coah. **G.** *Henrickson 22062* (Tex)-LL. *Stanford et al. 626* (GH)-Tamp. **I.** *González 21443* (F)-Qto. **J.** *González 2401* (LL)-Hgo. **K.** *Gold 324* (TEX)-Hgo. **L.** *Moore 2481* (GH)-Hgo. **M.** *Salinas & Solis 3238* (TEX)-Oax. **N.** *Tenorio 6882* (TEX)-Pue. **O.** *Dorado & Salinas s.n.* (Tex.)-Pue. **P.** *Tenorio 18341* (TEX)-Oax. **Q.** *Tenorio González 18341* (TEX)-Oax. **R–S.** Leaf clearings. **R.** *McVaugh 10346* (US). **S.** *Gonzalez 1443*. (MEXU). Scale in A = 0.3 mm, in B–Q = 20 mm, in R–S = 1mm.

states of Querétaro, Hidalgo, Puebla, and Oaxaca). The mesophyll has scattered cuboidal crystals that are more common in bundle-sheath extensions.

Venation, as seen in cleared leaves is pinnate, weakly brochidodromous to semicraspedodromus (Ellis et al. 2009). The primary vein is straight, symmetrical, and moderately thickened (Fig. 2R–S). Secondary veins are irregularly alternate, extending from the primary vein at angles of 20–40 degrees. In narrow leaves they tend to arch slightly towards the tip but do not extend to the leaf tip. The secondary veins exhibit moderate branching towards the margins, often forming through connections with adjacent secondary veins one or more series of arches below the margins, with the crenations served by tertiary or smaller veinlets. Intersecondary veins are composite and muched branched, connecting to the lower portions of adjacent secondary veins. Tertiary veins form random reticulations, mostly at right angles to the secondaries; they are percurrent and forked. There are 5 orders of vein branching; the areoles are well developed, random, 4–5 angled, the smallest veinlets are 1–3 times branched. Venation of small leaves differs in that the primary and secondary veins are much thicker than the tertiary and smaller veinlets, and secondary veins may not connect with superadjacent veins.

Stomata are restricted to the lower (abaxial) leaf surface and range in number from 96–175 per mm^2 in small leaves ca. 13 mm long, and 140–175 per mm^2 in larger leaves to 27 mm long. Stomata do not occur below the veinlets with bundle sheath extensions. The stomata are usually subtended by four subsidiary cells. Subsidiary cells are anomocytic in arrangement.

Inflorescences.—Flowers are usually solitary terminating new growth of the season (Fig. 1C), but occasionally, with vigorous new growth, more than one flower will develop, with the subtending flower(s) developing from lateral shoot(s) from a subterminal node in the new growth of the same season. In such conditions the flowers will appear to form simple corymbs or three-flowered cymes (Fig. 1E). The uppermost, reduced leaves, that form with the season's growth are typically crowded below the flower and extend onto the pedicel. The uppermost cauline leaves are typically only 8–18 mm long, petiolate with slender to deltate, gland-margined stipules. They have canaliculate petioles and gland-margined, glabrous blades (Fig. 3B). The uppermost leaves are reduced to linear to lanceolate bracts to 3–5 mm long, 0.5–1.2 mm wide, without stipules but with glands continuing from the petioles to the blade margins. True pedicels, when present, may be up to 2 mm long. The terminal flowers disrupt terminal growth of a shoot, continued growth occurs through development of subtending lateral shoots.

Flowers-Hypanthia.—Pedicels terminate in thick-walled, coriaceous, obconic, hypanthia topped with 5 sepals, 5 petals and about 20 stamens (Figs. 3C, 5A). The ovaries are not attached to the hypanthia except at their sessile bases. The free portion of the hypanthia is about 0.7–1 mm in thickness. The outer hypanthial surface is light green, glabrous and shiny. The inner surface is yellowish-green in color, nectariferous, sometimes vertically ribbed (the ribs reflecting the position of stamen traces), with a somewhat expanded inner rim subtending the filaments.

Sepals.—The hypanthia terminate in five coriaceous, light greenish, broad-based, ovate to oblong-ovate, lance-ovate, usually acuminate, imbricate sepals (Figs. 1E, 3B). Where the sepal margins overlap, underlying sepal margins are membranous to 0.5(–0.9) mm wide and are sometimes cordate at the broad sepal base. The external or overtopping sepal margins are usually not membranous but usually have distinctive reddish glands similar to those found on leaf margins. The sepal tips usually terminate with a reddish gland. The sepals may be glabrous throughout the abaxial surface or variously villous distally. The inner surfaces typically are glabrous in the lower half but distinctly villous distally and along the distal margins, with slender, crinkly, white hairs to 0.6(–0.9) mm long. There are some differences in sepal size throughout the range of the species; plants from Oaxaca-Puebla tend to have shorter sepals, but this is not consistent as similar short sepals occur in small flowers throughout its northern range. Sepal size usually reflects overall flower size, and flower size can vary with environmental conditions. The sepals usually persist on the rim of the hypanthium as ascending or reflexed structures (Fig. 3G).

Petals.—The five broadly obovate, broadly clawed petals are borne equally along the hypanthium rim alternate to the sepals. The petals are spirally arranged in bud and are oblique distally with the portion of the

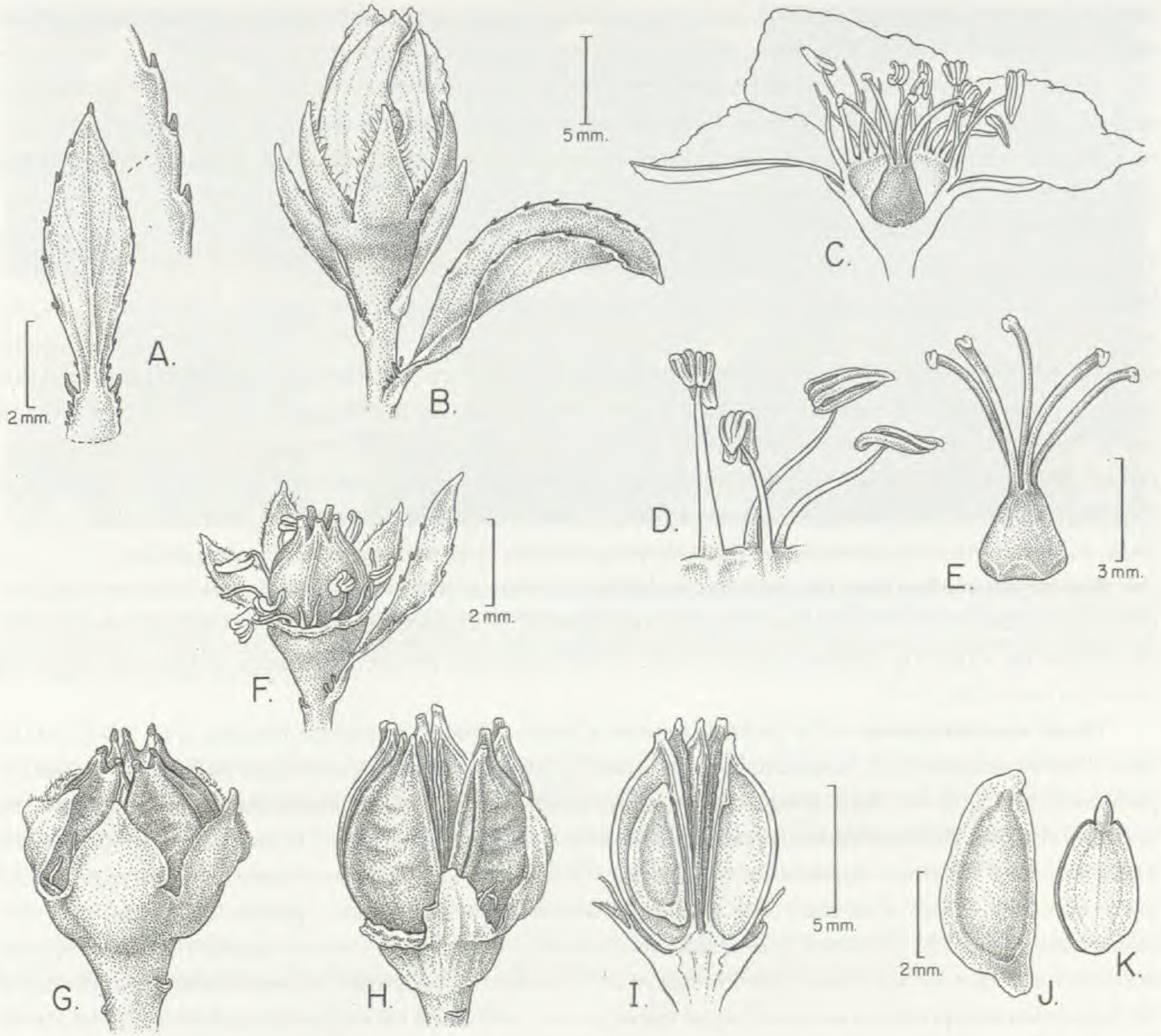


Fig. 3. Flower, fruit, and seed structure of *Lindleya mespeloides*. A. Floral bract showing marginal and basal glands and paired stipules. **B.** Preanthesis flower with subtending small leaf and bracts. **C.** Longitudinal flower section showing hypanthium and sessile ovary. **D.** Stamens at rim of hypanthium. **E.** Sessile ovary with styles and stigmas. **F.** Immature fruit, note subtending hypanthium, persistent bract, 5 style bases. **G.** Partially open fruit surrounded by dry hypanthium and sepals. Note the style bases have been split apart. **H.** Post-dehiscent fruit with some sepals removed showing dehisced carpels. **I.** Longitudinal view of mature fruit with carpel interior exposed showing seed. **J.** Seed. **K.** Embryo. Magnifications as indicated. A–E (*Henrickson 22112*, TEX); G–K (*Henrickson 22222*, TEX).

petal that develops under adjacent petals being much larger than the portion exposed in the bud (Figs. 1F, 5C). In most petals the right half of the petal is interior in bud and largest. But this will vary from flower to flower on one plant, with occasional flowers having the left half of the petal interior and larger than the right half. The petals are white, waxy appearing, well veined, thickened at the base, and thinning towards the sometimes crinkled margins. They spread outward at anthesis (Fig. 1F) and tardily abscise after anthesis. The mid vein often terminates in a single gland. When clearing the petals, the thick basal portion of petal often stains dark—it may be the source of the sweet floral aroma.

Androecia.—Flowers typically have 20 stamens borne at the inner rim of the hypanthia in one series or occasionally in two weak series with occasional smaller stamens born inside larger outer series of stamens (Fig. 3D). The inner and outer stamens usually develop opposite the petals with the interior stamen having a shorter incurved filament. The white filaments are acicular, very broad at the base, tapering distally. The filaments are attached to the mid-portion of the versatile anthers (Figs. 3D). Anthers are introrse in bud, 1.5–4 mm long, oblong, apiculate at the tip, with two truncated basal lobes. Anthers are light yellow, longicidal, with 4 anther sacs, and the medial septa between the anther sacs appears to be secretory (glandular) as it is dull reddish in color (in dried anthers) and stains strongly in microscope slides. Within the buds, the outer, larger stamens are erect with straight anthers, while the inner stamens have inflexed filaments as their anthers develop further within the crowded hypanthial cup. These inner anthers are typically bent below the attachment to the filaments (Figs. 3D). They usually retain this shape at anthesis.

Gynoecia.—The compound ovary is 5 carpeled, ovoid, glabrous, slightly 5-angled in transverse section. The gynoecium is sessile at the receptacle apex (Figs. 3C, 5A) and the carpels are united ventrally up to the level of ovule insertion forming a thick-walled compound ovary with axile placentation (Fig. 6D). The carpels are laterally united from the dorsal edge to near the ventral margin. The carpels, however, are not connate centrally where a five-lobed opening extends to the base of the ovary (Fig. 4A). Sterling (1966) noted that this is a carpel fusion pattern similar to that found in the Maloideae. He also noted that occasionally the carpels will not be fused ventrally. Each carpel contains two apical, pendent, collateral ovules, about 0.7–1 mm long attached at the inner tip of the locule and receiving a downward-oriented vein from the adjacent ventral trace (Fig. 5A). The short, thick funiculus appears to function as an obtruator. The ovules have a broad outer integument, a thinner inner integument, and the embryo sac is quite large with a crassinucleate nucellus.

The carpels are free from the inner hypanthium walls except at the very base. The five styles are separate, terminal, slender, cylindrical and are obliquely expanded at the stigmatic tip (Fig. 3E). A split develops across the oblique tip, exposing papillate interior tissue. Dried styles may persist on the fruit, or they may break off above the bases (Fig. 3F–I).

Floral vascularization.—The pedicel contains a single cylinder of vascular bundles (Fig. 5E–1). At the base of the hypanthium, 10 (occasionally more) traces separate from the central traces and extend up the hypanthium (Fig. 5E-3–4). These produce an irregular series of lateral traces that extend horizontally into the hypanthial tissue. The hypanthial traces branch in the mid to upper hypanthium to produce additional stamen traces (Fig. 5D). The traces opposite the sepals typically divide to form 2 stamen traces that then pass parallel to the eventual medial sepal trace. The traces alternate with the sepals (i.e., opposite the petals) may also branch near the mid-hypanthium to form additional stamen traces, or one or more stamen trace may separate from the trace near the top of the hypanthium. In addition the trace opposite the petal divides near the top of the hypanthium to produce two lateral sepal traces, one to each of the two adjacent sepals (Fig. 5B, D). At the rim of the hypanthium, the 5 sepals then each receive one medial trace and two lateral traces derived from adjacent petal traces. The lateral traces each divide into two or three separate traces at the base of the sepal, which then has five or more parallel traces that extend up through the sepal base and branch above (Fig. 5B). The petals each receive a single basal trace that quickly divides into five to seven traces. These continue to branch and anastomose further up the petal in a pattern as shown in Fig. 5C. The 20 stamens each receive single traces that, as noted above, separate from the original 10 hypanthial traces at some point in the mid to upper hypanthium.

The central traces remaining after the initial hypanthial traces diverge, form into five central packets (Fig. 5E-5–6). From this mass, five dorsal traces diverge opposite the sepal traces receiving tissue from two adjacent masses of vascular tissue (Fig. 5E–6). These leave behind five dense masses of vascular tissue that becomes the 10 inner ventral carpel traces (Fig. 5E–6). The dorsal traces continue upward along the ovary periphery. They give off series of branch traces to the ovary wall, but disposition of these lateral traces is obscured by the densely staining, tannin-containing cells of the developing ovary wall. The ventral vascular tissue forms ten ventral traces that continue up the inner portion of the ovary to a point where they approach the dorsal traces at the style base. The traces to the ovules extend downward from this point to the funiculi and ovules (Fig. 5A). As noted by Sterling (1966), no wing traces diverge from the ventral traces at this time.

Fruit.—Fruits are globose, five-ribbed, 5-carpelled, woody, loculicidal capsules, subtended in the lower one third or one fourth by a separate leathery hypanthium ringed with persistent ascending or deflexed sepals and filament bases (Figs. 3-F–I, 6A–D). The style bases remain at the fruit tip forming a series of apiculate tips.

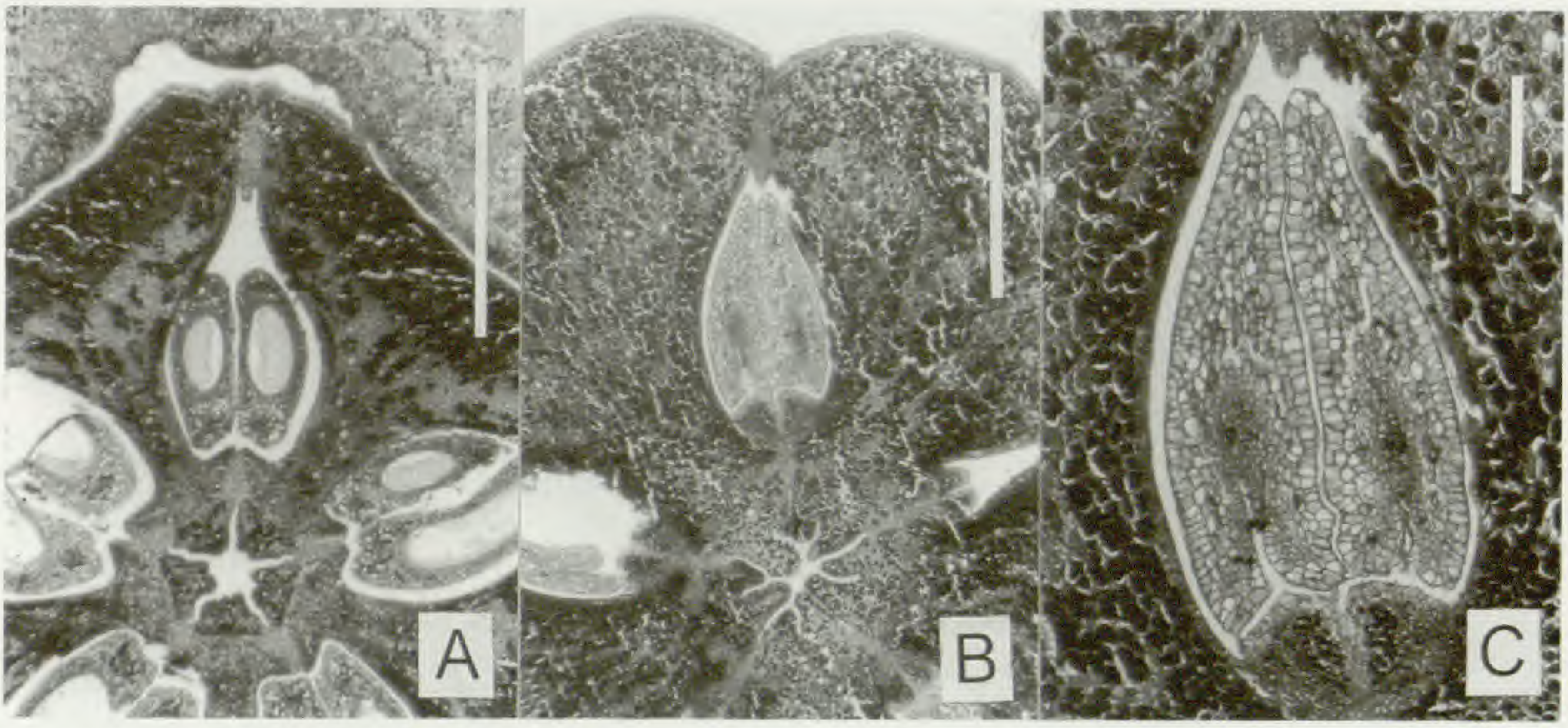


Fig. 4. Flower structures of *Lindleya mespeloides*. A. Transverse section of mid-compound ovary showing the paired ovules. Note the carpels are completely fused. B. Transverse section of upper compound ovary showing uppermost portion of ovary. The developing fruit wall in this area has many tannin-filled cells. C. Transverse section of upper portion of two ovules from B. All from *Henrickson 22118*, TEX (Galeana area, Nuevo León, México). Bar in A = 1mm, in B = 0.5 mm, in C = 0.1 mm.

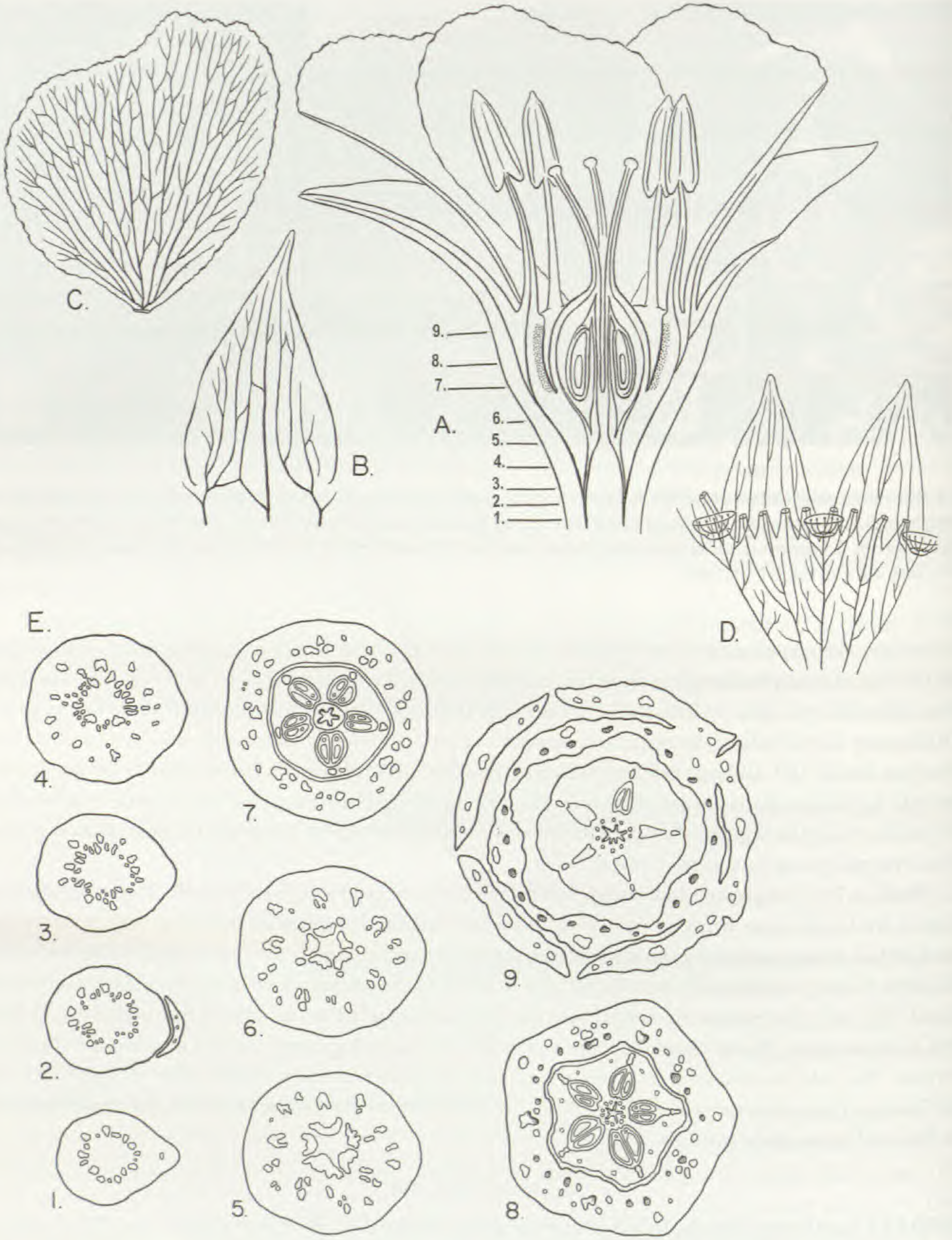
At maturity, the carpels dehisce loculicidally directly through the ventral traces, splitting the ventral traces and the base of the style through a suture that is visible even in the developing ovary wall (Fig. 6A). The dehiscence splits the style bases in half, and continues onto the distal portion of the abaxial fruit surface (Fig. 3G–H). The inner lateral walls of the carpels are smooth and cartilaginous (as in an apple), lined with a single layer of macrosclereids 100–120 µm thick and subtended by a thick layer of brachysclereids each 35–65 µm in diameter with lignified walls 11–22 µm thick (Fig. 6E). The highly lignified tissue extends 1.5 mm in radial thickness in the triangular segments between the locules. Only the outermost 0.5 mm of the abaxial-most portion of the triangular carpel segments is not lignified.

Seeds.—Two compressed, half-ovoid, dull-brown seeds are produced in each locule. The seed shape conforms to the locule space, being straight along the ventral edge and rounded on the dorsal edge, with one flattened surface (where contacting the adjacent seed) with the outer surface convex (Fig. 3J, 6G). The seed coat is dull, light brown, and thin; the innermost cells attached to the embryo have many irregularly rectangular crystals (Fig. 6F). The embryo is oriented with the hypocotyl superior to (i.e., above) the cotyledons. The embryo, occupies about 70 percent of the total seed length, leaving a thin wing, 0.2–0.5 mm wide, at the dorsal margins. The embryo consists of two compressed, oblong cotyledons and a smaller, obovoid hypocotyl (Fig. 3K). Endosperm is absent at maturity. The seeds are wind dispersed. Upon germination the cotyledons form the first seed leaves of the seedling.

TAXONOMIC TREATMENT

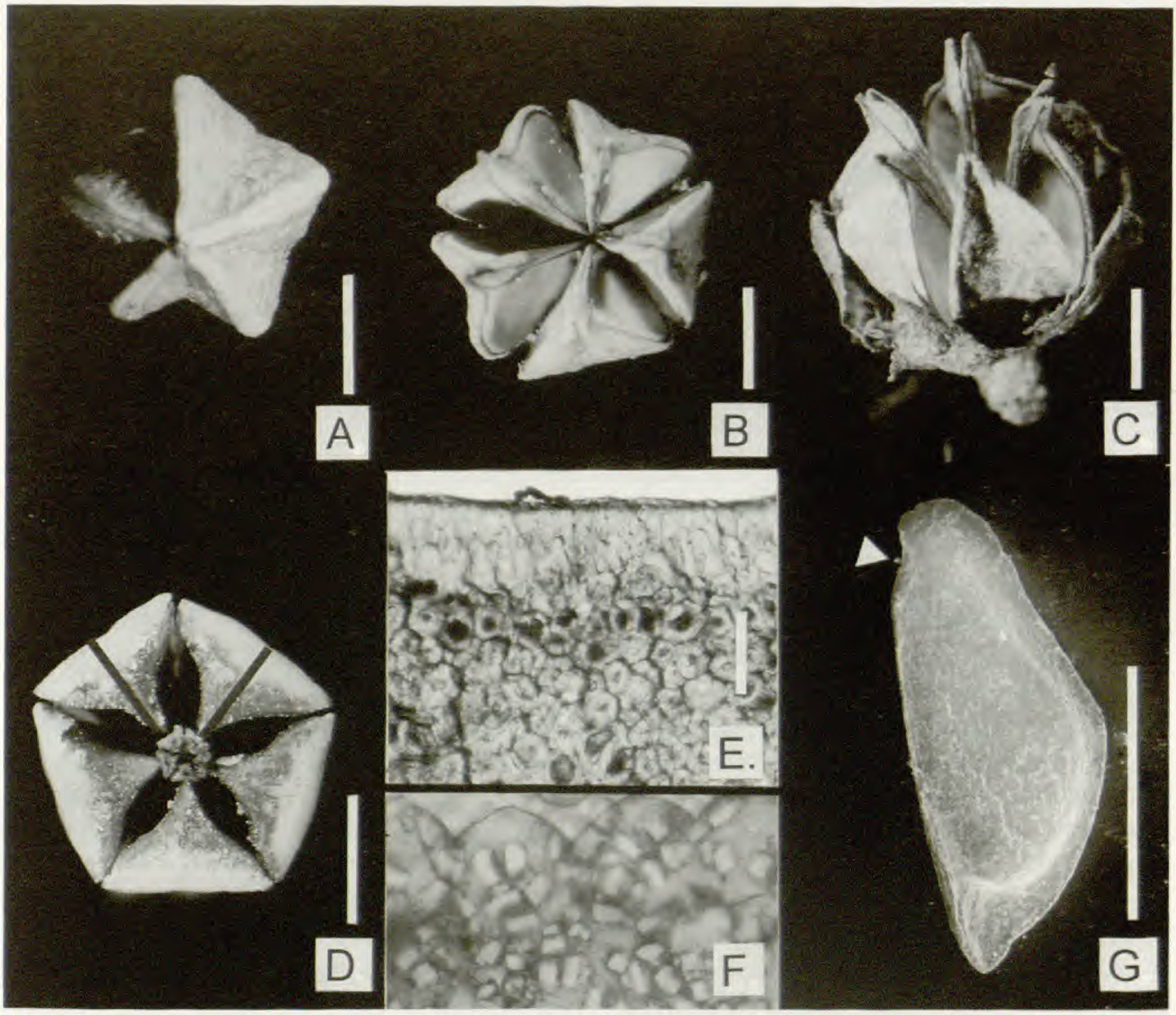
LINDLEYA Kunth Nov. Gen. Sp. [H.B.K.] 6:240 (ed. qto.); 188 (ed. fol.). 1824 (nom. cons.), non *Lindleya* Kunth Nov. Gen. Sp. [H.B.K.] 5, t. 480. 1821, (nom. rejic.) = *Casearia* Jacq. (Flacourtiaceae); non *Lindleya* Nees, Flora 4:299. 1821, (nom. rejic.) = *Laplacea* (Theaceae); *Lindleyella* Rydb., N. Amer. Fl. 22(3):259. 1908; *Neolindleyella* Fedde in Repert. Spec. Nov. Regni Veg. 48:11. 1940. Type species: *Lindleya mespiloides* Kunth.

Evergreen, multistemmed shrubs; periderm gray, smooth. Stems heteroblastic, tending to form shortened axillary spurs in arid conditions. Leaves simple, alternate; leaf bases short, the stipules acicular to deltate, maroon, sometimes with marginal glands; leaf blades narrow to broadly oblanceolate to obovate, ovate, acute to rounded, sometimes retuse at tip, cuneate with the margins decurrent on short petiole, the margins closely crenate, the marginal teeth terminating in distinct glands, the blade coriaceous, shiny green, glabrous on both surfaces,



Lindleya mespeloides

Fig. 5. Flower vascularization of *Lindleya mespeloides*. **A.** Longitudinal section of flower indicating vascularization in hypanthium, ovary and relative position of ovary to hypanthium (number of stamens reduced for clarity). **B.** Vascularization of sepal. **C.** Vascularization of petal (traced from photograph). **D.** Characteristic pattern of vascular branching in hypanthium showing vascular traces to stamens, petal bases and sepals. **E.** Vascularization pattern of flower as obtained from serial transverse sections at progressively higher portion of flower from pedicel (1), to ovary base (7), into upper ovary where sepals are separating from hypanthium (9). All from *Henrickson 22118*.



Fɪɢ. 6. Fruit and seed structure of *Lindleya mespeloides*. **A.** Top view of immature dried fruit showing five ridges that contain the dorsal traces. **B.** Top view of open loculicidial dehiscent fruit (without seeds). **C.** Lateral view of open fruit showing lower sepals and opened carpels. **D.** Transverse section of mature fruit showing five locules. The two black lines indicate limit of a single carpel. Adjacent carpels are completely connate. **E.** Structure of inner carpel wall consists of one row of macrosclereids 100–120 µm thick, subtended by thick layer of brachysclereids (from free-hand section). **F.** Surface view of epidermal cells of seed coat showing dense crystals. **G.** SEM micrograph of seed with characteristic narrow wing. Point of attachment to funiculus is indicated by arrow. (All *Henrickson 22056*, TEX). Bars in A–D, E = 3 mm, E–F = 100 µm.

major veins with bundle sheath extensions, venation brochidodromous to semicrospedodromus. Flowers complete, perigynous, usually solitary and terminal on long and short shoots, these sometimes forming terminal corymbs when the shoots aggregated or on long-shoot stems; bracts reduced, linear, gland-margined, borne on upper pedicel; hypanthia obconic, hemispherical in fruit, green, glabrous outside, nectariferous and yellow-green inside, coriaceous; sepals 5, imbricate, deltate to ovate, acute to acuminate, glabrous outside, villous near tip inside, somewhat coriaceous except along overtopped margins, spreading, persisting on fruit; petals 5, borne at the rim of the hypanthium, obliquely obovate, asymmetrical, white, spreading at anthesis, tardily deciduous, aromatic; stamens usually 20; filaments subulate, broadened at the base, borne at the inner rim of the hypanthium in a single (rarely two) series; anthers lanceolate, large, versatile, longicidal, yellowish; ovary superior (perigynous); carpels 5, in one series, antesepalous, completely connate laterally into an ovoid ovary; styles terminal, distinct, the stigmas terminal, oblique; ovules 2 per carpel, collateral, apically attached, pendent, the micropyles superior, the funiculi thickened, the tissue serving as an obtruator. Fruits spheroidal, woody, loculicidally dehiscent capsules, the lower third surrounded by the coriaceous, persisting hypanthium, the carpels dehiscent distally along ventral and dorsal sutures, with thick, inwardly cartilaginous valves; seeds 2 per locule, compressed, narrowly winged abaxially, brown, the seed coat thin, the embryo with oblong-ovate, flattened cotyledons, the hypocotyl small, superior; endosperm absent. With one species.

Lindleya mespiloides Kunth, Nov. Gen. Sp. [H.B.K.] 6:240. 1823. *Lindleyella mespiloides* (Kunth) Rydb. N. Amer. Fl. 22(3):259. 1908. Type: MEXICO. Hidalgo: Inter La Puente de la Madre de Dios et vicum Magdalenae, (near Magdalena, ± 10.6 km ENE of Actopan, Hgo.), May (holotype: P, fragment F!).

Lindleyella schiedeana Rydb. N. Amer. Fl. 22(3): 259. 1908. Type: MEXICO. Hidalgo: Inter Zimapan et San José del Oro; *Schiede s.n.* (holotype: NY!). Distinguished by Rydberg as having more obovate (not oblong-lanceolate or oblanceolate) leaf blades 21–45 mm long, 11–21 mm wide, with acute, rounded to emarginate tips, and obovate (not rounded-obovate) petals about 15 (not 8–10) mm long. While the leaves of this collection are the widest observed among specimens examined, the type collection appears to represent a specimen of *L. mespiloides* with very large features. Other specimens from this region have much smaller or equally-large petals but smaller leaves. As noted above, leaf and flower size can be affected by environmental conditions. The type locality is about 80 km NW of that of *L. mespiloides*. As it is distinguished only by quantitative characters, its recognition is considered to be without merit.

Erect, much-branched, evergreen shrubs to small trees 1–3(–5) m tall, in dry habitats forming small, tightly, divaricately branched shrubs with many short shoots, in mesic habitats forming erect-ascending, moderately branched, tall shrubs; stems heteroblastic; long-shoot branches with internodes 7–15 mm long, glabrous, initially maroon, developing a close smooth, gray periderm; short-shoot branches 1–5(–7) cm long, variously branched, with internodes 0.4–1.5(–5) mm long. Leaves with petioles 1–2(–4) mm long; stipules 0.4–2.2 mm long, acicular to deltate, maroon, when longer more attenuate and bearing marginal glands; leaf blades narrowly oblanceolate, oblanceolate, spatulate, obovate, sometimes elliptical-oblanceolate, rarely somewhat ovate, (3.5–)11–32(–55) mm long, (1.6–)4–13(–21) mm wide, acute, acute-acuminate, rounded to emarginate at the tip, narrowly cuneate with the margins forming wings above the short petiole at base, the margins closely crenate to crenulate with 5–10(–15) teeth per cm of margin, the teeth each terminating in a maroon, conical gland 0.1–0.3 mm long, the blades coriaceous, glabrous throughout, shiny, dark green, slightly concave above, more yellow-green beneath, the midvein yellowish and raised on both surfaces. Flowers terminal, solitary on short, leafy shoots, rarely in terminal 3-flowered racemes, the subtending leaves reduced, the uppermost leaf(s) often reduced to linear, gland-margined bract(s) to 5 mm long; pedicels 1–2 mm long, glabrous, thick; hypanthia obconic, 4–5 mm wide (to 7 mm wide pressed), green, glabrous outside, yellowish-green, nectariferous inside above the ovary, the distal rim slightly expanded; sepals 5, ± imbricate, deltate to ovate, (3.3–)5–7(–9) mm long, (2.3–)3–4.5(–5.5) mm wide, acute to acuminate at the tip, coriaceous and green medially, with membranous whitish to pinkish margins 0.5–0.7 mm wide where overtopped, glabrous outside, glabrous at the base but densely villous near the tip inside and often villous-ciliate throughout the margins, the outer sepals sometimes with conical glands along the margins, the thin inner margins somewhat cordate at the base, the sepals spreading in flower and persisting around the fruit at maturity; petals broadly obovate to obovate-orbicular, obliquely asymmetrical distally, contorted in bud with the left (or right) margin of the petals overlapping the adjacent petals, the petals (7–)11–16(–19) mm long, (5.5–)11–14(–19) mm wide, spreading [the flowers (17–)22–40 mm in total diameter], obliquely rounded to emarginate at the tip, broadly cuneate above a very short and broad claw at the base, firm, thickish, waxy, white, spreading, emitting a sweet aroma, remaining on the flower well after anthesis, eventually deciduous, stamens usually 20; filaments linear-subulate, distinct, (2–)3.5–7(–8) mm long, to 0.5–0.8 mm broad at the expanded bases, borne in the inner rim of the hypanthium, of variable length and size with the shortest filaments occurring inside a larger filament opposite the sepals; whitish, glabrous throughout; anthers lanceolate (1.5–)2.5–3.5(–4) mm long, apiculate at the tip, cordate, the basal lobes often spreading or folded, ± versatile, reddish to usually dark yellow; ovary two-thirds + superior; carpels 5, completely connate, 2.5–4 mm high in the flower; styles 5, free to the base, 3.2–6.5 mm long, erect, stigmatic at the expanded tips. Fruits of woody, ovoid-spheroidal, long-persistent capsules, 7–10 mm long and wide, with the lower third surrounded by the persisting hypanthium, the carpels each loculicidly dehiscent in the distal two thirds, the locules radial, with cartilaginous interior lateral surfaces, the valves thick, woody, green, turning dark red to maroon, drying dark brown, glabrous; ovules 2 per locule, pendent;

seeds two per locule, oblong-ovate in outline, flattened, 4.3–6 mm long, 1.8–2.6 mm wide, narrowly winged on the curved abaxial margin, the adaxial margin straight; cotyledons ovate, endosperm absent, radical superior.

The species is characterized by its shrub to small tree growth habit with smaller plants of more xeric habitats often developing short-shoot branches and a somewhat thorny aspect, by its smooth gray bark, by its small to moderately large shiny green, mostly oblanceolate, acute to round-tipped leaves with gland-tipped finely crenulate margins, by its large terminal, sweetly aromatic flowers with a thickened obconic hypanthium that bears 5 glabrous sepals with thin villous-ciliate margins, 5 large, white, obliquely obovate to somewhat orbicular petals, and ± 20 stamens with subulate filaments and large versatile anthers, and by its superior, 5-carpelled ovary with 2 suspended ovules per locule, and 5 separate styles. The fruit are globose, woody, loculicidally dehiscent capsules with each locule producing two flattened seeds, each with a short wing along its outer margin. The flowers are conspicuous and remain on the plant after the anthers have shed their pollen creating a conspicuous floral display. The fruits are often long persistent, allowing recognition of the species in the field.

The species has three regions of distribution (Fig. 7): northern Oaxaca and adjacent Puebla, where it occurs oak-pine woodlands, chaparral and thorn scrub in association with species of *Malacomeles, Vauquelinia, Comarostaphylos, Rhus, Quercus, Juniperus, Pinus, Acacia, Leucanea, Beaucarnea,* and *Yucca* etc., from 1900–2400 meters elevation; in Hidalgo and adjacent northern Querétaro, where it again occurs from pinyon-oak-juniper woodland, chaparral association with many of the same genera. Its largest distribution is in the Sierra Madre Oriental and Chihuahuan Desert region from southwestern Tamaulipas, southern Nuevo León, northern San Luis Potosí, northern Zacatecas, northeastern Durango, the southern half of Coahuila and adjacent southeastern Chihuahua where it occurs in pinyon-juniper woodland, chaparral and canyons in desert scrub often in limestone, rarely gypseous or sandstone substrates in association with species of *Rhus, Garrya, Ceanothus, Fraxinus, Cercocarpus, Gochnatia, Vauquelinia, Berberis, Arctostaphylos, Quercus, Arbutus, Juniperus, Agave, Yucca, Dasylirion, Ungnadia, Leucophyllum, Condalia, Mimosa, Mortonia, Foresteria, Acacia,* and *Pinus* from 1100–2700 m elevation. Flowering typically occurs in May but may occur from March to September usually following rains, with occasional flowering occurring throughout the year.

Throughout the wide range of the species some notable variation occurs. Most apparent is the variation in leaf size. Most specimens from Hidalgo and Oaxaca have moderate large leaves 18–55 mm long, 8–18 mm wide. In contrast, most specimens from Coahuila and Nuevo León have smaller leaves, 10–26 mm long, 3.5–8 mm wide. The separation is by no means complete, as some specimens from both Hidalgo and Oaxaca also have small leaves. Leaf size corresponds to habitat, as plants in dry exposed areas have very small leaves that contrast with larger leaves of plants of nearby less-arid, shaded sites. As noted above, plants from Hidalgo, Querétaro, Puebla and Oaxaca have bundle-sheath extensions extending to the 4th and 5th order of vein branching in contrast to only the 1st, 2nd, and in part to the 3rd order of branching in more northern range. Specimens observed from Puebla and Oaxaca also tend to have shorter sepals measuring 3.0–5.2 mm long. In contrast, sepals from Hidalgo and northward specimens tend to be larger, (3.0–)4.5–7(–9) mm long, but there is considerable overlap, with sepal length corresponding to flower size and being variable even on a single specimen. Flowers range in total diameter (petal tip to petal tip) from 17 to 40 mm. Fruits also vary in size, with occasional specimens having fruits much smaller or larger than average.

PHYLOGENETIC RELATIONSHIPS

The placement of *Lindleya* within the Rosaceae has been problematic. Numerous subfamilial and tribal classifications of the Rosaceae have been proposed (Focke 1888; Hutchinson 1964; Schulze-Menz 1964; Cronquist 1981; Takhtajan 1987 1997, 2009; Kalkman 1988, 2004; Thorne 1983, 1992) etc. and most all retain four subfamilies, (some older treatments have five subfamilies with the inclusion of the Chrysobalanoideae, or six with the Neuradoideae) that corresponded well to fruit types: the Spiraeoideae, with follicles, (rarely achenes—*Holodiscus*, or capsules—*Vauquelinia, Lindleya*); Rosoideae with achenes (rarely druplets—*Rubus*); the Amygdaloideae with drupes (*Prunus* etc.), and the Maloideae (Pomoideae) with pomes (*Malus* etc.). Within these subfamilies, the treatments differed in the placement of genera within tribes. See summary in Potter et al. (2007).

FIG. 7. Distribution of *Lindleya mespeloides* in Mexico.

There has always existed a problem group of six genera with woody fruit and winged seeds some with follicles, others with capsules, consisting of: *Quillaja*, (plant polygamo-dioecious, fruit of five radiating woody follicles each with many (10–16) seeds in two series per carpel—northern South America); *Kageneckia* (dioecious, fruit with five separate follicles with many seeds in two series per carpel—western South America); *Vauquelinia* and *Lindleya*, (dry capsules with two-winged seeds per carpel—Mexico); *Exochorda* (plant polygamo-dioecious; fruit with five, rather compressed woody follicles—Eurasian) and *Lyonothamnus* (two follicles with 1–4 non-winged seeds—California). Most classifications placed these within various tribes (Quillajeae, Exochordeae) within the Spiraeoideae.

Cytological Data.—As cytological data became available, it was found that the subfamlies had one or more base chromosome numbers with the Spiraeoideae having $x=9$, the Amygdaloideae $x=8$, the Rosoideae $x=7, 9$ (rarely 8) and the Maloideae $x=17$. The high chromosome number in Maloideae caused Sax (1931, 1932, 1933) and later Stebbins (1950, 1958) and many others (see Phipps et al. 1991; Rohrer et al. 1991, Cronquist 1981) to promote the view that the Maloids arose via paleo-allopolyploidy from $x=9$ Spiraeoideae and $x=8$ Amygdaloideae ancestors or from within the Spiraeoideae (Gladkova 1972).

In 1976 Goldblatt contributed chromosome numbers of several of the problem genera noted above. Of these *Exochorda* was found to be $x=8$, *Kageneckia* and *Lindleya* $x=17$; *Vauquelinia* $x=15$; and *Lyonothamnus* $x=27$ and *Quillaja* $x=14$. The high numbers in these taxa again gave clues that their relationship may lie with the Maloideae, and *Lindleya* and *Vauquelinia* were subsequently transferred to the Maloideae (Pyroideae) by Thorne (1983) and Takhtajan (1987). The 5-carpelled, dry-fruited *Exochorda* ($x=8$) was considered by Goldblatt (1976) to belonging to the $x=8$ Prunoideae, which has been supported by molecular data (Morgan et al. 1994). *Kageneckia* and *Quillaja*, which have similar appearing fruits, remained in subfamily Quillajeoideae (Thorne 1983; Takhtajan 1987).

Floral morphology Data.—Sterling (1966), on the basis of ovary morphology, considered the Quillajeae (containing *Exochorda*, *Kageneckia*, *Lindleya*, *Quillaja*, and *Vauquelinia*) to have sharp differences in the gynoecium structure and number and orientation of ovules. He noted that *Lindleya* had ovaries with complete lateral intercarpellary fusion of a type characteristic of the Maloideae, but with minimal hypanthium fusion. He also noted that the carpels of *Vauquelinia* were also maloid in nature though fused only basally and ventrally while being separate laterally.

Data from Rusts.—Savile (1979) summarized the use of fungus-host relationships in plant phylogeny. He notes that cedar-apple rusts *Gymnosporangium* occur throughout Pomoideae (Maloideae) with species also known from Myricaceae, Hydrangeaceae and from two genera of Spiraeoideae (*Vauquelinia* and *Porteranthus*—now *Gillenia*). He cites *Gymnosporangium vauqueliniae* Long and Goodding (1939) on *Vauquelinia californica* from Arizona and interestingly, *Gymnosporangium externum* Arth. & F. Kern in Arth., on *Gillenia* in eastern United States, which had been known since 1903. The on-line "Fungal Database" also gives references of *Gymnosporangium vauqueliniae* also on *Vauquelinia corymbosa subsp. karwinskii* from Nuevo León, Mexico and additional collections of *G. externum* on both species of *Gillenia* in the eastern United States (http://nt.ars.grin.gov/fungaldatabases). *Gymnosporangium* has not been reported on *Lindleya*.

Summary of non-molecular Data.—If we stop here and look at the data accumulated by the 1980s, we know that *Lindleya* has the same chromosome number as members of the then recognized Maloideae, and has some floral features in common with the Maloideae. We also have data from Cedar-apple rusts linking the related *Vauquelinia* with the Maloids. But confusingly, the rusts also occurred in another Spiraeoid, namely *Gillenia*. But as there was evidence that indicated that *Vauquelinia* and *Lindleya* were related to Maloids, there was no data indicating whether they were derived *from* the fleshy-fruited Maloids, or if they were basal to the fleshy-fruited Maloids. When we monographed *Vauquelinia* (Hess & Henrickson 1978), we had no evidence pertaining to the relative placement of *Vauquelinia* to the fleshy-fruited Maloids, so in that paper we concentrated just on species relationships. In the 1991 symposium on the Evolution in the Maloideae (Rosaceae) published in Systematic Botany, *Vauquelina* and *Lindleya* was not mentioned nor included in data sets (Phipps et al. 1991; Robertson et al. 1991). But by the mid 1990s, molecular data began to provide answers and laid the groundwork for a new phylogeny of the Rosaceae.

Molecular Data.—Molecular data presented by Morgan et al. (1994) from chloroplast rbcL sequences provided the first independent evidence for a needed subfamilial rearrangement of the Rosaceae. Their paper divided the family along the same lines as cytological data. Their data, however, showed that the old Rosoideae was polyphyletic, that the $x=7$ genera (*Filipendula, Fallugia, Geum, Waldsteinia, Potentilla, Fragaria, Agrimonia, Rosa, Rubus* and the $x=8$ *Alchemilla*) formed the core of the Rosoideae and the $x=9$ genera formed four distinct groups: the *Neviusia, Rhodotypos* group; the *Cercocarpus, Purshia, Lyonothamnus* group; and the core Spiraeoideae with basal *Spiraea-Aruncus-Holodiscus* group, separate from a derived *Physocarpus-Neillia* group, and another *Sorbaria* group associated with *Chamaebatiaria* including the achene-bearing *Adenostoma. Exochorda* fell into the x=8 Amygdaloideae. Their data excluded the South American *Quillaja* from the Rosaceae.

Of significance to this paper, their data showed *Kageneckia, Lindleya* and *Vauquelinia* were basal to the remainder of the x=17 Maloideae, i.e., their data showed *Vauquelinia* and *Lindleya*, with capsular fruits, and *Kageneckia* with follicle-like fruits, as remnants of a clade that have given rise to the core Maloideae. That is, they were basal to the Maloids, not dry-fruited derivatives of fleshy-fruited Maloids.

Campbell et al. (1995), using the internal transcribed spacers (ITS) of the nuclear ribosomal DNA region, studied phylogenetic relationships within the Maloideae. Their study, however, concluded that the Maloideae was not monophyletic. They also noted that *Vauquelinia* forms a well supported clade with fleshy-fruited *Eriobotrya* and *Raphiolepis* that is the sister group to the remainder of the Maloideae. These data, however, were badly skewed, as their "*Vauquelinia*" sample was actually *Raphiolepis* collected at the University of Arizona campus by a graduate student, vouchered by a specimen collected twenty years earlier in 1975. Their data set did not include material of *Lindleya, Kageneckia*, and as it turned out, also did not contain *Vauquelinia*.

Data presented by Evans et al. (2000) on the "Granule-Bound Starch Synthase I" gene (GBSSI) provided further insights into the phylogeny of Rosaceae. The portion of this nuclear gene used (near the 5' end) consists of seven complete, short exons, and parts of two other exons alternating with non-coding introns. While all other diploid families in which this gene has been used, have only one GBSSI sequence, all diploid Rosaceae have two distinct sequences (designated as GBSSI-1 and GBSSI-2) that differ in the length of, or presence or absence of, the introns between particular exons providing evidence of Rosaceae monophyly. Species of Maloideae, with their higher chromosome number, have two copies or loci of each sequence, each of which have differences in their base-pair sequences that are designated GBSSI-1A and 1B, and GBSSI-2A and 2B. So there are six different sequences or loci, the GBSSI-1 and -2 in the diploid non-maloids studied, and GBSSI-1A, -1B, -2A, and -2B occurring the Maloideae. The sequence data, using only exon base pairs, showed that various sampled collections of *Kageneckia* had GBSSI-1A, -2A and -2B loci; and *Vauquelinia* had GBSSI-1A, -1B, -2A and -2B loci as in members of the Maloideae. Their results again showed that *Kageneckia* and *Vauquelinia* were basal to, or sister to, the "core" Maloideae.

A later report by Evans and Campbell (2002) used CBSSI gene to investigate the origin of the x=17 Maloideae. Their phylogenetic analysis of some 42 genera showed that GBSSI-1 and -2 alleles of *Prunus* (Amygdaloideae) were not closely associated with the Maloideae, but rather the sequences from the genus *Gillenia* (a herbaceous, x=9 Spiraeoid, with compound leaves and 5 separate ovaries each with 4–6 ovules that form folicular fruits with non-winged seeds) were strongly associated with, and basal to, sequences of *Vauquelinia, Lindleya* and *Kageneckia* at the base of the Maloideae clade. *Gillenia* has a GBSSI-1 locus that shares distinct intron deletions and additions with the GBSSI-1B loci of the Maloideae and the GBSSI-2 intron shared a distinct base pair substitution with the GBSSI-2B loci of *Vauquelinia, Kageneckia* and *Lindleya* and core Maloideae placing the diploid *Gillenia* at the base of the Maloideae.

Thus *Gillenia* would appear to be an extant survivor of a lineage ancestral to the Maloids. But what is the other parent? Their survey of the Amygdaloideae has found no potential parent. The other parent has either not been sampled or is long extinct. They conclude that the other parent could have been another x=9 Spiraeoid that, in forming a hybrid via amphiploidy, could double the chromosomes to x=18, (2n=36) and this could be reduced to x=17 (2n=34) via aneuploidy (Evans & Campbell 2002). But whatever the other parent would be, there is no reason to expect its lineage to be extant today. But definitely one of the parental lineages has a surviving member, that being *Gillenia*, a genus of two species native to the eastern United States.

The most recent molecular study of relationships within Rosaceae was presented by Potter et al. (2007) that investigated the relationships of 88 genera using nucleotide sequence data from six nuclear and four chloroplast regions. Their paper resulted in a complete infrafamilial rearrangement recognizing three clades as subfamilies. The basal subfamily **Rosoideae** consists of herbs, shrubs rarely trees, that lack cyanogenic glycosides and sorbitol. They have alternate, usually compound, stipulate leaves; ovaries are usually numerous (rarely 1), separate, free from the hypanthium, some borne in a spiral arrangement on expanded receptacles, and the fruit are indehiscent [$x=7(-8)$—including *Agrimonia*, *Filipendula*, *Fragaria*, *Geum*, *Potentilla*, *Rosa*, *Rubus* etc.]. The subfamily **Dryadoideae** clade consists of shrubs, subshrubs, with cyanogenic glycosides and traces of sorbitol and a tendency to have nitrogen fixing symbionts. The leaves are simple or compound, stipulate; ovaries are 1 or many; fruits are achenes, ($x = 9$) including *Cercocarpus*, *Chamaebatia*, *Dryas* and *Purshia* (including *Cowania*). The Dryadoideae is sister to a highly diverse **Spiraeoideae**[1] clade consisting of mostly shrubs, small trees with some cyanogenic glycosides and strong sorbitol presence. Leaves are usually simple, alternate, the stipules persistent (deciduous in *Prunus*); ovaries number 1–5, mostly separate, radially oriented, usually free from the hypanthium, and fruits ranging from achenes, drupes, to pomes ($x= 8, 9, 15, 17$). It includes what was in the subfamilies Spiraeoideae (*Spiraea*, *Holodiscus*, *Petrophyton* etc.), Amygdaloideae (*Prunus*), and Maloideae (*Amelanchier*, *Crataegus*, *Malus*, *Pyrus* etc.) of previous classifications and several other groups.

Within the subfamily Spiraeoideae, the Maloid clade was designated in Potter et al. (2007) as the supertribe Pyrodae [the subfamily name Pyroideae Burnett (1835) named for *Pyrus*, the pear, has priority over name Maloideae Weber (1964)]. Basal in the supertribe is the genus *Gillenia* ($x=9$), that Evans and Campbell (2002) showed is a surviving genus of a lineage that gave rise to the Maloids. The supertribe has a single tribe, Pyreae, containing the three genera *Lindleya*, *Kageneckia* ($x=17$), and *Vauquelinia* ($n=15$)—its chromosome number the product of further aneuploidy and the tribe Pyreae has one subtribe, Pyrinae, that includes all the core maloids with apple-like fruits (pomes). But I see a problem with this classification. There remains no rank to distinguish the variation in the core Pyrinae (the maloids) as investigated by Lo and Donoghue (2012). And that is the subject of another paper.

***Lindleya* vs. *Vauquelinia*.**—Both *Lindleya* and *Vauquelinia* (Hess & Henrickson 1987) are moderately large, evergreen shrubs, distributed from northern, east-central to southern Mexico, with *Lindleya* ranging from northern Oaxaca to western Coahuila and the three species of *Vauquelinia* occurring from central Oaxaca to northern Baja California Norte, south-central Arizona and trans-Pecos Texas. Both genera occur in arid to semiarid scrublands, often limited to more mesic niches on north-facing slopes and along drainages or on rocky habitats where their roots can reach deeper moisture. Both have coriaceous leaves with well developed, fibrous bundle-sheath extensions with leaves of *Vauquelinia* being much larger and usually more coriaceous than those of *Lindleya*.

The smaller flowers of *Vauquelinia* are arranged in distinct well-branched compound corymbs (but see Evans & Dickinson 1999, who consider the inflorescences to be determinate, alternately branched dichasia with lateral pleiocasia similar to those found in some *Crataegus*, sensu Weberling 1989), not mostly solitary as in *Lindleya*. As in *Lindleya*, their leathery hypanthia bear five, ± thick, persistent sepals, five, white, ovate petals, (18–)20 stamens with tapered filaments, yellowish, introrse anthers and the sessile 5-carpelled ovary is mostly free from the hypanthium and topped with five separate styles, each somewhat compressed distally with broad stigmas. But unlike *Lindleya*, sepal margins of *Vauquelinia* do not contain the multicellular glands; anthers and petals are much smaller; ovaries are villous; and carpels are connate only along the inner (adaxial or ventral) margins—the outer (lateral and abaxial) margins are free (see Hess and Henrickson 1987). In *Vauquelinia*, each carpel has two basal-attached ovules (not apically attached as in *Lindleya*); the ovules, as in *Lindleya*, have two integuments, and the upper portion of the ovule develops into a wing. In *Vauquelinia*, mature fruits are more ovoid to oblong-ovoid (not ovoid-globose) in shape, and the fruit body is distinctly five lobed in cross section with five radial incisions, villous to strigose (not glabrous), but as in *Lindleya*, each carpel

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[1] The use of Spiraeoideae for the subfamily name will be altered due to the changes to Art. 19 of the Code approved in the Melborne (18th) Congress proposed by McNeill and Turland 2011 mandating priority of infrafamilial names based on the types of conserved family names over non-conserved names. Therefore the subfamily Amygdaloideae based on Amygdalaceae Marquiz (1820 nom. cons.) would have priority over names based on both Malaceae Small (1903, nom. cons.) and Spirareaceae Bertuch (1801, not conserved). However, Gunner et al. (2011) have proposed conserving Malaceae against Amygdalaceae to allow usage of the subfamily Maloideae for the subfamily.

is loculicidally dehiscent all across the ventral and distal portion of the dorsal sutures, splitting the persisting style base to shed the winged seeds. The embryos in *Vauquelinia* are about half the total seed length, are ascending, with basal hypocotyls (not two thirds the seed length with apical hypocotyls as in *Lindleya*). In both genera the seed coat is thin, brown, and endosperm is lacking. They also differ in chromosome number, with *Vauquelinia* n=15 and *Lindleya* n=17.

The South American (Chile, Peru, Brazil) *Kageneckia* (n=17) is quite distinct. The 3(–4) species are dioecious, ± large shrubs, vegetatively quite similar to some species of *Vauquelinia* in having thick, coarse leaves and occurring in dry scrublands. They have flowers ± 20–40 mm in diameter with attenuate sepals, moderately large, oblong-ovate white petals, 15–20 stamens along the hypanthial rim in male flowers but with reduced staminodia, and 5 separate vertical ovaries in female flowers, with terminal short styles and 2 rows of ovules (10–12 total) along the ventral traces. In fruit, the separate carpels expand abaxially and radiate outward to enclose the seed wings and the fruiting ovaries open along both the ventral and dorsal sutures to disperse the 10–12 winged seeds.

Spjut (1994) refers to the fruit of *Vauquelinia* as a coccetum "a multiple fruit with dehiscent fruitlets" opening along the dorsal and ventral sutures, with a note implying that the carpels are only partially connate with each carpel having a separate style-stigma. But the distinction between the fruits of *Vauquelinia* and *Lindleya* is only in the amount of lateral connation of the 5 carpels, being restricted to near the interior (ventral or adaxial) region in *Vauquelinia* but throughout the lateral surfaces in *Lindleya*. In overall structure and function, they are both loculicidal capsules. In contrast in *Kageneckia*. the carpels are completely separate, and Spjut (1994) would designate the fruit as a follicetum (i.e., a cluster of follicles) but while dehiscence occurs primarily along the dorsal suture, it continues onto the ventral suture, and his definition removes it from the follicle category, making it fit Spjut's definition of a coccetum as in *Vauquelinia*.

In molecular phylogenies that include *Vauquelinia*, *Lindleya* and *Kageneckia* [Potter et al. (2007); Campbell et al. (2007); Lo & Donoghue (2012)], *Lindleya* and *Kageneckia* are most often associated and sister to *Vauquelinia* and the rest of the pome-bearing Pyrinae. But also see Campbell 2007 for analysis of separate GBSSI genes.

APPENDIX 1

Representative Specimens: **MEXICO. Chihuahua:** Sierra de Pampas, W of Hacienda El Berrendo, 27°20'N, 104°43'W, 25 Aug 1972, *Chiang et al. 8832* (LL, NY-2); 20 km ENE Cd. Jiménez, NW summit Sierra de Chupaderos, 27°12'N, 104°43'W, 5300 ft, 2 Oct 1973, *Henrickson 13776* (TEX). **Coahuila:** E slope Sierra Almargre, 4800 ft, 5 May 1973, *Gentry & Engard 23219* (CAS, US); Vicinity of Santa Elena Mines, E foothills of Sierra de las Cruces, 30 May 1941, *Stewart 378* (F, GH, LL); Sierra Mojada, S of Esmeralda, 27°16'N, 103°41'W, 1 Sep 1972, *Chiang et al. 9086n* (LL); 23 (air) mi NW of Las Delicias, Valley N of Sierra de las Delicias, 26°23'N, 102°52'W, 4800 ft, *Henrickson 6124* (TEX); ± 29 (air) mi WNW of Cuatro Cienegas, N slope of Sierra de la Madera, 7.8 (rd) mi W of Rancho Cerro de la Madera, Cañón Desiderio, 27°08'N, 102°30'W, 12 Aug 1976, *Henrickson & Prigge 15310* (TEX); Cerro San Pedro, near N.L. line, 2 mi E of Ejido Presa de San Javier, 24°44'N, 100°46'W, 2200 m, 21 Aug 1974, *Wendt & Lott 608* (TEX); Sierra de Jimulco, 8 km NE Estacion Otto, 27 Sep 1972, *Chiang et al. 9552h* (LL); Sierra de Parras, 5500 ft, *Shreve & Tinkham 9859* (GH); 10 mi W Saltillo, near Las Barrancas, 3 May 1959, *Correll & Johnston 21400* (GH, NY, LL); Caneros Pass, 29 May 1890, *Pringle 3116* (A, F, GH, NY-2, LL). **Durango:** N end Sierra del Rosario, 20 km SW of Mapimí, 2 Nov 1972, *Wendt et al. 19035c* (LL). **Zacatecas**: 8 mi S of Majoma, 6800 ft, 4 Sep 1938, *Shreve 8581* (US); Concepcion del Oro, 2500–2700 m, 18–19 Jul 1934, *Pennell 17419* (GH, NY, US); Puerto de Rocamontes, at Zacatecas-Coahuila state line, 24°44'N, 101°10'W, 1990 m, 29 Mar 1973, *Johnston et al. 10491a* (LL). **San Luis Potosi:** 15.1 rd. mi N of Zac-SLP, hwy 49 on rd to Charcas, near Cerro Tecalote, 22°30'N, 101°09'W, 2100 m, 23 Sep 1978, *Henrickson & Lee 17553* (TEX); La Joya, 4 km NW de Ventura, Mcpio Villa Hidalgo, 1900 m, 11 Jan 1955, *Rzedowski 5705* (TEX); 20 mi S. Huizache Jct on Mex 57, 3 mi E on rd to Guadalcazar 22°42'N, 100°47'E, 5800 ft, 14 Jun 1979, *Hess & Byrne 4710* (F); E de Núñez, km 84 carretera San Luis Potosí-Antigua Morelos, 1600 m, 18 Nov 1954, *Rzedowski 5549* (ENCB). **Nuevo León:** Mts near Monterrey, Jul 1933; *Mueller & Mueller 539* (LL); 1.5 km E of El Barrosito, 1.5 km W of Puerto Prieto in S part of Sierra la Tomita, 24°36'N, 100°38'W, 2100 m, 19 Jun 1972, *Chiang et al. 8018* (CAS, NY, LL); Rd from San Rafael to Dieciocho de Marzo and Galeana, 8 mi E of San Rafael, 25°03'N, 100°25'W, 22 Oct 1982, *Dorr et al. 2500* (CAS, NY, TEX); Sierra Madre Oriental, Cieneguillas to Pablillo by upper trail, 15 mi SW Galeana, 17 Jun 1934, *Mueller & Mueller 884* (A, F, NY, TEX); 3 mi above Iturbide, rd to Galeana, 2000 m, 18 May 1949, *McVaugh 10562* (TEX, US); 13 km al E San Antonio Peña Nevada, 32°50'N, 99°57'W, 24 May 1992, *Hernandez et al. 2692* (TEX); Rancho Cielo, 11 km de Gomez Farias, 22 Sep 1974, *Medrano et al. 7425b* (GH). **Tamaulipas:** 4 km W Miquihuana, 23°42'N, 99°45'W, 3110 m, 3 Aug 1941, *Stanford et al. 626* (DS, GH, NY); 34 km N Tula, 5.5 km N of La Presita, 23°20'N, 99°39', 1700 m, 20 May 1973, *Johnston et al. 11141* (LL). **Queretero:** ca. 80 km NE of Querétaro, above Pilón, rd to Pinal de Amoles, 2700 m, 24 Apr 1949, *McVaugh 10346* (GH, LL, TEX, US). **Hidalgo:** 7 km N de Cardonal, 14 Aug 1965, *González*

2850 (DS, TEX); Cerro San Miguel, 14 km NNE de Actopan, 2300 m, 6 May 1965, González 2401 (DS, LL); Barranca walls above Metzquititlan, road to Zacualtipan, 1600–1800 m, 24 Mar 1947, *Moore 2481* (GH). Puebla: Los Naranjos, May 1908, *Purpus 3234* (F, GH, NY); Mcpio Caltepec, Cerro El Mirador al SW de Coatepec, 19 Apr 1985, *Tenorio 8822* (TEX); 8 km al NE Acatepec, 16 May 1981, *Chiang et al. 1959* (TEX). **Oaxaca:** 3 km al SW de Tamazulapán sobre carr. Tamazulapán-Chilapa de Diaz, 15 May 1982, *Rico et al. 332* (F); Cerro sobre el camino de Teposcolula a San Andres Lagunas, 10 May 1981, *Cedillo et al. 770* (CAL, F); 3 km al S de Santiago Teotongo por la Terracería a San Pedro Nopala, 17°45'N, 97°33'W, 12 May 1986, *Salinas & Solis F3238* (TEX); 3 km SW de Magdalena Jicotlán a Santiago Teotongo, 97°29'N, 17°47'W, 1 Aug 1985, *Salinas & Dorado F2691* (F).

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ILLUSTRATIONS AND STUDIES IN NEOTROPICAL ORCHIDACEAE. 5. THE *LEPANTHES OVALIS* GROUP (PLEUROTHALLIDINAE) WITH THREE NEW SPECIES FROM COSTA RICA

[1]Diego Bogarín
Jardín Botánico Lankester
Universidad de Costa Rica
P.O. Box 302-7050
Cartago, COSTA RICA, A.C.
diego.bogarin@ucr.ac.cr

Christina M. Smith
Jardín Botánico Lankester
Universidad de Costa Rica
P.O. Box 302-7050
Cartago, COSTA RICA, A.C.
christina.smith@ucr.ac.cr

Daniel Jiménez
Jardín Botánico Lankester
Universidad de Costa Rica
P.O. Box 302-7050
Cartago, COSTA RICA, A.C.
admin@tools.co.cr

ABSTRACT

We revise and characterize the group of species close to *Lepanthes ovalis*. Three new species from Costa Rica are described and illustrated. **Lepanthes dikoensis** Bogarín & C.M. Sm., sp. nov. is similar to *L. viridis* but differs mainly by the smaller leaves (to 4 cm long) and smaller flowers (to 6.5 mm in diameter), the glabrous petals with the lower lobe ovate, falcate, shorter than the lobes of the lip, both lobes yellow with red-orange and scarlet, the lip scarlet, apically yellowish and the appendix oblong. **Lepanthes expansilabia** Bogarín & C.M. Sm., sp. nov. is similar to *L. erinacea* but differs by the pendent plants, the petals with the lobes oblong, subsimilar, the lower lobe yellow, the lip spreading with the lobes separated and not touching each other, leaving the appendix exposed. **Lepanthes tarrazuensis** Bogarín & D. Jiménez, sp. nov. is similar to *L. seegeri* but differs in the glabrous petals, the lip glabrous with ciliate apices, the upper lobe of petals truncate, without lobules at the inner apical corner, the petals and lip basally red, tinged with yellow-orange at apex, the blades of the lip touching each other above the column and the appendix shorter, not extending far from the column. An illustration of *L. erinacea*, a key to the species of the group and a table summarizing the differences between the Costa Rican taxa are provided.

RESUMEN

Revisamos y caracterizamos el grupo de especies cercanas a *Lepanthes ovalis*. Se describen e ilustran tres especies nuevas de Costa Rica. **Lepanthes dikoensis** es similar a *L. viridis*, pero se diferencia principalmente por las hojas más pequeñas (hasta 4 cm de largo) y flores más pequeñas (hasta 6,5 mm de diámetro), los pétalos glabros con el lóbulo inferior ovado, falcado, más corto que los lóbulos del labelo, ambos lóbulos de color amarillo con rojo-anaranjado y escarlata, el labelo escarlata, apicalmente amarillento y el apéndice oblongo. **Lepanthes expansilabia** es similar a *L. erinacea* pero se diferencia por las plantas péndulas, los pétalos con los lóbulos oblongos, subsimilares, el lóbulo inferior de color amarillo, el labelo expandido y con los lóbulos separados que no se tocan entre sí, dejando el apéndice expuesto. **Lepanthes tarrazuensis** es similar a *L. seegeri* pero difiere en los pétalos y el labelo glabros con los ápices ciliados, el lóbulo superior de los pétalos truncados, sin lóbulos en la esquina interior apical, los pétalos y el labelo basalmente rojos, teñidos de color amarillo-anaranjado en el ápice, las láminas del labelo tocándose entre sí por encima de la columna y el apéndice más corto, que no se extiende lejos de la columna. Se proporciona una clave para las especies del grupo, una ilustración de *L. erinacea* y una tabla que resume las diferencias entre los taxones de Costa Rica.

With about 120 species currently recognized, *Lepanthes* Sw. is one of the most diverse genera of the Pleurothallidinae in Costa Rica (Bogarín & Fernández 2010). As discussed in previous works, the large number of species, their morphological variation and the continuous discovery of new species in less explored areas, have led us to treat the genus in taxonomic informal groups or alliances. In order to complete the taxonomic revision of *Lepanthes* in Costa Rica, we treated preliminarily the following groups: *Lepanthes jimenezii* Schltr. (Pupulin &

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[1] Herbario UCH, Universidad Autónoma de Chiriquí, P.O. Box 0427, David, Chiriquí, Panama Centro de Investigación en Orquídeas de los Andes "Ángel Andreetta," Universidad Alfredo Pérez Guerrero, Ecuador

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Bogarín 2010); *L. schizocardia* Luer (Pupulin et al. 2010). Two other groups are under review: *L. guatemalensis* Schltr. (Pupulin & Bogarín in prep.) and *L. minutilabia* Ames & C. Schweinf. (Smith et al. in prep.).

In this paper, we studied a group of species related to the Jamaican endemic *Lepanthes ovalis* (Sw.) Fawc. & Rendle, the first species of *Lepanthes* to be described and which was originally placed in *Epidendrum* L. (Swartz 1788). The other species of this group are *L. erinacea* Rchb.f., one of the first species described in Costa Rica (Reichenbach 1855), *L. pan* Luer & Dalström from Ecuador (Luer 1996), *L. seegeri* Luer from Panama (Luer 1987), *L. trichocaulis* Luer & R. Escobar (Luer 1988) and *L. viridis* Pupulin & Bogarín, recently published from Costa Rica (Pupulin & Bogarín 2011). All members share similar plant morphology, having ramicauls with long-ciliate sheaths with markedly dilated, long-ciliate ostia. The leaves are subcoriaceous, always light green without purple stripes or spots. The congested racemes arise under or above the leaves and are shorter than the leaves (rarely larger in some specimens of *L. erinacea*). The sepals are ovate, acute to obtuse, pubescent or glabrous. The upper lobes of the petals are wider and longer than the lower lobes. The lip is triangular, cordate or subcordate, with the sides strongly folded and embracing the column at sides (rarely expanded), the blades are flattened with cuneate connectives, the apex is cleft leaving a narrow space between the apices with a pubescent appendix (Luer 1987; Luer 1996; Pupulin & Bogarín 2011). At the moment the group range includes Costa Rica, Panama, Colombia, Ecuador and Jamaica. We add three species proposed here as new to science. A key to the species of the group is provided. Additional material is provided online at www.epidendra.org

1. Lepanthes dikoensis Bogarín & C.M. Sm., sp. nov. (**Figs. 1A, 2**). Type: COSTA RICA. Cartago. Jiménez: Pejibaye, Tausito, El Copal Biological Reserve, along Tigre, Mariposa and Gárvula trails, 9°47'02.7"N 83°45'04.3"W, 1020 m, premontane wet forest, epiphytic in secondary forest 18 Jun 2005, *D. Bogarín et al. 1625* (holotype: JBL).

A *Lepanthes viridis* Pupulin & Bogarín, foliis brevioribus, floribus in diametro brevioribus, petalis glabris, scarlatis-flavis, lobo inferiore ovato falcato, labello scarlato in apice flavo, lobulis labelli quam lobo inferiore petalorum longioribus et appendice oblonga et a *Lepanthes ovalis* (Sw.) Fawc. & Rendle, stirpe pendente, foliis brevioribus, ostiis vaginarum ciliatis, floribus minoribus, petalis glabris, scarlatis-flavis, lobulo inferiore petalorum lunato, falcato, sepalis aurantiacis, appendice longiora statim dignoscenda.

Plant epiphytic, caespitose, pendent herb, up to 15 cm long. **Roots** slender, flexuous, up to 1 mm in diameter. **Ramicaul** more or less descending, up to 10.5 cm, enclosed by 11–21 ciliate, lepanthiform sheaths, lightly ciliate especially on new growth; the ostia markedly dilated, ciliate. **Leaves** coriaceous, green, elliptic, subobovate, acuminate with a short apiculus, 3.0–4.0 × 1.0–1.5 cm; cuneate base narrowing into a petiole ca. 3.5 mm long. **Inflorescence** racemose, distichous, successively flowered, borne above the leaf, shorter than the leaves, up to 3 cm, peduncle 1.5–2 cm long, rachis 0.5–1.0 cm. **Floral bracts** 1 mm long, ciliate. **Pedicel** 1.5 mm long, persistent. **Ovary** up to 1 mm long. **Flowers** light orange, yellow, red-orange and scarlet; sepals light orange; petals yellow with red-orange and scarlet; lip scarlet; column red. **Dorsal sepal** ovate, acute, connate to the lateral sepal for about 1 mm, 3.2 × 2.9 mm. **Lateral sepals** ovate to elliptic, acute, connate for about 1 mm, 2.5 × 2.5 mm. **Petals** essentially glabrous, transversely bilobed, entire, 0.8 × 2.4 mm; the upper lobes broadly uncinate, rounded, overlapping, the apex broadly rounded; the lower lobes ovate, falcate, with apex broadly rounded, slightly smaller than the upper lobes. **Lip** bilaminate, adnate to the column, 1.8 × 1.3 mm expanded; blades narrowly oblong, pubescent, with narrowly rounded ends, falcate; connectives broadly cuneate, up to 1 mm long, perpendicular to the column and not leaving it exposed; body broadly oblong, connate to the base of the column; appendix narrowly oblong, pubescent. **Column** cylindric, 1 mm long; anther apical; stigma ventral. **Pollinia** two, ovoid. **Anther cap** cucullate.

Representative specimens: **COSTA RICA. Cartago. Jiménez:** Pejibaye, between Tausito and Selva, around El Copal Biological Reserve, shores of Taus river and Quebrada Selva, 9°47'5.22"N 83°45'46.1"W, 1197 m, premontane wet forest, epiphytic in secondary forest, 1 May 2008, *D. Bogarín et al. 4768* (CR); same locality, *D. Bogarín et al. 4793* (JBL); Selva, El Copal Biological Reserve, 9°47'00"N 83° 45'20" W, 1000–1200 m, 2 Jun 2001, *M. Blanco & R. Narit 1924* (CR); Taus, elev. aprox. 1000 m, 10 Nov 1984, *R.L. Dressler et al. 155* (USJ).

Distribution.—Only known from Costa Rica.

Habitat and ecology.—Epiphyte in secondary premontane wet forest on the Atlantic watershed of Cordillera de Talamanca, between 1000 and 1200 m of elevation.

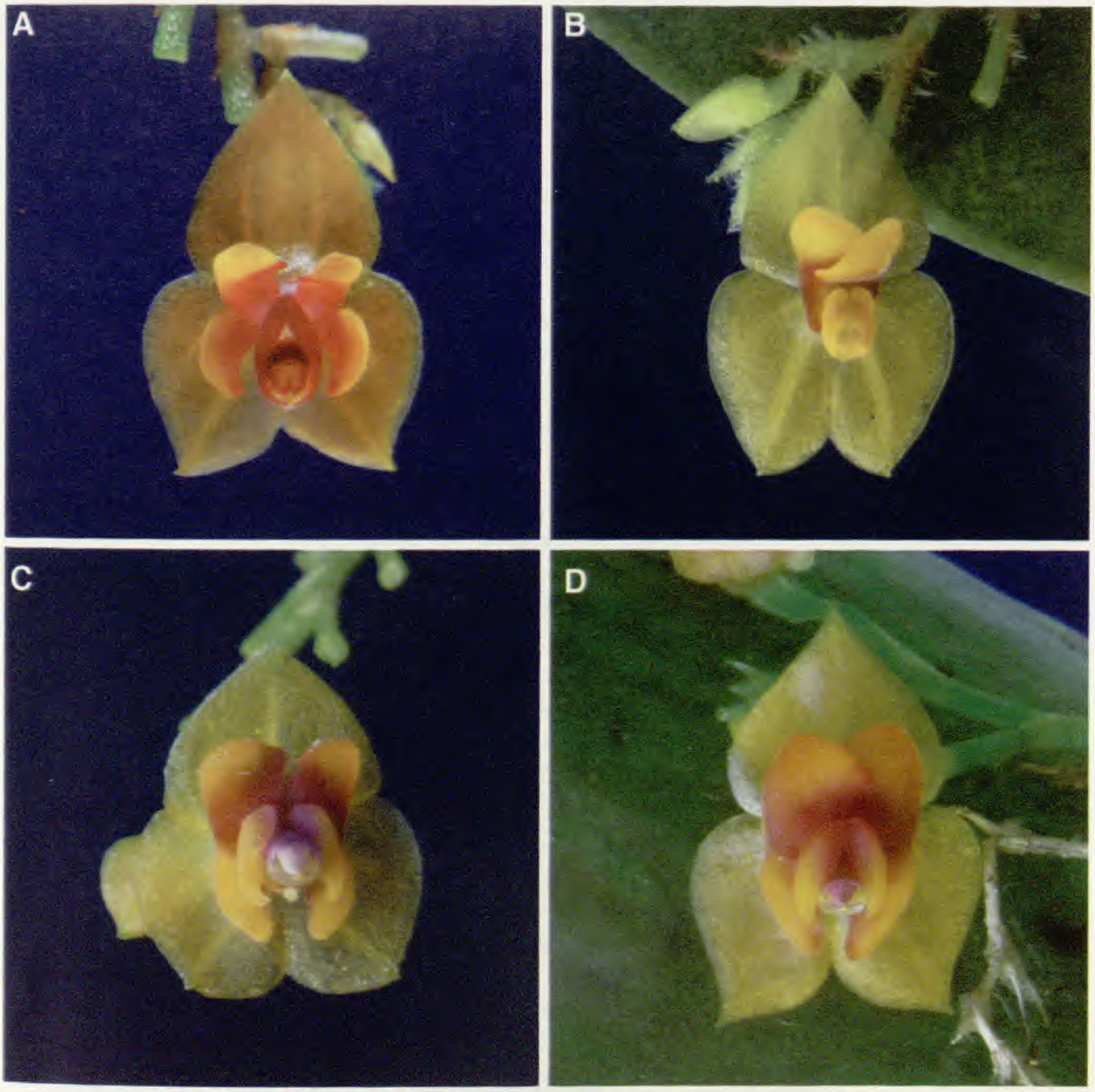

Fig. 1. Floral morphology of species of the *L. ovalis* group in Costa Rica. A) *L. dikoensis*. B) *L. erinacea*. C) *L. expansilabia*. D) *L. tarrazuensis*.

Etymology.—From the Costa Rican indigenous language Bribri *Dikö* and the Cabécar *Diká*, "pejibaye" or "peach-palm" (*Bactris gasipaes* Kunth), after the name of the district of Pejibaye de Jiménez, Cartago, where all the specimens of this *Lepanthes* were collected.

Phenology.—Plants have been recorded in flower from June to November.

Discussion.—It is similar to *L. viridis* but differs in the smaller leaves up to 4 cm long (vs. longer, to 6 cm long), smaller flowers to 5.7 mm in diameter (vs. to 12 mm), petals glabrous-minutely pubescent (vs. ciliate-hispid), the lower lobe ovate, falcate, shorter than the lobes of the lip (vs. lanceolate, subfalcate, as long as the lobes of the lip), both lobes yellow with red-orange and scarlet (vs. green with red at base) the lip scarlet, apically yellowish (vs. green with dark red at the base of each lobe), the appendix oblong (vs. rounded). It is also similar to *L. ovalis* but differs in the pendent plants (vs. erect to suberect), smaller mature leaves 4 × 1.5 cm (vs. 6 × 2.3 cm), ramicauls with ciliate sheaths and ostia (vs. minutely ciliate-scabrous), the petals glabrous (vs. the upper lobe glabrous, the lower minutely pubescent), the upper lobe oblong, apically rounded (vs. suborbicular),

FIG. 2. *Lepanthes dikoensis* Bogarín & C.M. Sm. **A)** Habit. **B)** Flower. **C)** Dissected perianth. **D)** Column and lip, lateral view. **E)** Lip, spread. Drawn by D. Bogarín from the holotype (JBL-Spirit).

lower lobe of the petals lunate, strongly falcate (vs. narrowly triangular, subfalcate), the color of flowers, the sepals orange (vs. yellow), the lower lobe of petals basally scarlet with the apex yellow-orange (vs. yellow-orange, without the scarlet stain), and the appendix narrowly oblong (vs. a small, rounded lobule) (Fig.1). The differences between Costa Rican taxa are summarized in Table 1.

2. Lepanthes erinacea Rchb.f., Bonplandia (Hanover) 3(15–16):225. 1855. (**Figs. 1B, 3**). Type: COSTA RICA. [Cartago. Turrialba]: Turialva in Costarica, *A. Oersted s.n.* (holotype: W).

Lepanthes apiculifera Schltr., Repert. Spec. Nov. Regni Veg. Beih.19:177. 1923. Type: COSTA RICA. [Alajuela]: Bois humides, San Pedro de San Ramón, alt. 1100 m, Jul 1921, *A.M. Brenes 72* (holotype: B, destroyed; lectotype designated by Barringer, Fieldiana, Bot., n.s., 17:8. 1986, AMES, drawings of type, AMES).

Lepanthes endresii Luer, Lindleyana 7:106. 1992. Type: COSTA RICA. Cartago: heights above El Tejar south of Cartago, Jun, ca. 1867, *A.R. Endres 509* (holotype: W).

Lepanthes wercklei Schltr., Repert. Spec. Nov. Regni Veg. 10(257–259):396. 1912. Type: COSTA RICA. [Cartago]: Bei Pacugao [Pacayas], c. 2000 m, blu'hend im Mai 1901, *K. Wercklé 16173* (holotype: B, destroyed; lectotype designated by Pupulin, Bot. J. Linnean Soc. 163:137. 2010, US-578037, digital photograph; drawing of type, AMES-100728)

Plant epiphytic, caespitose, erect to suberect herb, up to 15 cm tall. **Roots** slender, flexuous, up to 1 mm in diameter. **Ramicaul** erect to suberect, up to 10.5 cm long; enclosed by 9–14 heavily ciliate, lepanthiform sheaths, the ostia markedly dilated, heavily ciliate. **Leaves** coriaceous, green, ovate to orbicular, slightly conduplicate, emarginated, subacuminate with a short apiculus, 2.5–5.0 × 1.0–2.3 cm; the rounded base narrowing into a petiole to 3 mm long. **Inflorescence** racemose, distichous, successively flowered, borne below the leaf, can be longer than the leaves, up to 4.5 cm; peduncle 1.2–1.4 cm long; rachis 0.8–3.2 cm. **Floral bracts** 1 mm long, ciliate. **Pedicel** 1.5–2.0 mm long, persistent. **Ovary** up to 2 mm long. **Flowers** yellow with red-orange; the sepals yellow, petals yellow with red-orange, lip yellow and lightly tinged with orange, column yellow. **Dorsal sepal** ovate, acute, connate to the lateral sepal for about 1 mm, 3.0 × 2.5 mm. **Lateral sepals** ovate to elliptic, acute, connate for about 1 mm, 2.5–3.0 × 2.5–3.0 mm. **Petals** minutely pubescent, transversely bilobed, entire, 1.5 × 2.0 mm; upper lobes with shortly ciliate margins, flabellate, overlapping, apex broadly rounded, with an obtuse angle in the inner margin; lower lobes oblong, oblique, much smaller than the upper lobes. **Lip** bilaminate, adnate to the column, 1.4 × 1.3 mm expanded; blades ovate, falcate, pubescent, with rounded ends, connectives broadly cuneate, up to 1 mm long, perpendicular to the column and not leaving it exposed; body oblong, connate to the base of the column; appendix oblong, pedunculate, pubescent. **Column** cylindric, 1 mm long; anther apical; stigma ventral. **Pollinia** two, ovoid. **Anther cap** cucullate.

Distribution.—Only known from Costa Rica.

Phenology.—Plants were recorded in flower from June to December.

Habitat and ecology.—Growing as an epiphyte in primary and secondary premontane wet forest, between 1000 and 1500 m of elevation mostly along the Cordillera Volcánica Central and Cordillera de Talamanca.

Discussion.—It is distinguished by the erect plants with ramicauls with long ciliate sheaths, the yellow sepals and column and the red petals with the apex orange-red. The most important feature is the upper lobe of the petals, which is flabellate with the broadly rounded apices overlapping, and the oblong, oblique lower lobes, much smaller than the upper lobes and shorter than the blades of the lip. The blades of the lip are widened basally and the appendix is oblong and pubescent (Fig.1). Table 1 summarizes other differences between the Costa Rican taxa belonging to this group.

The species was described three additional times as *Lepanthes apiculifera* Schltr. (Schlechter 1923), *L. endresii* Luer (Luer 1992), and *L. wercklei* Schltr. (Schlechter 1912). However, the unmistakable shape of the petals in the type material of the latter three species matches the drawing and description presented for *L. erinacea* (Reichenbach 1855). The illustration published in Xenia Orchidacea 1: Tab. 49 (Reichenbach 1858) is somewhat schematic but shows a plant with stiff ramicauls with long ciliate sheaths and several inflorescences developed from below the leaf. The depicted flower had widened upper lobes of the petals and the lip was spread, hiding the tiny lower lobes of the petals.

Representative specimens: **COSTA RICA. Cartago:** Zona Protectora La Carpintera Cordillera Central, primary and secondary forest near the summit of the hill, 09°53'31"N 83°58'12"W, 1500 m, epiphytic, 30 Jun 1995, *J.F. Morales 4723* (INB); Paraíso, Orosi, Muñeco de Navarro,

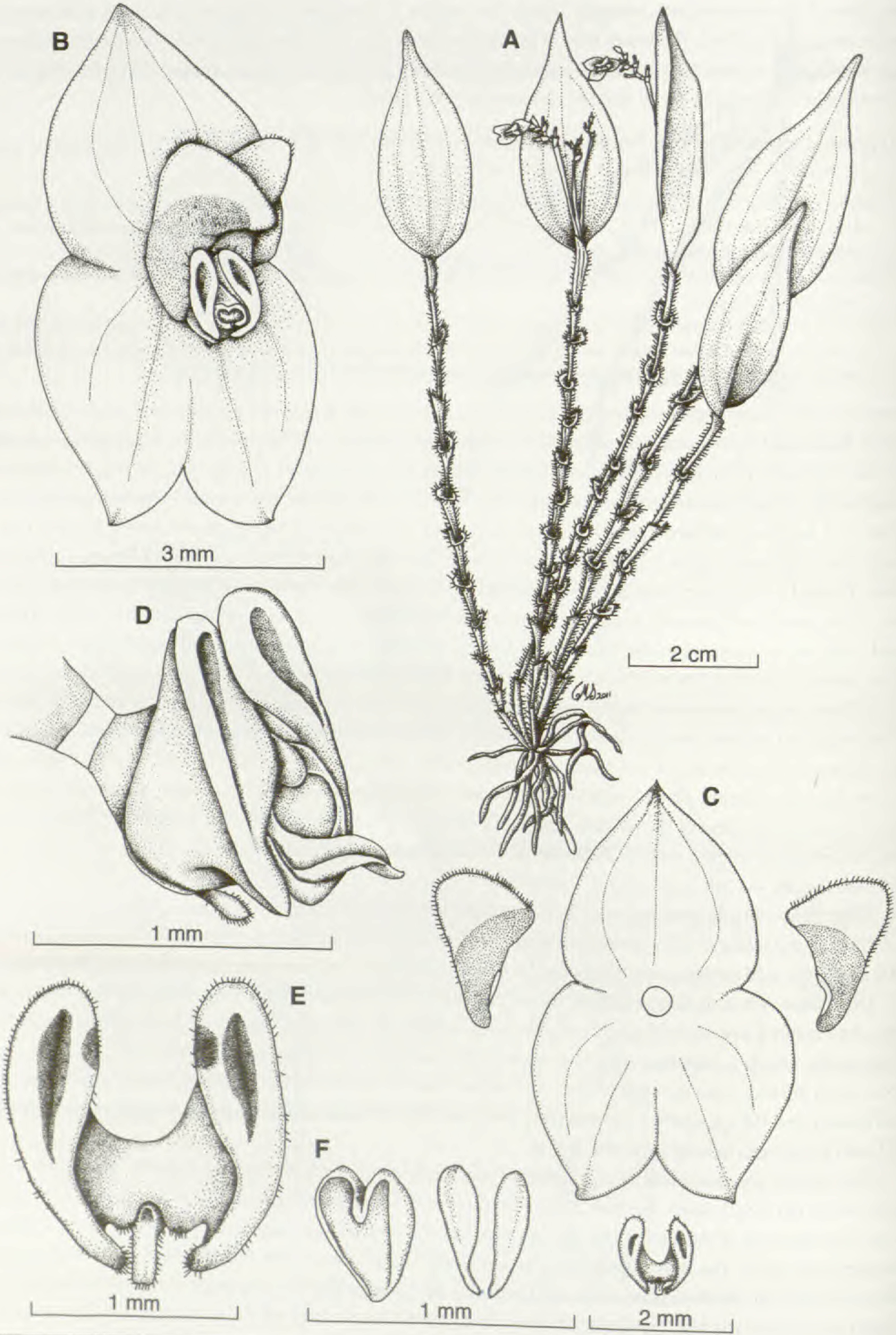

Fig. 3. *Lepanthes erinacea* Rchb.f. A) Habit. B) Flower. C) Dissected perianth. D) Column and lip, lateral view. E) Lip, spread. F) Pollinarium anther cap. Drawn by C.M. Smith from *F. Pupulin 7477* (JBL-Spirit).

Table 1. Comparison of the species of *L. ovalis* group in Costa Rica.

Character	*L. erinacea*	*L. expansilabia*	*L. dikoensis*	*L. tarrazuensis*	*L. viridis*
Habit	Erect to suberect	pendent	pendent	erect	pendent
Ramicaul sheaths	heavily ciliate	lightly ciliate especially on new	lightly ciliate especially on new growth	heavily ciliate growth	heavily ciliate
Ostia	heavily ciliate	less ciliate than *L. erinacea*	less ciliate than *L. erinacea*	heavily ciliate	heavily ciliate
Leaves	ovate to orbicular, subacuminate, rounded base	elliptic, subobovate, acuminate, cuneate base	elliptic, subobovate, acuminate, cuneate base	elliptic to oblong, acute to acuminate, cuneate base	oblanceolate to obovate, acuminate, cuneate base
Inflorescence	borne below the leaf, can be longer than the leaves	borne above or behind the leaf, shorter than the leaves	borne above the leaf, shorter than the leaves	borne below (rarely above) the leaf, shorter than the leaves	borne above the leaf, shorter than the leaves
Sepal color	yellow	yellowish	light orange	light orange	orange-yellow
Petal color	yellow with red-orange	lower lobe yellow upper red-orange and scarlet	both lobes yellow with red-orange and scarlet	scarlet red with orange apics	green with red at base
Lower petal lobe	oblong, oblique, much smaller than the upper lobes	oblong, subfalcate, obtuse, slightly smaller than the upper lobes	ovate, falcate, rounded, slightly smaller than the upper lobes	oblong to narrowly triangular, smaller than the upper lobes	lanceolate, subfalcate, obtuse, slightly smaller than the upper lobes
Lip color	yellow, lightly tinged with orange	yellow with the bases of lobes lavender	scarlet, apically yellowish	orange tinged with scarlet red at bases	green with dark red at the base of each lobe
Lip blades	ovate, widened basally and touching each other	ovate, slightly widened basally and not touching each other	narrowly oblong and touching each other	ovate, widened and touching each other basally	subfalcate-lanceolate, apices approximate
Column color	yellow	purplish-lavender	red	purplish-pinkish	dark red

1300 m, 12 Apr 1998, *M. Blanco 824 & L. G. Espinoza* (USJ); Paraíso, Cachí, Peñas Blancas, 9°49'51.3"N 83°46'13.1"W, 1400 m, premontane wet forest, epiphytic on trees in pastures and secondary mature vegetation, 13 Nov 2008, *F. Pupulin et al. 7477* (JBL). **Heredia:** near Varablanca, 5 Dec 1984, *R.L. Dressler et al. 256* (USJ).

3. Lepanthes expansilabia Bogarín & C.M. Sm., sp. nov. (**Figs. 1C, 4**). Type: COSTA RICA. Puntarenas: Coto Brus, Limoncito, Unión, ca. 800 m, invenit William Chacón, flowered in cultivation at Orquidario Happy Garden, 20 Apr 2011, *D. Bogarín 8766* (holotype: JBL; isotype: CR).

Habitu *Lepanthem erinaceam* Rchb.f. et affinibus similis praecipue differt stirpe pendente, ramicaulis vaginis cum ostiis minute ciliatis, lobulis petalorum oblongis subsimilaribus, lobo inferiore flavo, labello expanso lobulis separatis et appendice exposita.

Plants epiphytic, caespitose, pendent herb, up to 11 cm long. **Roots** slender, flexuous, up to 1 mm in diameter. **Ramicauls** more or less descending, up to 7 cm; enclosed by 6–12 ciliate, lepanthiform sheaths, lightly ciliate especially on new growth, the ostia markedly dilated, ciliate. **Leaves** coriaceous, green, elliptic, subobovate, acuminate with a short apiculus, 2.5–4.3 × 1.7–2.2 cm; the cuneate base narrowing into a petiole ca. 3 mm long. **Inflorescence** racemose, distichous, successively flowered, borne above or behind the leaf, shorter than the leaves, up to 2 cm; peduncle 1.7 cm long; rachis 4–5 mm. **Floral bracts** 1 mm long, lightly ciliate. **Pedicel** 1.5 mm long, persistent. **Ovary** up to 1 mm long. **Flowers** yellow, orange, red and purple; sepals light yellow, petals yellow with the upper lobe stained with scarlet, the lip yellow, basally lavender, the column lavender at

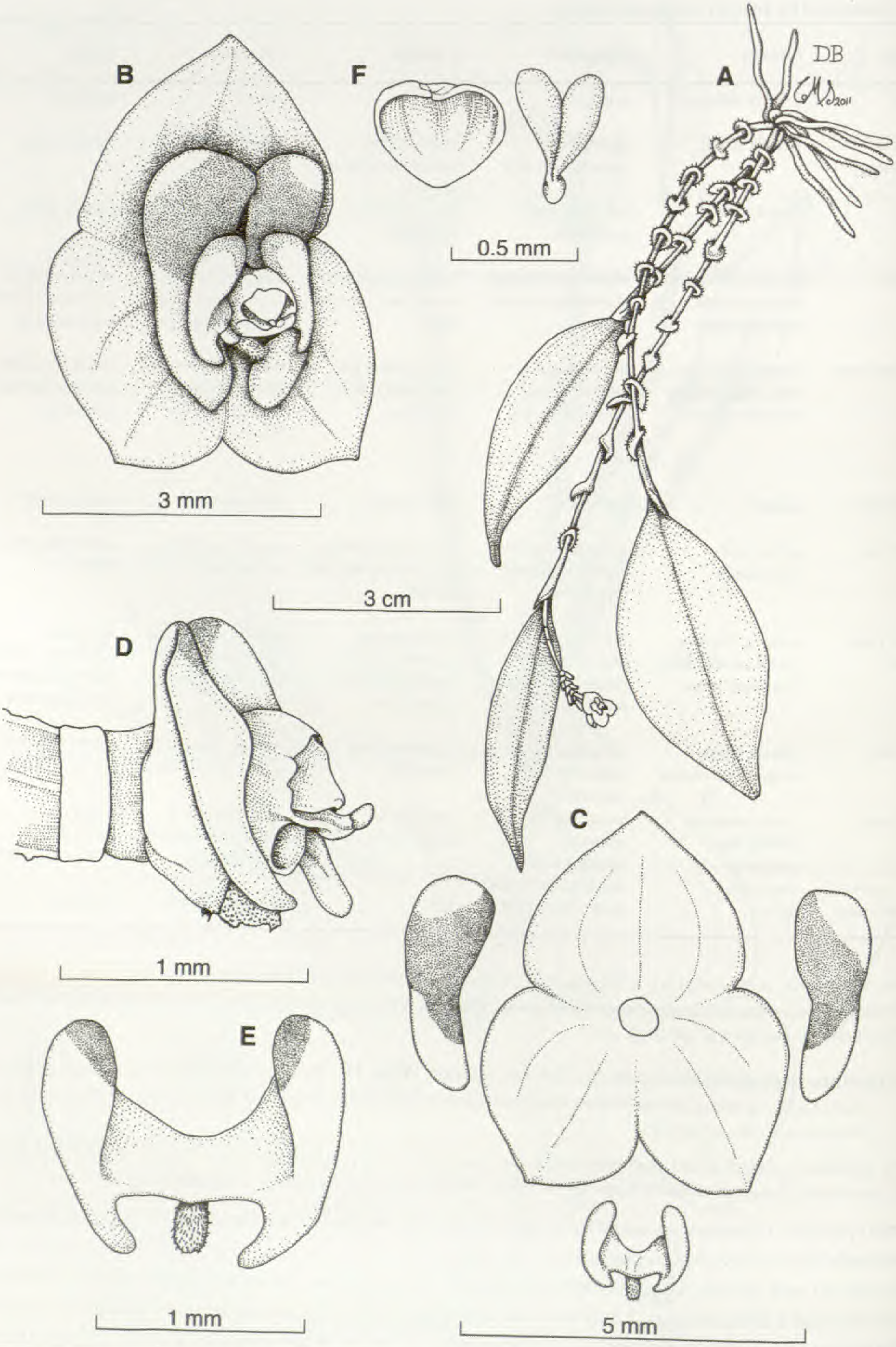

Fig. 4. *Lepanthes expansilabia* Bogarín & C.M. Sm. **A)** Habit. **B)** Flower. **C)** Dissected perianth. **D)** Column and lip, lateral view. **E)** Lip, spread. **F)** Pollinarium anther cap. Drawn by D. Bogarín and C. Smith from the holotype (JBL-Spirit).

apex. **Dorsal sepal** broadly ovate, obtuse or subacute, connate to the lateral sepal for about 1.3 mm, 3.3 mm × 2.8 mm. **Lateral sepals** ovate to elliptic, obtuse, connate for about 1.4 mm, 2.9 mm × 2.7 mm. **Petals** minutely pubescent, transversely bilobed, entire, 1.2 × 3.2 mm; the upper lobes oblong-obovate, truncate, not overlapping, the apex broadly rounded; the lower lobes oblong, obtuse, subfalcate, the apex broadly rounded, smaller than the upper lobes. **Lip** bilobate, spreading, adnate to the column, 1.2 mm × 1.5 mm, expanded; the blades ovate, with rounded ends, falcate; the connectives cuneate, up to 0.5 mm long, perpendicular to the column leaving the appenndix exposed; the body oblong, connate to the base of the column; the appendix oblong, pubescent. **Column** cylindric, 1 mm long; the anther apical; the stigma ventral. **Pollinia** two, ovoid. **Anther cap** cucullate.

Distribution.—Only known from the southern Pacific region of Costa Rica.

Habitat and ecology.—Epiphytic in tropical wet forest, premontane belt transition at 800 m of elevation along the Pacific watershed of Cordillera de Talamanca in southern Costa Rica.

Etymology.—From the Latin *expansus* "spread" and *labium* "lip," in reference to the spreading lip with the lobes not touching each other, leaving the appendix exposed.

Phenology.—Plants have been recorded in flower in April.

Discussion.—It is similar to *L. erinacea* but differs mainly by the pendent plants (vs. erect) with ramicauls with sparsely ciliate sheaths (vs. heavily ciliate), the petals with the lobes oblong, subsimilar (vs. the upper flabellate, the lower minute, oblique), the lower lobe yellow (vs. red), the lip spreading with the lobes separated and not touching each other, leaving the appendix exposed (vs. the apices of the blades approximate, hiding the appendix) (Fig.1). Other differences are summarized in Table 1.

4. **Lepanthes ovalis** (Sw.) Fawc. & Rendle, Fl. Jamaica 1:71. 1910. *Epidendrum ovale* Sw., Prod. 125. 1788. *Lepanthes concinna* Sw., Nova Acta Regiae Soc. Sci. Upsal. 6:85. 1799; emend. in Fl. Ind. Occ. 1557–1558. 1806, nom. illeg. *Epidendrum concinnum* (Sw.) Steud., Nomen. Bot. ed. 1:299. 1821. Type: JAMAICA: "Habitat in Montibus altis caeruleis Jamaicae, parasitica arborum," *O. Swartz s.n.* (holotype: not located; isotypes: BM, K, S, W).

Lepanthes crassifolia Rchb.f., Linnaea 41:47.1877. Type: JAMAICA: Vivam vidi in horto Kewensi, Sep 1873, concedente ill. Oliver. ex Jamaica missa dicebatur a hortulanis (holotype: W).

As noted by Pupulin (2009), there is no way to assume that any of the specimens at BM is the holotype. The species should be lectotypified after a more detailed study of the available material; drawing of type, W). For a complete description and illustration see Luer (2009).

Distribution.—Only known from Jamaica.

Habitat and ecology.—Epiphytic in cloud forest along the Blue Mountains.

Discussion.—Plants are recognized by the erect to suberect arching habit, the inflorescences developed above the leaf, the upper lobe of petals suborbicular, rounded, yellow with red-purple base, the lower lobe yellow, pubescent and the inconspicuous appendix.

5. **Lepanthes pan** Luer & Dalström, Monogr. Syst. Bot. Missouri Bot. Gard. 61:133–134, f. 178. 1996. Type: ECUADOR. Imbabura: Los Cedros Reserve, wet forest near Río Los Cedros, alt. 1200–1300 m, 24 Mar 1996, *S. Dalström, S. Ingram & K. Ingram-Ferrell 2200* (holotype: MO). For a complete description and illustration see Luer (1996).

Distribution.—Only known from Ecuador.

Habitat and ecology.—Epiphytic in wet forest at around 1200–1300 m of elevation.

Discussion.—It is distinguished by the erect plants with inflorescences developed behind the leaf, the lateral sepals acute, pubescent, the upper lobe of petals with a lobule at the inner apical corner, the lower lobe long-ciliate, pubescent, the apex of the lip is shallowly cleft with apiculate apices in apposition with a small triangular appendix.

6. **Lepanthes seegeri** Luer, Orchidee (Hamburg) 38:60. 1987. Type: PANAMA. Chiriquí: epiphytic in forest above Boquete, alt. 1600–1700 m, Apr 1985, collected by H. Seeger 678A, flowered in cultivation at Heidelberg University 16 Oct. 1985, *C. Luer 11424* (holotype: MO). For a complete description and illustration see Luer (1987).

Distribution.—Only known from Panama.

Habitat and ecology.—Epiphytic in cloud forest at around 1600–1700 m of elevation along the Cordillera de Talamanca in western Panama.

Discussion.—It is recognized by the erect plants with inflorescences developed behind the leaf, the lateral sepals obtuse, glabrous the upper lobe of petals with a lobule at the inner apical corner, the lower lobe long-ciliate, pubescent and the lip with a long, slender, descending, pubescent appendix that protrudes from a shallow sinus beneath the stigma.

7. Lepanthes tarrazuensis Bogarín & D. Jiménez, sp. nov. (**Figs. 1D, 5**). Type: COSTA RICA. San José: Dota, Santa María, between Santa María and Naranjillo de Tarrazú, 9°35'33.35"N 83°58'26.74"W, 1615 m, epiphytic, legit Daniel Jiménez, flowered in cultivation at Jardín Botánico Lankester, 14 Feb 2012, *D. Bogarín 9471* (holotype: JBL; isotype: CR).

A *Lepanthes seegeri* Luer, petalis labelloque glabris in apice ciliatis, flavis aurantiacis in base scarlatis, lobo superiore petalorum truncato non lobato, lobulis labelli conniventibus et appendice minore, a *Lepanthes dikoensis* Bogarín & C.M. Sm. stirpe erecta, lobo superiore petalorum trapeziformi, truncato, statim dignoscenda.

Plant epiphytic, caespitose, erect herb, up to 14 cm tall. **Roots** slender, flexuous, up to 1 mm in diameter. **Ramicauls** erect to suberect, 3.5–9.0 cm long, enclosed by 7–10 ciliate, lepanthiform sheaths, ciliate especially on new growth; ostia markedly dilated, ciliate. **Leaves** coriaceous, green, elliptic to oblong, acute to acuminate with a short apiculus, 3-veined, 3.2–5.3 × 1.1–2.5 cm; cuneate base narrowing into a petiole ca. 7 mm long. **Inflorescence** racemose, distichous, successively flowered, beneath (rarely above) the leaf, shorter than the leaves, up to 2.5 cm long; peduncle 1.3 cm long; rachis 1.2 cm. **Floral bracts** 1 mm long, ciliate. **Pedicel** 2 mm long, persistent. **Ovary** up to 1 mm long. **Flowers** sepals light orange, petals and lip with the bases scarlet-red and the apices yellowish-orange, the column pinkish-purplish. **Dorsal sepal** broadly ovate, acute, glabrous, connate to the lateral sepals for about 1.2 mm, 3.7 × 3.6 mm. **Lateral sepals** broadly ovate, acute, glabrous, connate for about 1 mm, 3.9 × 2.5 mm. **Petals** transversely bilobed, 1.8 × 4.2 mm, slightly ciliate along the margins; upper lobes oblong-trapeziform, overlapping, apex broadly rounded or truncate; lower lobes smaller than the upper lobes, oblong to narrowly triangular, oblique, apex rounded. **Lip** bilobate, adnate to the column, 1.5 × 2.2 mm expanded; blades ovate, glabrous with ciliate, rounded apices, subfalcate; connectives cuneate, up to 0.7 mm long, perpendicular to the column and not leaving it exposed; body oblong, connate to the base of the column; the appendix oblong, shortly pubescent. **Column** cylindric, 1.2 cm long; anther apical; stigma subapical. **Pollinia** two, ovoid. **Anther cap** cucullate.

Distribution.—Only known from the central-southern Pacific region of Costa Rica.

Habitat and ecology.—Epiphytic in premontane and lower montane rain forest along the Pacific watershed of Cordillera de Talamanca.

Etymology.—From the locality of Tarrazú in San José province. Tarrazú comes from an indigenous Huetar word of unknown meaning.

Phenology.—Plants were recorded in flower from February to March.

Discussion.—It is similar to *L. seegeri* but differs mainly by the glabrous petals and the lip glabrous with ciliate apices (vs. long ciliate-pubescent), the upper lobe of petals truncate, without lobules at the inner apical corner (vs. oblong, rounded, with lobule at the inner apical corner), the petals and lip basally red, tinged with yellow-orange at apex (vs. completely red without stains), the blades of the lip touching each other above the column (vs. slightly expanded and not touching each other), the appendix shorter, a small triangular lobule, not extending far from the apex of the column (vs. appendix longer, descending, extending far from the apex of the column) (Fig.1). Other differences are summarized in Table 1.

8. Lepanthes trichocaulis Luer & R. Escobar, Orquideología 17:224–226. 1988. Type: COLOMBIA. Antioquia: Munic. of Yarumal, Briceño, Quebrada El Oro, alt. 1820 m, collected by R. Escobar & E. Valencia, 14 Feb 1984, flowered in cultivation by L. & J. Posada at Colomborquídeas 26 Mar 1984, *R. Escobar 3245* (holotype: MO). For a complete description and illustration see Luer (1988).

Distribution.—Only known from Colombia.

Habitat and ecology.—Epiphytic around 1820 m of elevation (Luer 1988).

Discussion.—It is recognized by the erect plants, the inflorescences developed behind the leaf, the upper

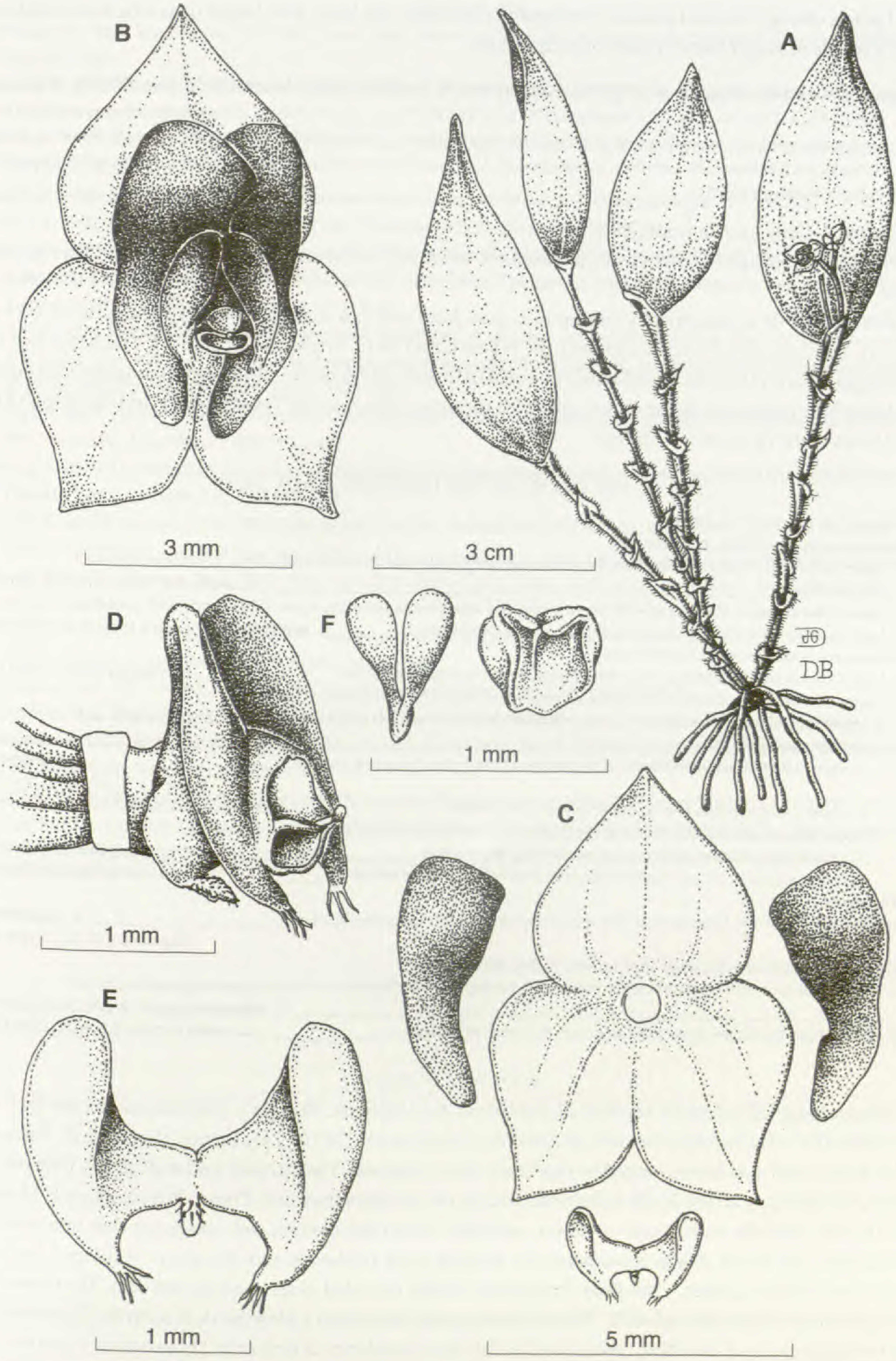

Fig. 5. *Lepanthes tarrazuensis* Bogarín & D. Jiménez. A) Habit. B) Flower. C) Dissected perianth. D) Column and lip, lateral view. E) Lip, spread. F) Pollinarium anther cap. Drawn by D. Bogarín and D. Jiménez from the holotype (JBL-Spirit).

lobe of petals oblong, rounded and not overlapping each other, the lower lobe longer or as long as the blades of the lip a couple of longer hairs in place of an appendix.

9. Lepanthes viridis Pupulin & Bogarín, Lindleyana in Orchids, Mag. Amer. Orch. Soc. 80:179. 2011. TYPE: COSTA RICA. TURRIALBA: Tuis, Cien Manzanas, 9°51'25"N 83°33'47"W, ca. 3,117 ft (950 m), along a minor tributary of Río Pacuare, premontane wet forest, secondary vegetation and remnants of primary, 26 May 2003, *F. Pupulin 4801, R. and K. Dressler, J. Aguilar, G. Gerlach, P. Kindlmann, H. León-Paéz, S. Pugh-Jones & E. Serrano* (HOLOTYPE: JBL). For a complete description and illustration see Pupulin and Bogarín (2011).

Distribution.—Only known from Costa Rica.

Habitat and ecology.—Epiphytic in premontane wet forest on the caribbean slopes of Cordillera de Talamanca.

Discussion.—It is superficially similar to *L. pan*, from which it mainly differs by the distinctly obovate leaves (vs. orbicular and shortly acuminate), the yellow flowers with bright green petals (vs. peach and red), the lateral sepals shorter than the dorsal sepal (vs. equal in length), the densely villose petals (vs. upper lobe pubescent, lower lobe pubescent on the outer half), with the upper lobe rounded (vs. truncate), and the apices of the lateral lobes of the lip acute (vs. obtuse).

KEY TO THE SPECIES OF THE *LEPANTHES OVALIS* GROUP

1\. Plants erect to suberect to arching.
2\. Inflorescences developed above the leaf.
3\. Upper lobe of petals suborbicular, rounded, yellow with red-purple base, the lower lobe yellow, pubescent, appendix inconspicuous **L. ovalis** (Sw.) Fawc. & Rendle (Jamaica)
3\. Upper lobe of petals oblong-trapeziform, truncate, red with orange apex, the lower lobe orange with scarlet at base, glabrous with slightly ciliate margins, appendix conspicuous **L. tarrazuensis** Bogarín & D. Jiménez (Costa Rica)
2\. Inflorescences developed behind the leaf.
4\. Upper lobe of petals flabellate, lower lobe shorter than the blades of the lip **L. erinacea** Rchb.f. (Costa Rica)
4\. Upper lobe of petals oblong or dolabriform, lower lobe longer than the blades of the lip.
5\. Upper lobe of petals rounded or truncate without lobules at the inner apical corner, lower lobe glabrous or with slightly ciliate margins **6**
6\. Upper lobes of petals and bases of the blades of the lip touching one another **L. tarrazuensis** Bogarín & D. Jiménez (Costa Rica)
6\. Upper lobes of petals and blades of the lip approximate **L. trichocaulis** Luer & R. Escobar (Colombia)
5\. Upper lobe of petals with a lobule at the inner apical corner, lower lobe long-ciliate, pubescent.
7\. Lateral sepals obtuse, glabrous; appendix long, descending **L. seegeri** Luer (Panama)
7\. Lateral sepals acute, pubescent; appendix a minute, triangular lobule **L. pan** Luer & Dalström (Ecuador)
1\. Plants pendent.
8\. Lip expanded, with the lobes distant from each other, leaving the appendix exposed **L. expansilabia** Bogarín & C.M. Sm. (Costa Rica)
8\. Lip not expanded, with the lobes approximate, hiding the appendix.
9\. Petals glabrous to minutely pubescent, the lower lobe shorter than the lobes of the lip, apex orange-yellow, lip red **L. dikoensis** Bogarín & C.M. Sm. (Costa Rica)
9\. Petals ciliate-hispid, the lower lobe as long as the lobes of the lip **L. viridis** Pupulin & Bogarín (Costa Rica)

ACKNOWLEDGMENTS

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BOOK REVIEWS

Christian Ziegler. Introduction by Michael Pollan. 2011. **Deceptive Beauties: The World of Wild Orchids.** (ISBN-13: 978-0-226-98297-7, hbk.). The University of Chicago Press, Chicago, Illinois 60637, U.S.A. (**Orders:** www.sinauer.com). $45.00, 183 pp., color photos throughout, 9¾" × 9¾".

The book jacket describes the author as "a biologist turned photographer specializing in tropical natural history." That is obviously a true statement—but it doesn't go far enough. This is a person who greatly enjoys what he's doing and it is clearly reflected in the beauty, the layout, and the genuine "feel"—and love—of orchids.

Michael Pollan's introduction, "Sex Among the Orchids," definitely catches the reader's attention with his opening statement: "We animals don't give plants nearly enough credit. " His following discourse is not only fascinating and treated with fact, history, and humor, the reader is easily fully engaged—and can't put the book down.

The photography is outstanding. Ziegler's accompanying chapters are well written, explanatory, and provide exceptional background, diversity, descriptions of various habitats, atmospheric changes, uses, concerns, biological changes that influence the habitat environments, and, of course, effects of human behavior as well—real or potential.

Expect to take time to browse and enjoy this volume. It is really well done, and it makes one very aware of potential challenges in the upcoming years.—*Helen Jeude, Volunteer and Assistant Editor, Botanical Research Institute of Texas, 1700 University Dr., Fort Worth, Texas 76107-3400, U.S.A.*

Carol Gracie with a foreword by Eric Lamont. 2012. **Spring Wildflowers of the Northeast: A Natural History.** 2012. (ISBN: 978-0-691-14466-5, hbk.). Princeton University Press, 41 William Street, Princeton, New Jersey 08540, U.S.A. (**Orders:** http://press.princeton.edu/titles/9668.html, 609-258-4884, 609-258-6305 fax). $29.95, 290 pp., 512 color illus., 7½" × 10".

What a welcome addition to wildflower literature! This is the ideal book for readers of all levels of expertise, from the professional botanist to the armchair naturalist. Princeton University Press affirms the value of Carol Gracie's passion and attention to detail, her botanical research and travel, her years of teaching, her insightful writing, and 500 revealing photographs. The book first appears to be a gorgeous coffee table book, but then, I opened those first pages, and found myself dropping down the rabbit hole into Carol Gracie's extraordinary botanical world rarely experienced by most people. Her teaching years at the New York Botanical Gardens, her intelligence and curiosity come alive to show the identification and natural history of a select group of woodland wildflowers from baneberries to violets. She thinks of the question before you ask it. She touches on complicated topics of climate change, ethnobotany, horticulture, medicine and more, without being tedious. In addition, she refers to Indian lore, botanical literature and art. Carol Gracie explains the reason for taxonomic name changes and adds an impressive list of references, which is testament to the extensive research to prepare this work. I have heard that some times when we look, we don't see. Carol Gracie teaches us to see. I salute this gifted plantswoman for focusing on the beauty and intricacies of northeastern wildflowers, adding a valuable contribution to our knowledge of the flora of the United States.—*Jane Austin Bruckner, graduate of Rutgers University, New Jersey, a Registered Nurse, a Certified Master Gardener and BRIT Volunteer, 1700 University Dr., Fort Worth Texas 76107-3400, U.S.A.*

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CALATHEA BASIFLORA (MARANTACEAE), A NEW SPECIES ENDEMIC TO PANAMA

Helen Kennedy

UCR Herbarium
Department of Botany and Plant Science
University of California Riverside
Riverside, California 92521, U.S.A.
ganders@mail.ubc.ca

ABSTRACT

Calathea basiflora H. Kenn., sp. nov., endemic to Comarca San Blas, Panamá, is described as new for inclusion in Flora Mesoamericana. Nine of the species considered endemic to Panamá are found in Prov. San Blas. *Calathea basiflora* is characterized by the herbaceous, obovate leaves, the inflorescences usually borne on a separate, leafless, shoot directly from the rhizome, the presence of both membranous and claviculate bracteoles and white flowers. It differs from *C. verecunda* H. Kenn. by the broader leaf blades (17–21.5 vs. 4–8 cm), the bracts with obtuse vs. acute to acuminate apices and the presence of claviculate bracteoles; from *C. rhizanthoides* H. Kenn. by the longer leaves (42–46 vs. 17–30 cm) and relatively shorter peduncles (less than 1.2 × vs. more than 3× the length of the inflorescence); and from *C. cleistantha* Standl. by the presence of 1–2 indurate, claviculate bracteoles vs. all bracteoles membranous.

RESUMEN

Calathea basiflora H. Kenn., endémica de la Comarca de San Blas, Panamá, se describe como nueva para su inclusión en Flora Mesoamericana. Nueve de las especies que son consideradas endémicas de Panamá crecen en la Prov. de San Blas. *Calathea basiflora* se caracteriza por tener la lámina de la hoja herbácea, obovada, las inflorescencias en un brote aparte que sale directamente del rizoma, sin hojas. Se diferencia de *C. verecunda* H. Kenn. por sus láminas foliares más anchas (17–21.5 vs. 4–8 cm), las brácteas con el ápice obtuso vs. agudo o acuminado; de *C. rhizanthoides* H. Kenn. por sus láminas foliares más largas (42–46 vs. 17–30 cm) y los pedúnculos relativamente más cortos (menos de 1.2 veces vs. más de 3 veces el largo de la inflorescencia) y de *C. cleistantha* Standl. por tener bractéolas 1–2 claviculado-endurecidas vs. todas membranáceas.

In the Flora of Panama (Woodson & Schery 1945), a total of 23 species of Marantaceae were listed with 14 in the genus *Calathea*. By 1972, Dressler (1972: 184) reported 35 species. Later, Kennedy (1976: 312–313) noted a total of 49 species and predicted an eventural increase to 60 or 70 because of the species richness found along the Río Guanche (Colón Prov.) and the El Llano-Cartí road (Panama Prov. and San Blas Prov.) and general inaccessibility of those areas at the time. More recently, Kennedy (2012: 49) reported 63 species of Marantaceae from Panama. Currently 67 species (ca. 191% increase from the 1945 Flora of Panama treatment) are recognized with 49 in the genus *Calathea*. Eighteen species are recognized as endemic, including the one described herein plus two as yet undescribed taxa. Additional collecting in Costa Rica, but especially in adjacent Colombia, will reduce this number.

TAXONOMIC TREATMENT

Calathea basiflora H. Kenn., sp. nov. (**Fig. 1**) TYPE: PANAMA. SAN BLAS: Río Playón Chico, Campamento Nebba Dummat, Filo del Sureste, 200–420 m, 09°14'N, 78°15'W, 10 Jul 1994, *H. Herrera 1661* (HOLOTYPE: PMA; ISOTYPES: MO 6315278, PMA 75534).

Calathea basiflora differs from *C. verecunda* in the wider leaf blades, 17.5–21.5 vs. 4–8 cm, the obtuse vs. acute to acuminate bract apex; from both *C. verecunda* and *C. cleisthantha* by the presence of 1–2 claviculate bracteoles vs. all bracteoles membranous; and from *C. rhizanthoides* by the larger leaf blades, 42–46 × 17.5–21.5 vs. 17–30 × 9.1–16.5 cm, two inflorescences per shoot vs. a single inflorescence, and the ratio of peduncle length to inflorescence length less than 1.2 vs. 3 or more.

Plants rhizomatous, perennial, herbs, 40–60 cm; cataphylls herbaceous, narrowly ovate, minutely pilose, hairs ca. 0.2 mm, 3.5–5.5 on shoots bearing an inflorescence. **Leaves** all basal, 1–2 per shoot; leaf sheath not auriculate, appressed pilose, hairs more dense along margins of wings and toward base, base and internode below, sericeous, ca. 40 cm; petiole with a distinct groove adaxially, scattered minutely pilose, hairs ca. 0.1 mm, 2.5–3 cm; pulvinus minutely tomentose adaxially, sides and abaxial portion glabrous, 1–1.5 cm; leaf blade soft,

Fig. 1. *Calathea basiflora* H. Kenn. Isotype (Herrera 1661, MO). Photo provided by Missouri Botanical Garden.

TABLE 1. Comparison of leaf and inflorescence characters among previously described and a new species with basal inflorescences.

Character	*Calathea basiflora*	*Calathea rhizanthoides*	*Calathea verecunda*	*Calathea cleistantha*	*Calathea elegans*
Leaf length (cm)	42–46	17–30	15–31	25–54	34–82
Leaf width (cm)	17.5–21.5	9.1–16.5	4–8	12–22	11.5–30
Petiole (cm)	2.5–3	7–25.5	17–47	3.5–15	(5.5–)25–40
Infls./shoot	2	1	1–2	(2–)4–9	1–3
Infl. height (cm)	(4–)5–7.5	2.4–3.2	2.5–4.2	3.5–5	5–12
Peduncle (cm)	4.5–7.5	11.5–24(–29.5)	0.9–4.5	1.5–3	(5–)14–36(–49)
Bracteoles	4; 2 membr., 1–2 clavic.	3; 2 membr. 1 claviculate	4; 4 membr. none clav.	4; 4 membr. none clav.	3: 2 membr. 1 claviculate

herbaceous, obovate, apex rounded with short acumen, base attenuate to cuneate-attenuate, 42–46 × 17.5–21.5 cm, lateral veins 13–18 per 3 cm, cross veinlets 33–37 per 5 mm (veins measured at midpoint of each side of blade), vein angles from midrib 31°–40°, measured at midpoint of blade; adaxial surface of blade green, minutely tomentose along marginal 4–8 mm on wider side, hairs ca. 0.2 mm, basal 1/7 glabrous, narrower side glabrous except at apex, midrib minutely appressed tomentose centrally, hairs 0.2–0.3 mm; abaxial surface minutely tomentose along blade within 0.5 cm of midrib, distally hairs sparser, only along veins, more densely so on major veins, but also tomentose all along the margin, midrib minutely appressed tomentose, hairs colorless, 0.1–0.2 mm. **Inflorescences** 2 per shoot, borne on separate leafless shoots directly from the rhizome, the first terminal, the second borne in the axil of the cataphyll subtending the terminal one, inflorescences borne below the leaves, lax, ellipsoid, (4–)5–7.5 × (2–)2.5–3.6 cm; peduncle sparsely pilose apically, somewhat more densely so toward base, 4.5–7.5 cm. **Bracts** 6–13, spirally arranged, thin, herbaceous, obovate, apex obtuse, margin and apex erect, 2.1–2.8 × 1.4–2.1 cm, each bract subtending up to 4 flower pairs; abaxial surface of bracts chocolately green, minutely pilose thoughout, somewhat more dense toward base, hairs 0.2–0.3 mm; bicarinate prophyll membranous, ovate, apex acute, 1.8–2.4 × 0.9–1.1 cm, 0.5–0.8 cm wide, carina to carina; secondary bract membranous, elliptic, apex obtuse, 2–2.3 × 0.8–1 cm; bracteoles 3–4 per flower pair, 2 lateral, membranous, 2.2–2.4 × ca. 0.5 cm, 1–2 medial, claviculate, 2.3–2.7 cm. **Sepals** membranous, narrowly obovate, acute, violet, glabrous, 23–24 × 3.5–4.5 mm. **Corolla** white, tube glabrous, 23–25 mm; corolla lobes subequal, elliptic, obtuse, glabrous, 12–15 × 5–6 mm. **Staminodes** 3, white; outer staminode ca. 9 mm; cucullate staminode 7–9 mm; anther ca. 2.5 mm; ovary smooth, glabrous, ca. 2 ×1.5 mm. **Capsule** unknown.

Distribution and habitat.—Calathea basiflora is endemic to Panamá. It is known only from the type, collected in the Comarca de San Blas at Filo del Sureste near Río Playón Chico, 200–420 m in wet forest habitat.

DISCUSSION

Calathea basiflora belongs to *Calathea* sect. *Breviscapus* Benth. It is readily distinguished from other Panamanian species by the herbaceous, obovate leaf blade, the inflorescences borne on a separate leafless shoot, the peduncle length less than 1.2 times inflorescence length, the the presence of both membranous and claviculate bracteoles, and the white flowers. In *C. verecunda* H. Kenn. the inflorescences are also borne on separate, leafless shoots but it differs in the narrower leaf blades, 4–8 vs. 17.5–21.5 cm, bracts with acute to acuminate vs. obtuse apices and bracteoles 4, all membranous vs. 2 membranous and 1–2 claviculate. *Calathea rhizanthoides* likewise has inflorescences borne on separate, leafless shoots, an obvate leaf, both membranous and claviculate bracteoles, and white flowers but differs in the smaller leaves, 17–30 × 9.1–16.5 vs. 42–46 × 17.5–21.5 cm, the single inflorescence per shoot vs. 2, and the peduncle length 3 or more times the lenght of the inflorescence vs. less than 1.2 times. *Calathea cleistantha* Standl. also has inflorescences borne on separate shoots but generally has more numerous, 2–4(–9) vs. 2, inflorescences, and lacks claviculate bracteoles. Both *C. elegans* H. Kenn. and *C. robin-fosteri* H. Kenn. also have membranous as well as claviculate bracteoles but are very different in habit, distinguised by their narrowly elliptic, stiff, coriaceous leaves vs. obovate, soft, herbaceous leaves and the petiole considerably longer than (rarely equal to) the sheath vs. sheath much longer than the petiole.

Etymology.—The specific epithet, *basiflora*, refers to the inflorescences borne directly from the rhizome at the base of the plant, well below the leaves.

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TWO NEW DISTICHOUS-BRACTED *CALATHEA* (MARANTACEAE) SPECIES FROM CENTRAL AMERICA

Helen Kennedy

UCR Herbarium
Department of Botany and Plant Science
University of California, Riverside
Riverside, California 92521 U.S.A.
ganders@mail.ubc.ca

ABSTRACT

Calathea ravenii H. Kenn., sp. nov. and **Calathea oscariana** H. Kenn., sp. nov. are described as new for inclusion in *Flora Mesoamericana*. *Calathea ravenii* is endemic to Panama, known only from the type locality, Puerto Obaldia, in Comarca San Blas (= Comarca Kuna Yala). It is distinguished from other Panamanian distichous-bracted species by the elliptic leaf blades, length 2.2–2.36 × width, the greenish, glabrous bracts with non-recurved apical margins, the single membranous bracteole per flower pair, and pale yellow flowers. *Calathea oscariana*, endemic to Guatemala, occurs in premontane wet forest. *Calathea oscariana* differs from the closely related *C. sclerobractea* K. Schum. by the non-recurved vs. recurved bract margin, the bracts minutely appressed tomentose throughout with hairs more dense at base vs. densely appressed tomentose along apical margin, the rest glabrous, and the usually greater length to width ratio of the blade, (1.52–)1.94–2.47:1 vs. 1.59–1.87:1; and from *C. crotalifera* S. Watson by the smaller bracts (2.2–2.5 × 3.2–4.2 vs. 2.9–3.5 × 4.2–5.4 cm) and cream-colored vs. yellow, yellow-orange or bronze bracts.

RESUMEN

Calathea ravenii H. Kenn., sp. nov. y **Calathea oscariana** H. Kenn., sp. nov. son descritas como nuevas para su inclusión en Flora Mesoamericana. *Calathea ravenii*, endémica de Panamá, es conocida solamente de la localidad del tipo, Puerto Obaldia, en la Comarca San Blas (= Comarca Kuna Yala). Se diferencia de otras especies dístico-bracteadas de Panamá, por la lámina de la hoja elíptica, 2.2–2.36 veces tan larga como ancha, las brácteas verdes, glabras y con los márgenes apicales no recurvados, una bractéola membranácea por cada par de flores y las flores amarillo pálidas. *Calathea oscariana*, endémica de Guatemala, crece en el bosque premontano muy húmedo. *Calathea oscariana* difiere de la estrechamente relacionada *C. sclerobractea* K. Schum. por las brácteas con los márgenes apicales no recurvados vs. recurvados, por las brácteas diminutamente tomentosas a lo largo de las brácteas con los pelos más densos en la base vs. densamente tomentoso en el margen apical, el resto glabro, y generalmente la relación de largo/ ancho de la lámina más grande, (1.52–)1.94–2.47: 1 vs. 1.59–1.87: 1; y de *C. crotalifera* S. Watson por las brácteas más pequeñas (2.2–2.5 × 3.2–4.2 vs. 2.9–3.5 × 4.2–5.4 cm) y cremosas vs. amarillas, amarillo-anaranjadas o bronceadas.

In Standley and Steyermark's (1952) Flora of Guatemala, they listed 13 native species and one cultivated one, *C. warscewiczii* (L. Mathieu) Planch. & Linden, none of which were endemic. Currently 18 species are recognized as native, with one, herein described, endemic. Of these, four additional *Calathea* species, *C. matudae* H. Kenn., *C. oscariana*, *C. sclerobractea* and *C. soconuscum* Matuda, have been collected in Guatemala as well as an additional *Stromanthe*, *S. tonckat* (Aubl.) Eichler. The herein described *C. ravenii*, presently known only from Panama, is included in the current total of 67 Marantaceae species recognized for Panama.

Calathea ravenii H. Kenn., sp. nov. (**Fig. 1**). TYPE: PANAMÁ. SAN BLAS: SE of Puerto Obaldia, forest, 18 Aug 1971, *T.B. Croat 16835* (HOLOTYPE: SCZ 1998; ISOTYPE: MO 2072652).

Calathea ravenii differs from the closely related *C. lasiostachya* Donn. Sm. in the glabrous vs. villous, appressed tomentose or hispid abaxial bract surface and smaller length to width ratio of the leaf blade (2.2–2.36:1 vs. > 3.5:1); from *C. caesariata* H. Kenn. by the glabrous vs. villous adaxial leaf surface; and from *C. crotalifera* by the longer (4–5.3 vs. 2.9–3.5 cm) green vs. yellow, yellow-orange or bronze bracts.

Plants perennial, herbaceous, ca. 1.5 m high; stem glabrous in upper portion. **Leaves** several basal and 1 cauline; leaf sheath not auriculate, very sparsely minute tomentose on sides, hairs 0.1 mm or glabrous throughout, ca. 20–21 cm in cauline leaf; petiole glabrous, 29–42 cm in cauline leaf; pulvinus broadly ellipsoid in cross-section, glabrous, 3.3–4 cm in cauline leaf; leaf blade pliable, herbaceous, elliptic, apex obtuse with a narrow acumen to 1.5 cm, base slightly unequal, obtuse, shortly attenuate, 46–54 × 21–24 cm, length:width ratios

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Fig. 1. *Calathea ravenii* H. Kenn. Isotype (*Croat 16835*, MO). Photo provided by Missouri Botanical Garden.

2.2–2.36:1 in cauline leaves, ca. 17 lateral veins per 3 cm and 15–19 cross-veinlets per 5 mm (both measured at midpoint of sides of blade), adaxial surface green, glabrous, midrib minutely pubescent in basal half, hairs 0.1 mm, abaxial surface nearly glabrous, minute hairs to 0.2 mm along some lateral veins close to midrib, midrib below minutely tomentose along sides, hairs 0.1–0.2 mm. **Inflorescences** 1–2 per shoot, first one terminal, subsequent one axial, imbricate, strongly complanate, subrectangular, narrower apically, 12.5–16 × 7.5–8 cm; peduncle glabrous, 22–36 cm. **Bracts** 14–16, herbaceous, distichous, overlapping at base when live, rachis usually not visible, broadly ovate in basalmost, transverse broadly elliptic in subsequent ones to broadly elliptic in uppermost, apex rounded with acumen in basalmost one, rounded to broadly obtuse in upper ones, margin straight (not recurved), 4–5.3 × 3.6–5.3 cm, each bract subtending 3 or more flower pairs, abaxial surface of bracts green, glabrous, adaxial surface glabrous; bicarinate prophyll membranous, rectangular-elliptic, apex rounded to subtruncate, glabrous, 3–3.2 × 1.0–1.5 cm, 0.9–1.1 cm wide, carina to carina; secondary bract membranous, elliptic, apex rounded to minutely tridentate, glabrous, 2.6–3 × (0.85–) 1.25–1.5 cm; bracteole 1 per flower pair, medial, membranous, 1.1–1.35 × 0.15–0.2 cm. **Flowers** open spontaneously, pale yellow (fide *Croat 16835*). **Sepals** membranous, narrowly obovate, obtuse, apical margin incurved, glabrous, 18–20 × 3–4 mm. **Corolla** tube glabrous, 26–32 mm; corolla lobes subequal, elliptic, obtuse to 90°, glabrous, 12–14 × 3.5–5 mm. **Staminodes** 3; outer staminode spathulate, 9–10 × 6–8 mm; callose staminode rounded apically, ca. 11.5 mm; cucullate staminode 6–8 mm; stamen with lateral, petaloid appendage, 1 mm wide, anther 2.5 mm; ovary smooth, glabrous, ca. 2.5 × 1.5 mm. **Capsule** unknown.

Distribution and habitat.—Calathea ravenii is known only from the type collection near Puerto Obaldia in wet tropical forest habitat. Considering the proximity of Puerto Obaldia to the border with Colombia, it is highly likely it will be eventually found there as well. It is apparently uncommon, as in two days collecting in July, 2005, in the vicinity of Puerto Olbalda, we failed to find any plants of it, even sterile ones, though another, previously unknown, undescribed species was found.

Discussion.—Calathea ravenii belongs to *Calathea* G. Meyer section *Calathea*, having the characteristic habit of several basal leaves and a cauline leaf subtending the 1-several distichous-bracted inflorescences. It is distinguished from other Panamanian species of *Calathea* with distichous, complanate, bracts by the elliptic leaf blades, length 2.2–2.36 × width, the greenish, glabrous bracts with non-recurved apical margins, 4–5.3 × 3.6–5.3 cm, the single membranous bracteole per flower pair, and pale yellow flowers. A comparison of five of the distichous-bracted Panamanian species is given in Table 1 (Kennedy 2011: 202). It is readily distinguished from the other three distichous-bracted species not mentioned in the table, *C. lasiostachya*, *C. caesariata* and *C. similis* H. Kenn. by its glabrous, green bracts and the glabrous adaxial surface of the leaf blade.

Etymology.—The specific epithet *ravenii*, is in honor of Dr. Peter Raven, director emeritus of the Missouri Botanical Garden. It is with deep gratitude that I have the privilege of naming a species in his honor as he was instrumental in my choosing the Marantaceae initially as an OTS field project and encouraging me to continue this for my PhD research, besides indirectly introducing me to my partner. I am glad to finally be able to thus acknowledge the debt of gratitude I owe for his help throughout my career, and that of numerous other botantists, in this manner.

Calathea oscariana H. Kenn., sp. nov. (**Fig. 2**). TYPE: GUATEMALA. ALTA VERAPAZ: Cobán, planta cultivada, 1370 m, 27 Jul 1994, *J. Véliz & M. Véliz 94.3926* (HOLOTYPE: BIGU 002395).

Calathea oscariana differs from the most closely related species, *C. sclerobractea*, by the erect, non-recurved, vs. recurved bract margins, the bracts minutely appressed tomentose throughout with hairs more dense at base vs. densely appressed tomentose along apical margin with the rest glabrous and from *C. crotalifera* by the cream-colored vs. yellow, yellow-orange or bronze colored bracts and its smaller, 2.2–2.5 × 3.2–4.2 vs. 2.9–3.5 × 4.2–5.4 cm, bracts.

Plants perennial, rhizomatous, caulescent, herbs, 2 or more m high. **Leaves** several, basal, and 1 cauline above an elongate stem internode; leaf sheath not auriculate, green, appressed tomentose, hairs to 1 mm, very densely tomentose to sericeous at very base in cauline leaves, 16–25 cm in cauline leaf; petiole green, appressed tomentose in basal ¼, subglabrous to glabrous apically 47–60 cm in cauline leaf; pulvinus glabrous except for row of minutely tomentose hairs adaxially, hairs ca. 0.2 mm, glabrous near junction with petiole, 5–7 cm in

FLORA MESOAMERICANA
Calathea cf *crotalifera* S. Watson
Del. Helen Kennedy 2006 (UBC)

02395

2395
Herbario BIGUA
Flora de Guatemala
Escuela de Biología, USAC
BASE HBG

Calathea insignis Peters in Mart
MARANTACEAE
GUATEMALA, Alta Verapaz, Cobán
Altitud 1,370 msnm.
Planta cultivada, utilizada para la elaboración de tamales(Envoltorio).
Col. J y M. Véliz 27/VII/1994
Det. M: Véliz 30/VIII/1994

94.3926

Fig. 2. *Calathea oscariana* H. Kenn. Holotype (*J. Véliz & M. Véliz 94.3926,* BIGU). Photo provided by Mario Véliz (BIGU).

cauline leaves; leaf blade firm, coriaceous, ovate, apex obtuse to rounded with somewhat eccentric acumen, base rounded, shortly abruptly attenuate, 40–58.5 × 16.2–35 cm, length/width ratio: (1.52–)1.94–2.47; adaxially green, glabrous except minutely tomentose at apex, midrib minutely tomentose; abaxial leaf surface sparsely minutely pilose, hairs not felt, ca. 0.2 mm, more prevalent on and along lateral veins, midrib densely appressed tomentose along sides basally. **Inflorescences** 1–3 per shoot, first one terminal, subsequent ones axial, imbricate, rectangular, strongly complanate, 10–17.4 × 3.6–4.2(–4.9) cm; peduncle green, densely appressed tomentose just below inflorescence, hairs sparse toward base, 20–28.5 cm. **Bracts** 14–26, distichous, transverse elliptic, apex retuse, apical margins straight, not recurved, 2.2–2.5 × 3.2–4.2 cm, bracts overlapping at base, rachis not or only occasionally visible, abaxial surface of bracts cream-colored, slightly darker, yellowish tan, along margins, with faint pink tinge at apex, near base and in basal portion of margin, minutely appressed tomentose, densely so at base adjacent to peduncle, adaxial surface glabrous except for a few scattered hairs near apex; bicarinate prophyll membranous, ovate, apex obtuse, sides and adjacent surface of carina densely appressed tomentose, center back glabrous, inner carina surface minutely pilose along margin, 1.6–1.8 × 0.8–1.1 cm, 0.65–0.9 cm wide, carina to carina; secondary bract membranous, elliptic, apex retuse, appressed pilose along margins and at apex, central portion glabrous; bracteole 1 per flower pair, medial, apical portion somewhat flattened, central portion thickened. **Sepals** membranous, elliptic, apex obtuse, margins infolded, pale yellow, glabrous, 15–17 × 3–3.5 mm. **Corolla** tube light yellow, sparsely appressed pilose, hairs not uniformly arranged but in more or less vertical bands, 13–15 mm; corolla lobes elliptic, obtuse, light yellow, minutely pilose, 9–11 × 3.5–4.5 mm. **Staminodes** 3, yellow-orange, outer staminode apex rounded, 8 × 6 mm; callose staminode apex obtuse with narrow, finger-like acumen, apical half tinged pink, 8–11 × ca. 4 mm; cucullate staminode ca. 6 mm; stamen yellow-orange with lateral petaloid appendage, anther yellow, ca. 2 mm. Style and stigma yellow-orange; ovary smooth, glabrous except for minute tufts of hairs just below sepal junction, ca. 2.2–3 × 1.5 mm. **Capsule** unknown.

Additional specimens examined: **GUATEMALA. Alta Verapaz:** Cobán, cultivada, 1350 m, 29 Jul 1994, *J. Véliz & M. Véliz, 94.3983B* (BIGU); **Izabal:** Livingston, Quebrada seca, dentro la selva, 800 m, 27 Jun 1998, *M. Véliz 98.6192* (BIGU). **Chiquimula:** Chiquimula, Olopa, Las Palmas, cultivada dentro de cafetales o áreas con banano, 1300 m, 18 May 1999, *M. Véliz 99.7115* (MEXU 998111). **Quetzaltenango:** Volcán Lacandón, Finca Vista Alegre, 1450 m, 14°48'45"N, 91°45'1.4"W, 11 Jun 2005, *M. Pérez 409* (USCG).

Distribution and habitat.—Calathea oscariana is endemic to Guatemala, occurring in the Departments of Alta Verapaz, Chiquimula and Quetzaltenango in montane wet forest from 800–1450 m. The collections from Alta Verapaz and Chiquimula were noted as being cultivated at those localities.

DISCUSSION

Calathea oscariana, like *C. ravenii* and *C. sclerobractea*, belongs to *Calathea* G. Meyer section *Calathea*. It is most closely related to *C. sclerobractea*, differing from it in the erect, non-recurved, vs. recurved bract margins, the bracts minutely appressed tomentose throughout with hairs more dense at base vs. densely appressed tomentose along apical margin with the rest glabrous, and the usually greater length to width ratios of the cauline leaf blades, (1.52–)1.94–2.47:1 vs. 1.59–1.87:1. In *C. sclerobractea*, the lowermost bract of the inflorescence is usually distanced from the second bract so that the rachis is visible, while in *C. oscariana* the first bract usually covers the base of second and the rachis is not visible. However, although commonly the case, it is not always so and other characters should be verified. Often in dried material, the bracts of *C. sclerobracteata* may shrink in such a way as to expose the rachis between the subsequent bracts and the recurved margins may be folded over in pressing, whereas in *C. oscariana* the upper bracts smoothly overlap, consistently covering the intervening rachis and margins remain flat. *Calathea oscariana* differs from *Calathea crotalifera* in bract color, cream-colored vs. yellow, yellow-orange or bronze and the smaller bracts, 2.2–2.5 × 3.2–4.2 vs. 2.9–3.5 × 4.2–5.4 cm. Both *C. oscariana* and *C. sclerobractea* are found in the higher, montane habitats, 800–1500 m, whereas *C. crotalifera*, in Guatemala, is more commonly found in the lowlands, below 500 m, but is known to occur up to 760 m.

In Guatemala, both *C. oscariana* and *C. sclerobracteata* are cultivated for their leaves. On the labels for *C.*

oscariana (*Véliz 99.7115*, MEXU) and *C. sclerobracteata* (*Véliz 99.7115B*, BIGU), growing together under cultivation, are the notes: "Planta cultivada dendro de cafetales o áreas con banano, sus hojas son empleadas para envolver la masa de los tamales." Likewise, such cultivation is noted on the type specimen, "Planta cultivada utilizada para la elaboración de tamales (Envoltorio)" and similar on *Véliz & Véliz 94.3983B* (BIGU). Interestingly, such use is not restricted to the campo, as I was served a tamale wrapped in the leaves of *C. oscariana* at the buffet in my hotel in Guatemala City. The portion of leaf was saved and pressed for later comparison.

Etymology.—The specific epithet, *oscariana*, was recommended by Mario Véliz (BIGU), who collected the type and provided photos and scans of the new species, as a dedication to his friend Señor Oscar Archila Euler (+), " la persona que la colectó y la tiene actualmente cultivada en su casa. ..."

ACKNOWLEDGMENTS

I am especially grateful to Andrew Sanders of the UCR herbarium for allowing me the space to store and study all the Mesoamericana loan material and for taxonomic discussions. I thank the following for help and use of the herbarium facilities: Gerrit and Jeany Davidse (MO), Mario Véliz and Jorge Vargas (BIGU), Marie S. Cermakova (USCG), Mario Sousa, Gloria Andrade and Gerardo Salazar (MEXU), Christine Niezgoda (F) and Carmen Galdames (SCZ). I gratefully acknowledge the considerable help of Mario Véliz in providing color photos of the inflorescences of both *C. oscariana* and *C. sclerobractea* as well as photographs of specimens for comparison. I am most grateful to Tom Croat for making the one and only (known) collection of *C. ravenii*. Teresa Salvato provided accommodations and transport for my work at UCR. I am deeply indebted to Fred Ganders for personally funding the cost of the herbarium visits and to the Missouri Botanical Garden for providing support for my accommodations while working in the MO herbarium (organized, thanks to Olga Martha Montiel). I thank Barry Hammel and an anonymous reviewer for help with the Spanish resumen and Gordon McPherson and the anonymous reviewer for their helpful suggestions and corrections. Thanks to the curators of F, MEXU, MO, PMA, and SCZ for the loan of their specimens. The type scan of *C. ravenii* was provided by the Missouri Botanical Garden and the scan of *C. oscariana*, by Mario Véliz (BIGU).

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COLUMNEA ANTENNIFERA, A NEW SPECIES OF GESNERIACEAE FROM THE CORDILLERA CENTRAL OF THE COLOMBIAN ANDES

John L. Clark
Department of Biological Sciences
Box 870345
The University of Alabama
Tuscaloosa, Alabama 35487, U.S.A.
jlc@ua.edu

Laura Clavijo
Department of Biological Sciences
Box 870345
The University of Alabama
Tuscaloosa, Alabama 35487, U.S.A.
lauriclav@gmail.com

ABSTRACT

A recent expedition to the Cordillera Central of the Colombian Andes resulted in the discovery of a new species of *Columnea* (Gesneriaceae, tribe Episcieae). The new species, **Columnea antennifera** J.L. Clark & Clavijo, is distinguished from other congeners by the presence of elongate corolla appendages that alternate with the corolla lobes, anisophyllous leaves, and a scandent obligate epiphytic habit. A discussion and images are provided to differentiate *Columnea antennifera* from *C. dissimilis*, *C. filamentosa*, and *C. rosea*. The characteristic of elongate corolla appendages is discussed and *Columnea antennifera* is compared with other taxa that share this unusual feature.

RESUMEN

Una reciente expedición al norte de la Cordillera Central de los Andes Colombianos permitió el descubrimiento de una nueva especie de *Columnea* (Gesneriaceae, tribu Episicieae); **Columnea antennifera** J.L. Clark & Clavijo, que se distingue de otras especies del género por la presencia de apéndices alargados alternos a los lóbulos de la corola, hojas anisófilas y hábito epífito escandente obligado. Se presentan fotografías y una discusión para diferenciar *Columnea antennifera* de *C. dissimilis*, *C. filamentosa* y *C. rosea*. Se discute la presencia de apéndices alargados en la corola de *Columnea antennifera* y se compara con otras especies que comparten este carácter inusual.

KEY WORDS: *Columnea*, Colombia, Episcieae, Gesneriaceae, Taxonomy

INTRODUCTION

The genus *Columnea* L. is primarily epiphytic and belongs to the New World subfamily Gesnerioideae and tribe Episcieae. *Columnea* ranges from Mexico south to Bolivia and is most diverse in the northern Andes of Colombia and Ecuador. With over 200 species, *Columnea* is the largest genus in the subfamily Gesnerioideae (Burtt & Wiehler 1995; Weber 2004; Skog & Boggan 2006). The genus is distinguished from other closely related genera by an indehiscent berry instead of a fleshy bivalved capsule.

Columnea antennifera J.L. Clark & Clavijo was discovered during a 2012 research expedition to the Colombian department of Antioquia in the Cordillera Central of the northern Andes. A remarkable character of *Columnea antennifera* is the presence of five elongate appendages near the corolla sinuses. The presence of corolla appendages and where they appear has been discussed in numerous artificial classifications of groups now recognized as *Columnea*, such as the section *Ortholoma* Benth. and the genus *Trichantha* Hook. (Morton 1963, 1971; Morley 1976; Smith 1994). Corolla appendages have not been thoroughly evaluated in a phylogenetic context and most likely this character is convergent within *Columnea*.

Columnea antennifera J.L. Clark & Clavijo, sp. nov. (**Fig. 1**) TYPE: COLOMBIA. ANTIOQUIA: Municipio Valdivia, Cordillera Central, road Ventanas to Briceño, before the quebrada El Oro, 07°05'20"N, 75°29'20"W, 1802 m, 19 May 2012 (fl), *J.L. Clark, J. Anderson, L. Clavijo, M. Mazo & D. Suescún 13036* (HOLOTYPE: COL; ISOTYPES: BRIT, HUA, MO, NY, UNA, US).

Differs from all other *Columnea* by the combination of the presence of broad calyx lobes, elongate appendages near corolla sinuses, obligate scandent epiphytic habit, and strongly anisophyllous opposite leaves.

Obligate scandent epiphytic climber; stems elongate and horizontal, 2–3 m long, suffrutescent, glabrescent below, sparsely pilose above. **Leaves** opposite, strongly anisophyllous in a pair; larger leaf with petioles terete, 4–10 mm long, blade coriaceous when dry, elliptic to oblong, 3–12 × 1.3–3.4 cm, base rounded to oblique,

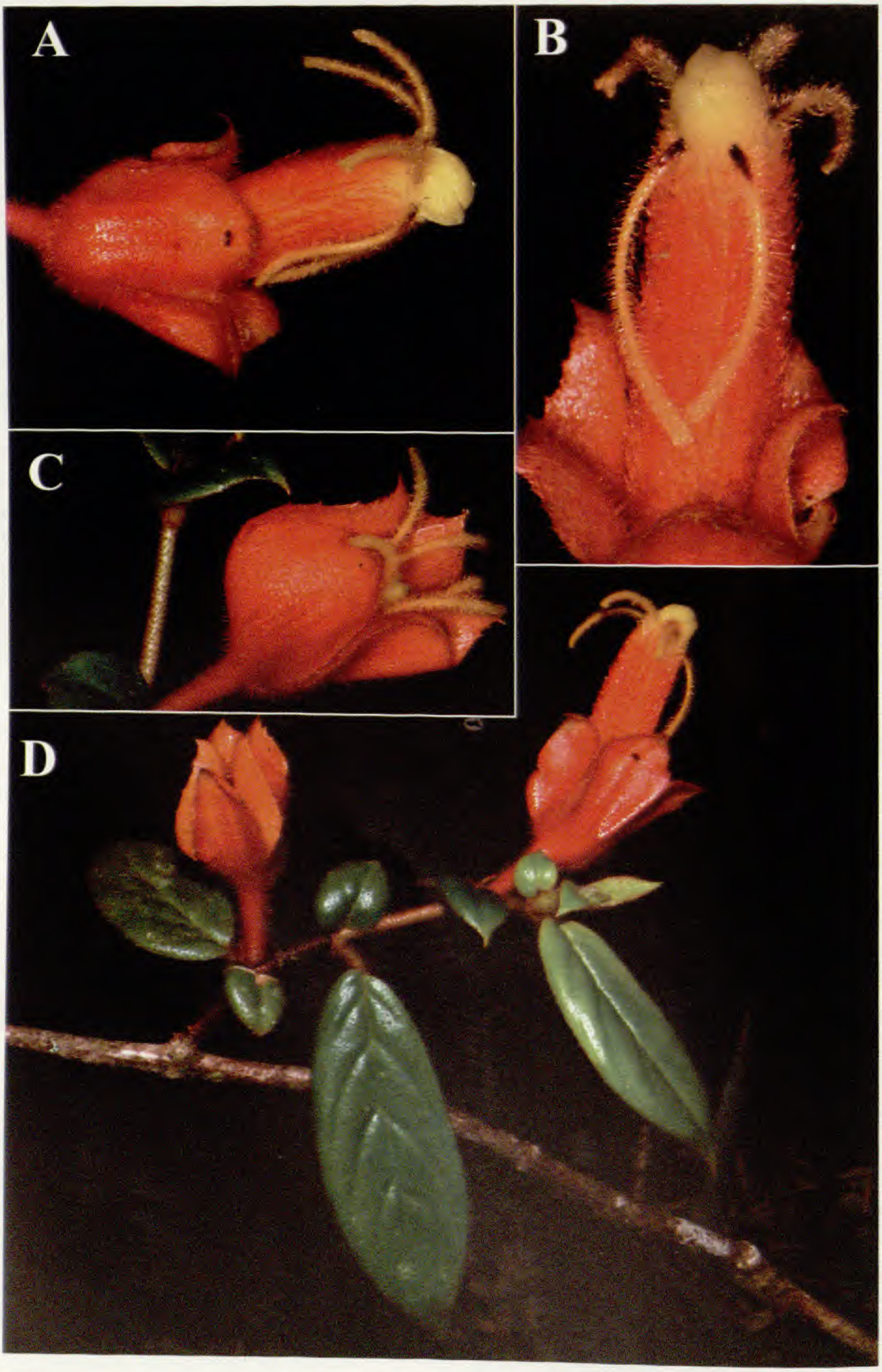

Fig. 1. *Columnea antennifera* J.L. Clark & Clavijo. **A.** Lateral view of flower. **B.** Front view of flower. **C.** Immature flower showing corolla appendages. **D.** Habit showing elongate stems and strongly anisophyllous leaf arrangement. (A–D from the holotype, *J.L. Clark et al. 13036*).

sometimes asymmetrical, apex acute, margin entire, adaxially shiny green, abaxially light green, sparsely pilose on upper surface and densely pilose on lower surface; smaller leaf greatly reduced relative to larger leaf, nearly sessile, orbicular to ovate, 1–2.7 × 0.5–1.5 cm, base rounded to cordate, apex acute, margin entire, surfaces and vestiture similar to larger leaf. **Flowers** solitary and erect; pedicels 1.3–2 cm long, red, pilose; calyx 2–3.5 cm long, uniformly bright red, inside and outside sparsely pilose, inside lanate at the base, lobes 5, erect at anthesis, each lobe tightly appressed to adjacent lobe and folded lengthwise, ovate, apex broadly acuminate, margin entire, 4 lobes nearly equal 0.7–1 × 1.2–1.5 cm, fused at the base for 1.5–2.6 cm, 5th lobe (dorsal) slightly smaller, fused at the base for 1.1–1.5 cm; corolla tubular, posture erect in calyx, 3.0–4.5 × 0.6–1.0 cm; outside uniformly bright red and tomentose, internally glabrate, lobes bright yellow, appressed, 5–6 × 2–2.5 mm, ovate; corolla appendages present in immature and mature flowers, located in each sinus alternate the corolla lobes, 14–20 mm long, pilose, bright yellow with or without a dark spot at the base; stamens 4, didynamous, included; filaments 12–15 mm long, coiled after anthesis, connate and adnate to the base of the corolla tube, glabrous; anthers connate, longer than broad, 2–2.5 × 1–1.5 mm, dehiscing by longitudinal slits; staminode not seen; nectary a dorsal gland, glabrous; ovary superior, lanate, ca. 5 × 4 mm, style ca. 30 mm long, glabrous, stigma included and capitate. **Fruits** not seen.

Columnea antennifera is morphologically similar to *C. dissimilis* C.V. Morton (Fig. 2, A–D). These two species are easily differentiated by the elongate corolla appendages in *Columnea antennifera* (Fig. 1) in contrast to the relatively short corolla appendages in *C. dissimilis* (Fig. 2A). The corolla appendages are developed in immature flowers of *Columnea antennifera* (Fig. 1C). In contrast, the corolla appendages in *Columnea dissimilis* are either absent or significantly reduced when the flowers are immature (Fig. 2B). Another species that has corolla appendages and is morphologically similar to *C. antennifera* is *C. filamentosa* (Figs. 2E, F). These two species are readily differentiated by the uniformly red corolla in *Columnea filamentosa* (Fig. 2E) in contrast to the red corolla with bright yellow lobes in *C. antennifera* (Fig. 1). Vegetatively these two species are differentiated by the isophyllous leaf arrangement in *Columnea filamentosa* in contrast to the strongly anisophyllous *C. antennifera*. A third species that has corolla appendages is *Columnea rosea* (C.V. Morton) C.V. Morton (Fig. 3E). However, the calyx lobes of *Columnea rosea* are deeply serrate to fimbriate (Fig. 3E) in contrast to the entire calyx margins of *C. antennifera* (Fig. 1).

Distribution and habitat.—*Columnea antennifera* is known from the northern Cordillera Central of the Colombian Andes in the department of Antioquia from montane forests (1800 m). Herbarium collections of *Columnea antennifera* were not seen during recent visits to the National University of Colombia (COL) or the University of Antioquia (HUA), but an additional population was observed and photographed near the type locality between Yarumal and Ventanas during a 1996 field expedition by Günter Gerlach from the Munich Botanical Garden (Botanischer Garten München-Nymphenburg).

Etymology.—The specific epithet, *antennifera*, refers to the resemblance of the elongate appendages at the apex of the corolla tube to insect antennae.

Classification.—*Columnea antennifera* appears to belong to section *Ortholoma* Benth. because of the presence of corolla appendages and an obligate epiphytic habit. However, the traditional sectional classification of *Columnea* is artificial and arbitrary. As an example, the section *Ortholoma* has been recognized at the generic level as *Trichantha* Hook. by previous authors (Morton 1963; Wiehler 1973, 1975). A monographic revision of *Trichantha* by Morton (1963) was followed by another paper by the same author (Morton 1971) with a reduction of all species recognized as *Trichantha* to *Columnea*. The type species for *Trichantha* is *Columnea minor* (Hook.) Hanst. and is characterized by the presence of appendages at the sinuses of the corolla (Fig. 3C, D). It is important to note that corolla appendages are not a unifying character for section *Ortholoma* or genus *Trichantha*. The type species for section *Ortholoma* is *Columnea anisophylla* DC., which lacks corolla appendages as do many other species that have been assigned to this section. The traditional sectional classification of *Columnea* has been shown to be artificial because many sections do not represent monophyletic lineages (Smith 1994; Smith & Sytsma 1994; Clark et al. 2006). A revised sectional classification system based on molecular sequence data is currently a collaborative research focus by numerous authors (e.g., James Smith, John L. Clark, Lacie Schulte and others).

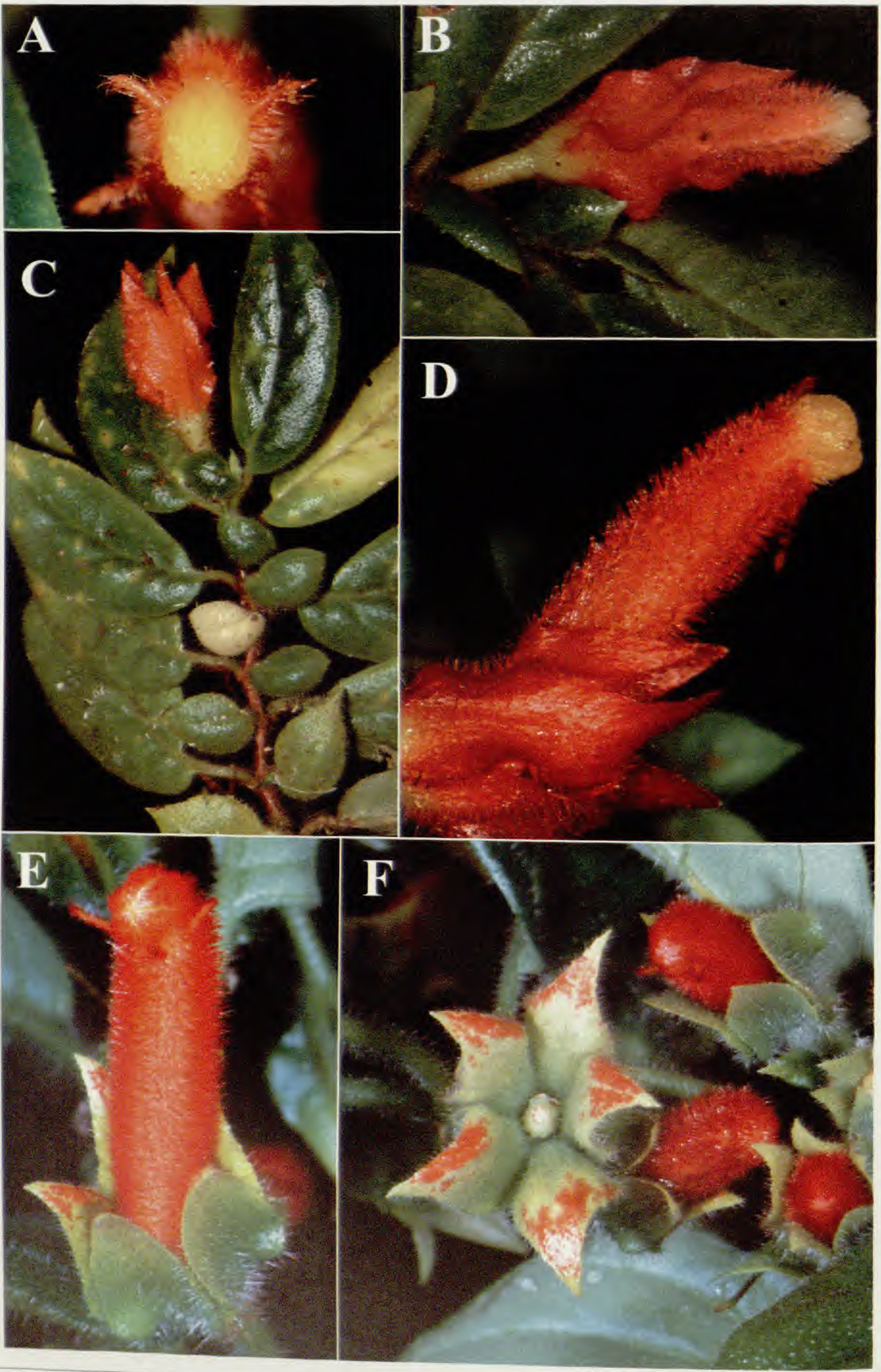

FIG. 2. *Columnea dissimilis* C.V. Morton (A–D) and *C. filamentosa* L.E. Skog (E–F). **A.** Front view of flower showing corolla appendages. **B.** Lateral view of immature flower. **C.** Habit showing anisophyllous leaf arrangement. **D.** Lateral view of flower. **E.** Lateral view of flower. **F.** Mature calyx showing dorsal nectary gland. (Photos A & D from *J.L. Clark 8629*; B from *J.L. Clark & J. de Gracia 12451*; C from *J.L. Clark & A. Zapata 12495*; D & F from *H. Wiehler et al. 1631* field collection that was cultivated and then vouchered for the holotype).

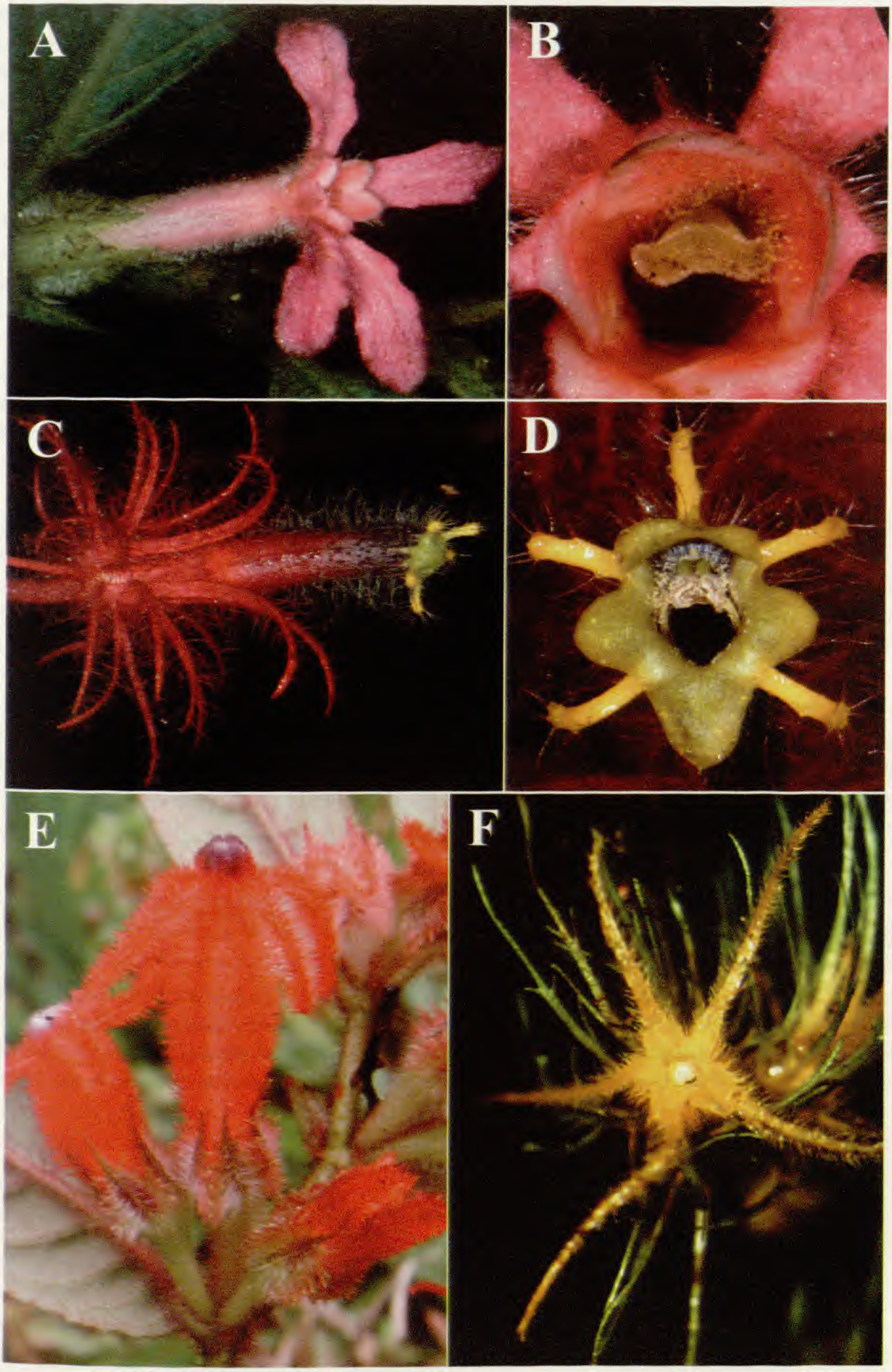

Fig. 3. Variation in corolla appendages present in *Columnea*. **A & B.** *Columnea coronata* Amaya, L.E. Skog & L.P. Kvist. **C & D.** *Columnea minor* (Hook.) Hanst. **E.** *Columnea rosea* (C.V. Morton) C.V. Morton. **F.** *Columnea filifera* (Wiehler) L.E. Skog & L.P. Kvist. (Photos A & B from *J.L. Clark et al. 12990*; C from *J.L. Clark et al. 10870*; D from *J.L. Clark et al. 9647*; E from *J. Betancur 12394*; F from *J.L. Clark et al. 7140*).

Corolla appendages vs. corolla lobes.—The presence of corolla appendages is widespread in *Columnea* and this character is often not accurately distinguished from corolla lobes. Various taxa from different sections have corolla appendages and this character is probably convergent within *Columnea*. For example, *Columnea filifera* (Fig. 3F) has been assigned to section *Collandra* Lem. (Kvist & Skog 1993) and genus *Dalbergaria* Tussac. (Wiehler 1992; Kvist & Skog 2004) because of subsessile leaves, dorsiventral shoots, and a facultative epiphytic habit. A recently described species, *Columnea coronata* Amaya, L.E. Skog & L. P. Kvist, was assigned to section *Collandra* (Amaya et al. 2004), where the specific epithet refers to a "corona" at the apex of the corolla tube. More accurately, the "corona" in *Columnea coronata* is homologous to reduced corolla lobes like those found in *Columnea antennifera*. Thus, what Amaya et al. (2004) referred to as "petals" in the description of *Columnea coronata* are actually appendages that appear petaloid (Fig. 3A) and what was described in Amaya et al. (2004) as the "corona" is homologous to reduced corolla lobes. Another species that has reduced corolla lobes and petaloid appendages is *Columnea filifera* (Fig. 3F). The petaloid appendages in *Columnea filifera* (Fig. 3F) are visible in the field and in photographs, but the corolla lobes are only visible with a hand lens or microscope. Phylogenetic studies on the evolution of corolla appendages and their presence in numerous lineages of *Columnea* will play an important role in understanding their function, homology, and role in plant-pollinator interactions.

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A NEW VARIETY OF *DECLIEUXIA CACUMINIS* (RUBIACEAE) FROM THE STATE OF TOCANTINS, BRAZIL, AND A REVIEW OF THE VARIETIES RECOGNIZED IN THE SPECIES

Joseph H. Kirkbride, Jr.
USDA-ARS, U.S. National Arboretum
Floral & Nursery Plants Research Unit
3501 New York Avenue NE
Washington, DC, 20002-1958, U.S.A.
joseph.kirkbride@ars.usda.gov

Piero G. Delprete
Herbier de Guyane, IRD - UMR AMAP
Boite Postale 165, 97323 Cayenne Cedex
Guyane Française (French Guiana), FRANCE
piero.delprete@ird.fr

ABSTRACT

A new variety of *Declieuxia cacuminis* Müll. Arg. is described and illustrated, *D. cacuminis* var. *tocantinensis* Delprete & J.H. Kirkbr. The new variety is endemic to the Brazilian state of Tocantins, and has been reported from *cerrado* vegetation in the southeastern corner of the state. A key is provided to distinguish the varieties now recognized.

KEY WORDS: *Declieuxia*, *Declieuxia cacuminis* var. *tocantinensis*, Rubiaceae, Tocantins, Brazil, Neotropics

RESUMO

Uma variedade nova de *Declieuxia cacuminis* Müll. Arg. é descrita e ilustrada, *D. cacuminis* var. *tocantinensis* Delprete & J.H. Kirkbr. A variedade nova é endêmica do estado brasileiro de Tocantins e foi encontrada na vegetação de Cerrado na região sudeste do estado. É fornecida uma chave para distinguir as variedades agora reconhecidas.

PALAVRAS CHAVE: *Decliexiua*, *Declieuxia cacuminis* var. *tocantinensis*, Rubiaceae, Tocantins, Brasil, Neotropicos

INTRODUCTION

Kirkbride (1976) revised the genus *Declieuxia* Kunth, and recognized 27 species and seven varieties in three species: *D. deltoidea* Müll. Arg. with two varieties, *D. cacuminis* Müll. Arg. with two varieties, and *D. cordigera* Mart. & Zucc. ex Schult. & Schult. f. with three varieties. A few years later (Kirkbride 1983), he added a third variety for *D. cacuminis*, *D. cacuminis* var. *decumbens* J.H. Kirkbr. With this, the known range of *D. cacuminis* was expanded from central Minas Gerais to south central Bahia. In 1997, another species was added to the genus, *D. decumbens* J.H. Kirkbr. (Kirkbride 1997), increasing the number of species to 28.

The Rubiaceae were treated for the *Flora dos Estados de Goiás e Tocantins* by Delprete (2010). The Distrito Federal, which is surrounded by the state of Goiás and only touchs the state of Minas Gerais on its southeastern corner, was also covered by the treatment. Delprete found nine species of *Declieuxia* in the state of Goiás, six in the Distrito Federal, and just one, *D. fruticosa* (Willd. ex Roem. & Schult.) Kuntze (the most widespread of the genus), in the state of Tocantins. Early in 2012, while finalizing a treatment of the Rubiaceae for the *Flora do Distrito Federal, Brasil*, Delprete encountered a specimen of *Declieuxia* from the state of Tocantins in the herbarium of the Reserva Ecologica do Instituto Brasileiro de Geografia e Estatística (IBGE) in Brasilia, that attracted his attention. Since he had reported just a single species of *Declieuxia* from the state of Tocantins, he immediately knew that the specimen represented a new taxon for this state, and possibly a new taxon for science. He consulted Kirkbride about the identity of the specimen, who in turn compared it with the *Declieuxia* specimens in the herbaria of the Smithsonian Institution (US) and New York Botanical Garden (NY). They concluded that the specimen is a member of *D. cacuminis* and is a fourth, new variety of the species, which is described and illustrated below. In addition, a key to the four varieties of *D. cacuminis*, short descriptions, and selected specimens for each variety, are also presented.

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SYSTEMATIC TREATMENT

Declieuxia cacuminis Müll. Arg., Flora 59(28):438. 1876.

Shrubs or **subshrubs** 15–150 cm tall, obconical or globose, with erect or spreading ramose branches, glabrous or puberulous; **branches** glabrate to puberulous or sparsely so. Internodes 0.1–2.7(–4.7) cm long. **Stipules** puberulous to glabrate, decurrent or not; stipular appendages 1 or 3 of unequal length, linear-subulate or linear to narrowly oblong, acute at apex, 0.1–4 mm long, the laterals when present half as long as the central lobe. **Leaves** opposite, petiolate, with or rarely without fascicles or a pair of smaller leaves in the axils, 1–2 pairs; petioles 0.5–6 mm long, puberulous; blades plane, broadly elliptic to elliptic to narrowly elliptic or ovate to narrowly ovate, attenuate to shortly so at base, obtuse to broadly acute to acute at apex, 3.2–25 × (1.2–)1.8–11 mm, 1.3–4 times longer than wide, chartaceous, asperous to puberulous above, glabrous to sparsely puberulous below; midrib prominulous above, prominent beneath; venation pinnate, secondary veins (1–)2–4 on each side, arcuate, anastomising, plane to faintly prominulous above, sulcate beneath; tertiary venation obscure. **Inflorescences** modified cymose, terminal at apical node, sessile or pedunculate, 0.8–2 × 0.4–2.4 cm, 6–48-flowered, with 1–4 branches, with the branches 1.6–12 mm long, puberulous to sparsely so. Peduncles 2–7.5 mm long, sparsely puberulous. **Dichasial** or **larger bracts** at the apex of the peduncle 2, linear to narrowly oblong or narrowly elliptic to narrowly obovate, acute to narrowly acute or obtuse at apex, 1–5 × 0.1–0.6(–2) mm, glabrous or glabrate to puberulous, eciliate or sometimes ciliate. **Flowers** heterostylous, some solitary or paired flowers subtended by 2 bracts, subpedicellate; pedicels 0.1–0.7 mm long, glabrous to glabrate; dichasial bracts linear to narrowly oblong to narrowly elliptic to narrowly obovate, acute to narrowly acute or obtuse at apex, 1–5 × 0.1–0.6 mm, glabrous or glabrate to sparsely puberulous, eciliate or sometimes ciliate. **Hypanthium** transversely elliptic to broadly elliptic in outline, 0.3–1.2 × 0.5–1.7 mm, densely puberulous. **Calyx lobes** 4, oblong to narrowly oblong, triangular to narrowly triangular, or ovate, obtuse or acute at apex, 0.2–0.6 × 0.1–0.2 mm, eciliate or sometimes ciliate. **Corollas** pale blue or white; tube 2.5–4.3 mm long, 0.9–2 mm in diam. at orifice, 0.4–0.7 mm in diam. at base, sparsely puberulous or glabrous externally; lobes ovate or oblong, narrowly acute to acute to broadly acute at apex, 1.1–3 × 0.3–2 mm, sparsely puberulous or glabrous outside. **Filaments** 0.2–0.4 or 1–1.4 mm long, sparsely, short puberulous to glabrate or glabrous; anthers 0.7–1.3 mm long. **Styles** 2–2.8 or 4–4.5 mm long, glabrous or sparsely granulate. **Ovule** 1 per locule. **Fruits** with pedicel 0.2–0.5 mm long, glabrous or glabrate; apical emargination 0–1 mm deep. **Mericarps** elliptic, circular to broadly elliptic in outline, 1.2–2.6 × 0.8–2.2 mm, 0.2–0.9 mm thick, sparsely puberulous, smooth.

Distribution.—Brazilian states of Minas Gerais, Bahia, and Tocantins (Fig. 1).

KEY TO THE VARIETIES OF *DECLIEUXIA CACUMINIS*

1\. Fruit with the apical emargination 0.5–1 mm deep; mericarps 0.8–1.1 or 1.6–1.8 mm wide; states of Bahia and Minas Gerais.
    2\. Stipules not decurrent; mericarps 2.2–2.6 × 1.6–1.8 mm, 0.7–0.9 mm thick; state of Minas Gerais ______ **cacuminis** var. **cacuminis**
    2\. Stipules decurrent; mericarps 1.5–2.1 × 0.8–1.1 mm, 0.2–0.4 mm thick; states of Bahia and Minas Gerais ______ **cacuminis** var. **decurrens**
1\. Fruit with the apical emargination 0–0.4 mm deep; mericarps 1.2–1.5 or 2–2.2 mm wide; states of Bahia and Tocantins.
    3\. Plants glabrous; stipular appendages 3; leaves with fascicles or a pair of smaller leaves in the axil; corolla tube 3–4.3 mm long, lobes 1.3–3 × 0.7–2 mm; anthers 0.8–1.3 mm long; mericarps elliptic to broadly elliptic, 2–2.4 × 2–2.2 mm, ca. 0.6 mm thick; state of Bahia ______ **cacuminis** var. **glabra**
    3\. Plants puberulous; stipular appendages 1 or 3; leaves without fascicles or a pair of smaller leaves in the axil; corolla tube 2.5–2.7 mm long, lobes 1–1.3 × 0.3–0.4 mm; anthers ca. 0.7 mm long; mericarps circular to sub circular, 1.2–1.5 × 1.2–1.5 mm, 0.2–0.5 mm thick; state of Tocantins ______ **cacuminis** var. **tocantinensis**

Declieuxia cacuminis var. **cacuminis,** Mem. New York Bot. Gard. 28(4):72. 1976. *Declieuxia cacuminis* Müll. Arg., Flora 59(28):438. 1876. TYPE: BRAZIL. MINAS GERAIS: "Sumo Brasiliae monte Itambé," 1818, *C.F.P. von Martius s.n.* (HOLOTYPE: M, fragment G).

Plants puberulous, except the calyx and sometimes the corolla glabrous. **Stipules** not decurrent. **Stipular appendages** 1 or 3. **Leaves** with fascicles or a pair of smaller leaves in the axil. **Fruits** with apical emargination 0.5–1 mm deep. **Mericarps** 2.2–2.6 × 1.6–1.8 mm, 0.7–0.9 mm thick.

FIG. 1. The distribution of the Brazilian endemic *Declieuxia cacuminis* Müll. Arg. and its four varieties, *D. cacuminis* var. *cacuminis*, var. *decurrens* J.H. Kirkbr., var. *glabra* J.H. Kirkbr., and var. *tocantinensis* Delprete & J.H. Kirkbr., in the Brazilian states of Bahia, Minas Gerais, and Tocantins. DF = Distrito Federal.

Distribution.—Endemic to *campo rupestre* (rocky outcrops) vegetation, with white-sand soils, above the tree line on Pico de Itambé in the Brazilian state of Minas Gerais (Fig. 1).

Additional specimens examined: **BRAZIL. Minas Gerais:** Serra do Espinhaço, eastern slope of Pico do Itambé, first large sand stone outcrop below the summit, 11 Feb 1972, *W.R. Anderson et al. 35833* (BR, C, F, G, K, LIL, NY, RB, UB, US); Serra do Espinhaço, eastern slope of Pico do Itambé, 1310 m, 13 Feb 1972, *W.R. Anderson et al. 35899* (COL, F, LE, LIL, NY, UB, US); Mun. Serro, alto do Pico do Itambé, 6 May 1942, *M. Magalhães 1804* (US).

Declieuxia cacuminis var. **decurrens** J.H. Kirkbr., Mem. New York Bot. Gard. 28(4):72. 1976. TYPE: BRAZIL. MINAS

Gerais: ca. 8 km W of Grão Mogol, 950 m, 16 Feb 1969, *H.S. Irwin, R. Reis dos Santos, R. Souza & S.F. Fonsêca 23348* (holotype: UB; isotypes: F, G, K, NY, RB, UB, US).

Plants puberulous, except the calyx and sometimes the corolla glabrous. **Stipules** decurrent. **Stipular appendages** 1 or 3. **Leaves** with fascicles or a pair of smaller leaves in the axil. **Fruits** with the apical emargination 0.5–1 mm deep. **Mericarps** 1.5–2.1 × 0.8–1.1 mm, 0.2–0.4 mm thick.

Distribution.—Declieuxia cacuminis var. *decurrens* is the most widespread variety of the species. It is found in the northernmost reaches of the Serra da Espinhaço in the Brazilian state of Minas Gerais and across the Chapada de Diamantina in the Brazilian state of Bahia (Fig. 1). All four localities are at medium to higher elevations (740–1300 m) in zones of *campo rupestre* vegetation on white-sand soils.

Additional specimens examined: **BRAZIL. Bahia:** Chapada Diamantina, Piatã, caminho para Três Morros, Ponto 01, campos gerias, 13°4'25"S, 41°47'51"W, 1300 m, 2 May 2009, *M.L. Guedes et al. 15087* (ALCB, US); Serra Geral de Caitité, ca. 1.5 km S of Brejinhos das Ametistas, 11 Apr 1980, *R.M. Harley et al. 21216* (K, NY, US); Ibiquara, 25 km N de Barra da estiva, estrada nova para Mucugê, 1100 m, 20 Nov 1988, *R.M. Harley et al. 26965* (K, US); Mun. Grão Mogol, Rio Itacambiruçu, 21 Apr 1978, *G. Hatschbach 41264* (MBM, NY, US); Mun. Oliveira dos Brejinhos, Estrada Canabrava a Chapadão de Cima, próximo ao alto da Serra Geral, 16 Mar 1998, *G. Hatschbach et al. 67811* (MBM, US). **Minas Gerias:** Grão Mogol, 24 Jul 1978, *G. Hatschbach 41534* (MBM, US); ca. 8 km W of Grão Mogol, 950 m, 16 Feb 1969, *H.S. Irwin et al. 23348* (K, NY, US); ca. 15 km W of Grão Mogol, 950 m, 19 Feb 1969, *H.S. Irwin et al. 23539* (paratypes BR, C, F, LE, LIL, NY, UB, US); Serra de Grão Mogol, Pagão, 1000 m, 12 Nov 1938, *F. Markgraf et al. 3479* (paratypes F, RB); Grão Mogol, Córrego Escurinha, 740 m, 23 Jul 1986, *D.C. Zappi et al. CFCR9855* (NY).

Declieuxia cacuminis var. **glabra** J.H. Kirkbr., Ann. Missouri Bot. Gard. 70:204. 1983. Type: BRAZIL. Bahia: Serra das Almas, middle and upper NE slopes of Pico das Almas, ca. 25 km WNW of the Vila do Rio de Contas, ca. 41°57'W, 13°33'S, 1600–1850 m, 19 Mar 1977, *R.M. Harley, S.J. Mayo, R.M. Storr, T.S. Santos & R.S. Pinheiro 19691* (holotype: UB; isotypes: CEPEC, K, NY, US).

Plants glabrous. **Stipules** decurrent. **Stipular appendages** 3. **Leaves** with fascicles or a pair of smaller leaves in the axil. **Fruits** with the apical emargination 0–0.4 mm deep. **Mericarps** 2.2–2.4 × 2–2.2 mm, ca. 0.6 mm thick.

Distribution.—This variety is known only from the center of the Chapada de Diamantina in the Brazilian state of Bahia. It is also found at higher elevations in *campo rupestre* vegetation. Even though plants of this variety and those of *Declieuxia cacuminis* var. *decurrens* are found in central Bahia, the two varieties are allopatric.

Additional specimens examined: **BRAZIL. Bahia:** Abaíra, Catolés de Cima, Serra do Rei, subida pelo Tijuquinho, 16 Nov 1992, *W. Ganev 1458* (K); Mun. Rio das Contas, Pico das Almas, 20 Feb 1987, *R.M. Harley et al. 24457* (K); Mun. Rio das Contas, Pico das Almas, vertente leste, subida do pico do Campo do Queiroz, 16 Nov 1988, *R.M. Harley et al. 26174* (K, US).

Declieuxia cacuminis var. **tocantinensis** Delprete & J.H. Kirkbr., var. nov. (**Fig. 2**). Type: BRAZIL. Tocantins. Mun. Porto Alegre do Tocantins, bacia do Rio Tocantins, sub-bacia do Rio Balsas (T-9, 9 Km da área 3, Ponto 20), estrada para Ponte Alta, entrada após Cachoeira da Fumaça, 546 m, 11°05'26"S, 46°52'00"W, solo argilo-arenoso-avermelhado, quartzo, afloramento calcário, relevo plano a ondulado (morro), campo sujo/cerrado ralo (savana gramineo-lenhosa), cerrado sobre o morro, 4 Jul 2009, *M.L. Fonseca, F.C.A. Oliveira, A.P. Silva Filho & V.C. Oliveira 6086* (holotype: IBGE; isotypes: HUTO-n.v., HUVA-n.v., RB-n.v.).

Subfrutex puberulus, stipulis decurrentibus, trilobis sed unilobis, folii axillis sine foliis parvis in fasciculis vel paribus, corollae tubo 2.5–2.7 mm longo, corollae lobis 1–1.3 × 0.3–0.4 mm, fructibus apicis incisura 0.2–0.4 mm, mericarpiis circularibus vel subcircularibus, 1.2–1.5 × 1.2–1.5 mm, 0.2–0.5 mm crassis.

Plants puberulous. **Stipules** decurrent. **Stipular appendages** 1 or 3. **Leaves** without fascicles or a pair of smaller leaves in the axil. **Corolla** with tube 2.5–2.7 mm long, with lobes 1–1.3 × 0.3–0.4 mm. **Anthers** ca. 0.7 mm long. **Fruits** with the apical emargination 0.2–0.4 mm deep. **Mericarps** circular or sub circular, 1.2–1.5 × 1.2–1.5 mm, 0.2–0.5 mm thick.

Comments.—The flowers and fruits of *Declieuxia cacuminis* var. *tocantinensis* are appreciably smaller than those of the other three varieties; additional characters that can be used to distinguish this variety from the other varieties of this species, can be found in the key provided above.

Distribution.—The other three varieties of *Declieuxia cacuminis* occur at higher elevations in *campo rupestre* vegetation on mountains in Minas Gerais and plateaus in Bahia, east of the Rio São Francisco. *Declieuxia cacuminis* var. *tocantinensis*, however, has a different distribution and ecology. It is found in the Brazilian state

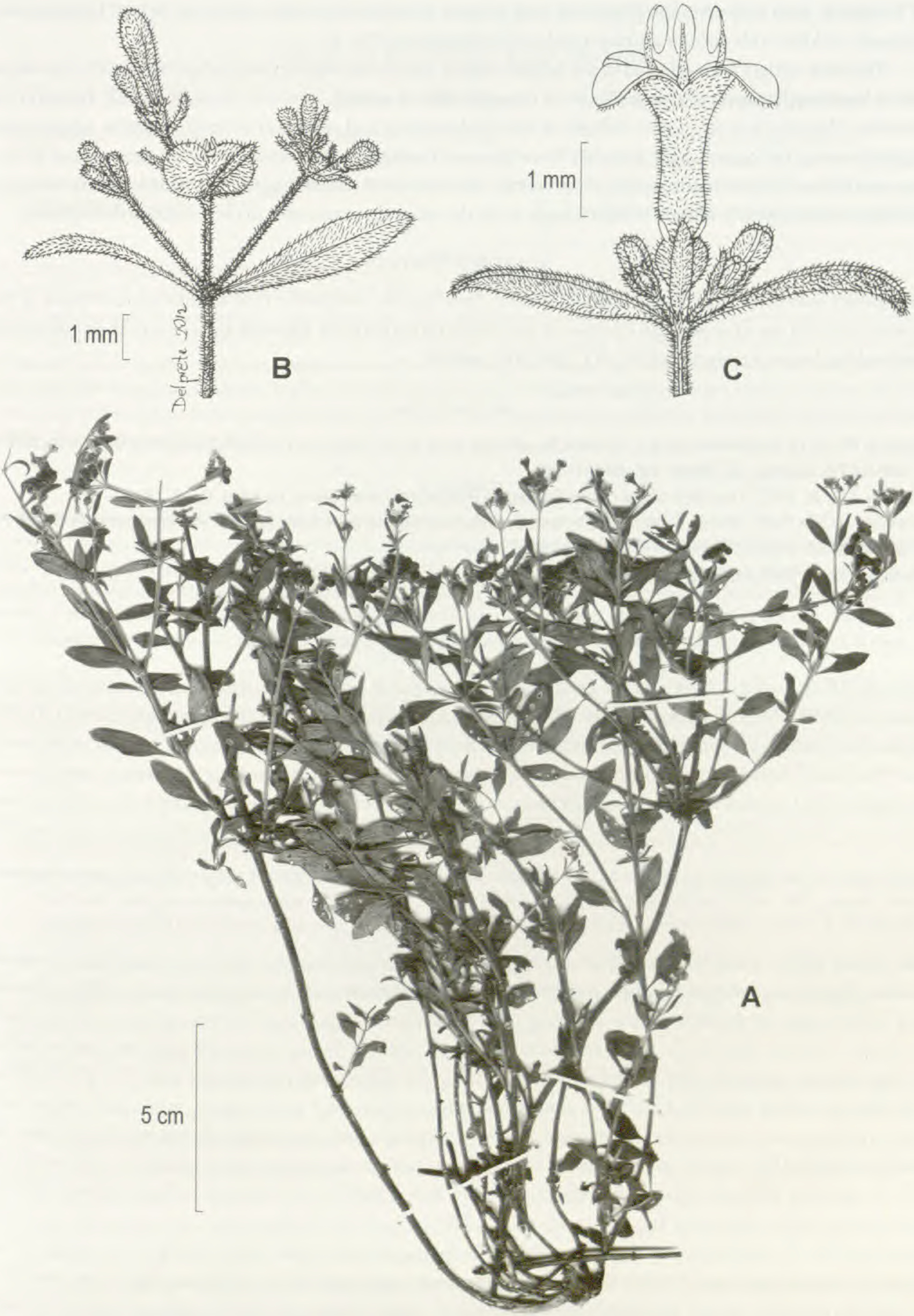

FIG. 2. *Declieuxia cacuminis* Müll. Arg. var. *tocantinensis* Delprete & J.H. Kirkbr. **A.** Habit. **B.** Inflorescence with flower buds and young fruit. **C.** Inflorescence branch with flower buds and a flower in anthesis (all from holotype, *M.L. Fonseca et al. 6086*).

of Tocantins, west of the Rio São Francisco, and at lower elevation in *cerrado* vegetation (a type of savannah), on sandy, reddish soils poor in nutrients and rich in aluminum (Fig. 1).

This new variety was collected in the Jalapão region, which has large areas of white-sand soils. The elevation is lower with respect to the elevations of the other three varieties; however, the type locality is not on the Brazilian Planalto. It is on a lower plateau, at the northernmost end of the Serra Geral de Goiás, which is the divide between the basins of the Rios São Francisco and Tocantins at the border between the states of Tocantins and Bahia. Relative to the nearby river valleys, this area is 50–100 m higher, so the new variety occurs at the highest elevations in its area of distribution as do the other three varieties in their areas of distribution.

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A PREVIOUSLY UNRECOGNIZED SPECIES OF *SENEGALIA* (FABACEAE) FROM NORTHEASTERN BRAZIL

David S. Seigler
Department of Plant Biology
University of Illinois
Urbana, Illinois 61801 U.S.A.
seigler@life.illinois.edu

John E. Ebinger
Department of Biology
Eastern Illinois University
Charleston, Illinois 61920 U.S.A.

Petala Gomes Ribeiro
Departamento de Botânica
Universidade Estadual de Feira de Santana
Av. Transnordestina, s/n, Novo Horizonte
44036-900, Feira de Santana, Bahia, BRASIL

ABSTRACT

During the course of our work on the genus *Senegalia* Raf. of Brazil, we encountered a collection [*M. Blanchet* 2772 (F, GH, K)] that Bentham (1842) cited first under *Acacia velutina* DC. and subsequently (1875, 1876) as *Acacia monacantha* Willd. Until now this collection has mostly been accepted under the latter name. However, as more specimens have become available, it is clear that they represent a hitherto undescribed species that is distinct from both *Senegalia monacantha* (Willd.) Seigler & Ebinger (syn. *Acacia monacantha*) and *Senegalia velutina* (DC.) Seigler & Ebinger (*Acacia velutina*). It is here described and illustrated as **Senegalia paganuccii** Seigler, Ebinger, & Ribeiro and compared to its probable nearest relative *Senegalia tenuifolia* (L.) Britton & Rose. The new species is endemic in Brazil where it occurs in the states of Bahia, Minas Gerais, and Piauí, Brazil.

RESUMEN

En el progreso de nuestro estudio sobre el género *Senegalia* de Brasil se encontró que unos ejemplares *M. Blanchet* 2772 (F, GH, K) que fueron citados por Bentham como *Acacia velutina* DC. (1842) (*Senegalia velutina* (DC.) Seigler & Ebinger) y después (1875, 1876) como *Acacia monacantha* Willd. (*Senegalia monacantha* (Willd.) Seigler & Ebinger). Aunque la mayoría de los materiales han sido aceptados como tal, no obstante con una mayor disponibilidad de colecciones se puede clarificar que las características de estos materiales son distintas y que corresponden a una nueva especie. Ejemplares de este taxon obtenidos en los estados de Bahía, Minas Gerais y Piaui, Brasil, se describen aquí como **Senegalia paganuccii** Seigler, Ebinger, & Ribeiro, y son comparados con la especie más afín *Senegalia tenuifolia* (L) Britton & Rose.

During the course of our work on the genus *Senegalia* Raf. of Brazil, we encountered a collection [*M. Blanchet* 2772 (F, GH, K)] that Bentham (1842) cited first as *Acacia velutina* DC. and subsequently (1875, 1876) as *Acacia monacantha* Willd. This material had mostly have been accepted under the latter name, but as more collections have become available, it is clear that they represent a previously undescribed species distinct from both *Senegalia monacantha* (Willd.) Seigler & Ebinger (syn. *Acacia monacantha*) and *Senegalia velutina* (DC.) Seigler & Ebinger (syn. *Acacia velutina*).

Senegalia paganuccii Seigler, Ebinger, & Ribeiro, sp. nov. (**Fig. 1**). TYPE: BRAZIL. BAHIA: Município Rio de Contas, 10 km do Río de Contas na estrada para Marcolino Moura, Caatinga (13°36S, 41°43W, elev. 500–600 m), 15 Nov 1988, gemmae (buds, gem.) & flowers (fl.), *R.M. Harley, D.J.N. Hind & T.B. Cavalcanti 26439* (HOLOTYPE: HUEFS; ISOTYPES: CEPEC, CTES, F, K, NY, SP, SPF).

Shrub or small **tree** to 6 m tall, ramified from the base; bark grayish; twigs reddish brown to dark purple, not flexuous, terete, usually puberulent; short shoots absent; prickles brown to purple-brown, apex usually darker, flattened, recurved, woody, 1–3 mm long, 1–3 mm at the base, glabrous, scattered along the twig, petiole and rachis, commonly paired at some nodes; perulate buds commonly presently at leaf axil, ovate or elliptic in profile, 5–7 × 2–4 mm. **Leaves** alternate, commonly paired at some nodes, 30–100 mm long; stipules light to dark brown, lanceolate, symmetrical, flattened, straight, herbaceous, 4–10 × 1.5–5.5 mm, pubescent and ciliate, early deciduous; petiole slightly grooved adaxially, 6–19 mm long, pubescent; petiolar gland solitary, usually located just below the lowest pinna pair, sessile, attached near the middle, the margins of the petiolar gland turning upward, oval to orbicular, 0.6–1.5 mm across, cup-shaped, glabrous; rachis adaxially grooved, 25–80 mm long, pubescent, an oval gland 0.4–0.9 mm across between the upper and sometimes other pinna pairs, rachis glands 0.4–0.8 mm across, oval, cup-shaped, glabrous; pinnae 4 to 11 pairs per leaf, 25–45 mm long, 4–10 mm apart; paraphyllidia 0.3–0.7 mm long, mostly absent; petiolule 0.8–1.5 mm long; leaflets 25 to 40 pairs per pinna, opposite, 0.7–1.1 mm apart, linear, 4–6 × 0.9–1.4 mm, glabrous, lateral veins not obvious, 1

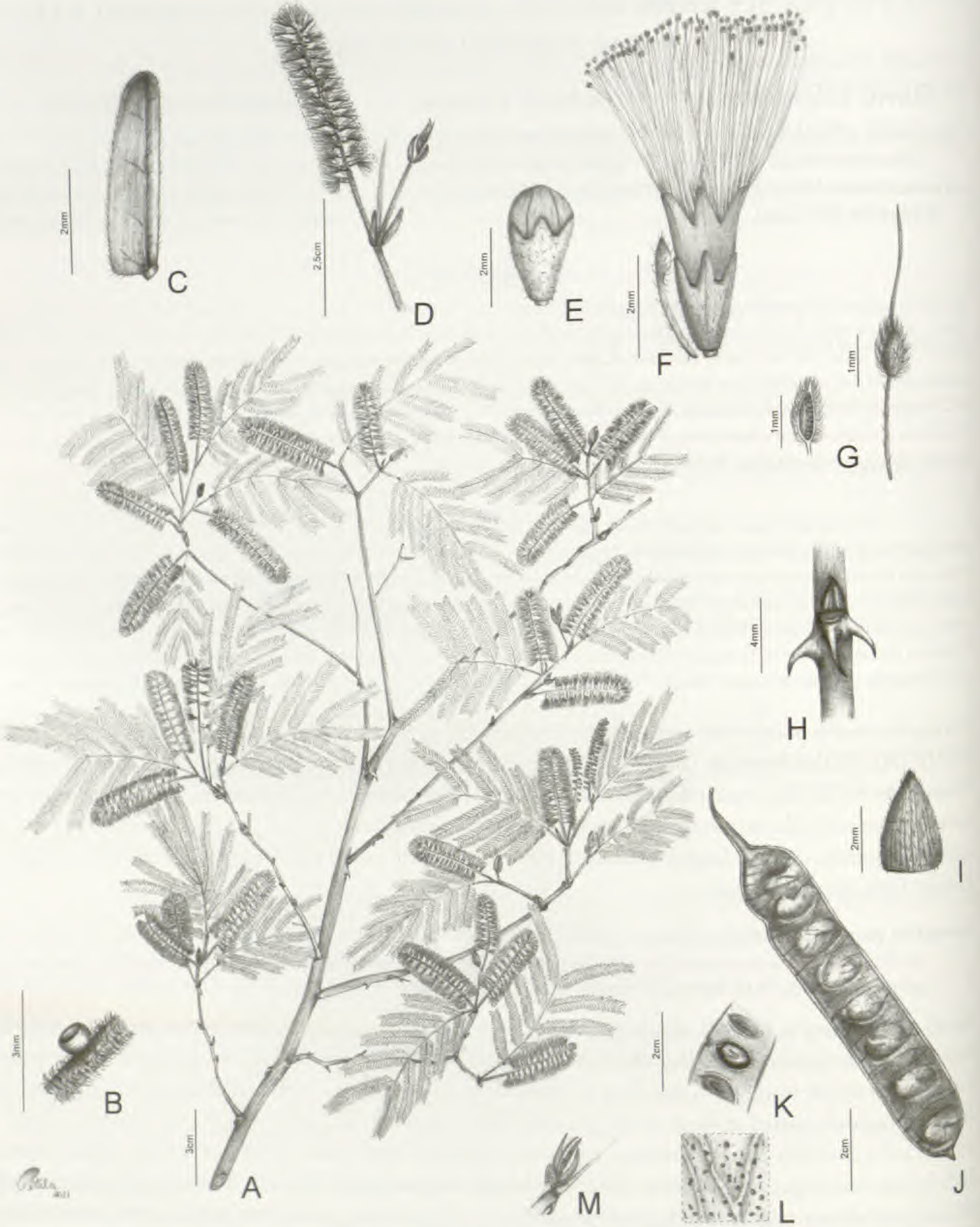

Fig. 1. *Senegalia paganuccii* Seigler, Ebinger, & Ribeiro. **A.** Flowering branch. **B.** Petiolar gland. **C.** Leaflet upper surface. **D.** Inflorescence. **E.** Flower bud. **F.** Flower at anthesis. **G.** Gynoecium showing detail of ovary. **H.** Prickles. **I.** Vegetative bud detail. **J.** Fruit. **K.** Detail of inner surface of the fruit showing the seed. **L.** Fruit, detail of surface showing the glands and hairs. **M.** Bud. Drawn by P.G. Ribeiro. A–B, D–G, M from *L.P.Queiroz et al. 7931* (HUEFS); C, H–I from *R.M. Harley et al. 26439* (HUEFS); J–L from *A.A. Conceição et al. 1925* (HUEFS).

vein from the base, base oblique and truncate on one side, margins ciliate, apex obtuse, midvein submarginal. **Inflorescence** a densely 40–75-flowered cylindrical spike, 9–15 × 20–45 mm, 1 to 3 in the leaf axils; peduncles 6–22 long, 0.4–0.6 mm thick, pubescent; receptacle not enlarged; involucre absent; floral bracts spatulate, 0.9–1.4 mm long, puberulent, early deciduous. **Flowers** sessile, white to cream-colored; calyx 5-lobed, 1.2–1.9 mm long, glabrous; corolla 5-lobed, 2.0–2.7 mm long, glabrous, lobes one-quarter the length of the corolla; stamens 45–84, filaments 4.5–6.5 mm long, distinct; anther glands absent; ovary pubescent, on a stipe to 1.1 mm long. **Legumes** oblong, 60–110 × 17–27 mm, straight, flat, not constricted between the seeds, coriaceous, transversely striate, puberulent, numerous minute purple glands present, dehiscent along both sutures; stipe 8–15 mm long; apex acute, short-beaked. **Seeds** uniseriate, 6.5–8.5 × 3.8–5.5 mm, orbicular, flattened, smooth, no pulp, dark brown; pleurogram U-shaped, 1.4–2.4 mm across; funicle exarillate.

Distribution and ecology.—Tropical deciduous forests, savannas, caatingas, and disturbed sites from sea level to 1000 m in eastern Brazil in the states of Bahia, Minas Gerais, and Piauí.

Phenology.—Flowering May–July, September–December; Fruit January–June, August–December.

Local Names.—espinheiro-preto (Minas Gerais), jurema-branca (Bahia), jurema-preta (Bahia), jurema (Bahia).

Conservation Status.—Restricted to the states of Bahia, Minas Gerais, and Piauí, Brazil, this species appears to be relatively common in that region with a number of recent collections seen.

Etymology.—We have named this species after Dr. Luciano Paganucci de Queiroz, Universidade Estadual de Feira de Santana, Brazil, a student of the legumes, especially those of the caatinga and more generally of Northeastern Brazil.

Specimens examined: **BRAZIL. BAHIA: Abaíra:** estrada Piatã-Abaíra, acima da entrada do Andrequisé, carrasco seco com solo argiloso, 13°17 S, 43°08 W, 900 m, 22 Sep 1992 (gem., fl.), *W. Ganev 1168* (HUEFS, K, NY, SPF). **Barra:** médio São Francisco, Barra Pau d'arco Lagoa do Canto, caatinga, 11°05 S, 41°42 W, 17 Nov 2007 (fr.), *M.L. Guedes et al., 14499* (ALCB). **Bom Jesus da Lapa:** estrada para Ibotirama, caatinga, 11 Apr 2002 (fr.), *J.G. Carvalho-Sobrinho et al. 505* (HUEFS); Basin of the Upper Sao Francisco River, just beyond Calderão, ca 32 km NE from Bom Jesus da Lapa, caatinga with damp sand área, 13°10 S, 43°13 51 W, ca. 500 m, 18 Apr 1980 (fr.), *R.M. Harley 21520* (CEPEC, NY, RB). **Caem:** 2 km E de Vila Cardoso, na estrada Capim Grosso-Juazeiro, caatinga, 11°7 58 S, 40°3 41 W, 410 m, 24 Nov 2003 (gem., fl.), *L.P. Queiroz et al. 7931* (CEN, HUEFS); same location, *7932* (CEN, HUEFS). **Campo Alegre de Lourdes:** mata na estrada para a Pitomba, mata, 9°29 4 S, 43°5 20 W, 510 m, 14 Jun 2001 (fr.), *T.S. Nunes et al. 390* (CEPEC, HUEFS, HRB). **Caturama:** Caieiras, caatinga arbórea, 13°17 27 S, 42°13 32 W, 634 m, 5 Sep 2007 (fr.), *A.A.Conceição et al, 2390* (HUEFS). **Ibipeba:** Barragem de Mirorós, caatinga densa, 11°30 S, 42°12 W, 25 Mar 1991 (fr.), *P.E. Nogueira 228* (IBGE). **Irecê:** Barra do Mendes, caminho para Ipupiara, mata ciliar, 11°49 39 S, 42°08 12 W, 25 Oct 2009 (fr.), *M.L.Guedes el al. 16112* (ALCB). **Jacobina:** ca. 10 km na estrada de Jacobina para Morro do Chapéu, campos rupestres, 14 Mar 1990 (fr.), *A.M. Carvalho & J. Saunders 2798* (CEPEC, K, RB, TEX). **Maracás:** entrada da Boca do Mato, 791 m, 19 Dec 2004, *M.M. da Silva-Castro, I.F. Castro, R.F. Brito, J.H. Falcão, & C.R.A. Costa 953* (HUEFS). **Marcionílio Souza:** s.loc., caatinga arbórea, Jul 1980, *G.C.P. Pinto 203* (HRB, IPA, MBM). **Morpará:** estrada para Morpará, beira do rio Paramirim, caatinga verde, 11°43 50 S, 43°13 39W, 396 m, 15 Dec 2007 (fl.), *A.A.Conceição el al. 2640* (HUEFS); Morro da Antena, caatinga sobre solo pedrogoso, 11°33 25 S, 43°16 40 W, 17 Dec 2007 (fl., fr.), *A.A. Conceição et al. 2722* (HUEFS). **Palmeiras:** s.loc., 3 Oct 2003 (fl.), *A. Bocage et al. 871, 878* (IPA, UFRGS); same location, 4 Oct 2003 (fl.), *A. Bocage et al. 881, 882, 883* (IPA, UFRGS), *887* (IPA, JPB, UFRGS). **Paramirim:** caminho Catuarama para Mateus, caatinga, 13°17 50 S, 42°14 44 W, 593 m, 28 Apr 2007 (fr.), *A.A.Conceição et al. 1925* (ALCB, HUEFS). **Pilão Arcado:** caminho para Brejo do Zacarias (Brejinho), 9 Dec 2005, *A.A. Conceição et al. 1548* (HUEFS); same location, vegetação dunas, 10°0 9 S, 42°30 35 W, 10 Nov 2005 (gem., fl.), *A.A. Conceição et al. 1586* (HUEFS). **Pindaí:** rodovia BR-122, 10 km S de Pindaí, carrascal, 800 m), 2 Jul 2004 (gem., fl.), *G. Hatschbach et al. 78761* (MBM). **Remanso:** saída de Remanso a Pilão Arcado, 9°44 17 S, 42°23 49 W, 28 Feb 2000 (fr.), *L. Passos et al. 393* (ALCB, CEN, HUEFS, HRB, RB, SPF); estrada para Pilão Arcado, entrada à direita, ca. de 29 km da cidade, caatinga em solo arenoso, 9°45 18 S, 42°18 10 W, 414 m, 16 Jun 2001 (fr.), *T.S. Nunes, et al.* (ALCB, CEPEC, HRB, HUEFS). **Rio de Contas:** estrada para Jussiape, caatinga, em solo arenoso, pedregoso. 13°32 S, 41°52 W, 7 Sep 2003 (gem., fl., fr.), *R.M. Harley & A.M. Giutietti 54686* (HUEFS). **Seabra:** Distrito de Bebedouro, 12 km a partir do ramal que leva ao distrito, caatinga arbustiva, 27 Jan 1998 (fr.), *A.M. Amorim et al. 2186* (CEPEC, SP); 3 km S de Logoa do Chure no estrada para SEABRA, 1000 m, 22 Jun 1993, *L.P. de Queiroz & N.S. Nascimento 3370* (HUEFS). **Sebastião Laranjeiras:** Serra do Monte Alto, contato savana/caatinga/floresta estacional, 14°32 15 S, 42°54 34 W, 850 m, 7 May 2009 (fr.), *S. Sousa Silva et al. 535* (HRB, IBGE, VIC). **Sento Sé:** subida do Morro, 9°51 15 S, 42°3 11 W, 420 m, 13 Nov 2007 (fr.), *C. Correia et al. 324* (HUEFS); same municipality, 9°51 44 S, 42°2 40 W, 495 m, 14 Nov 2007 (gem., fl.), *C. Correia et al. 336* (HUEFS). **Souto Soares:** 3 km N de Souto Soares, camino a Mulungu do Morro, caatinga arbórea, ca. 12°03 S, 41°38 W, ca. 750 m, 26 Nov 1992 (fl.), *M.M. Arbo, et al. 5317* (GH, HUEFS, K, MO, NY, SP, SPF). **Umburanas:** Distrito de Delfino, Fazenda Boa Esperança, caatinga, encosta e vale do rio dos Morins, afluente do rio Salitre, 10°30 19 S 41°19 51 W, 750 m, 24 May 2008 (fr.), *E. Melo et al. 5736* (HUEFS). **Utinga**, *M.Blanchet 3772* (K, MO); Próximo a Butirama, caatinga, 10°33 S 43°38 W, 6 Apr 1978 (fr.), *J.S. Assis 138* (HRB, RB); km 50, entre Tremendal e Piripá, 620 m), 15 Oct 1970 (fl.), *D. Andrade-Lima 6056* (IPA). **Without municipality:** Río San Francisco, 1838, *M.Blanchet 2772* (F, GH, IT, K). **MINAS GERAIS:** 13 km by road W of Januária on road to Serra das Araras, 575 m, 19 Apr 1973, *W.R. Anderson 9162* (CM, MO, NY); 13 km by road W of Januária on road to Serra das Araras, 575 m, 19 Apr 1973, *W.R. Anderson 9163* (NY); approx. 10 km W of Januária, understorey species of deciduous forest on limestone soil, 15°30 S, 44°30 W), 24 Oct 1972 (fl.), *J.A. Ratter et al. 2657* (K, NY, UB, UEC). **Coronel Murta:** s.loc., floresta estacional decidual, 16°31 S, 42°09 W, 269 m) 12 Nov 1981 (fl.), *O.A. Salgado 230* (CEPEC,

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1                 10                  20                  30                40
. ? . G C S . . - - - . . . C G . A A A - - - - . . . . . . . . ? . . . G . . .
- - - . . . . . - . . A A C C M - M C G C G C G T C C M C T G G A C G . . . . .
G - - - A . . . . . . - - - - . . . . - - - - G C G C C C G A G G C C T - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - . . . . . A
. . - - - - - - - . . . . . - A . . - - . . . . . . . . . . C . - M . . . . . .
- - . . . . . . A . . A. T . . . G - - - . . G . . . . - - - - - - - - - - - -
- - - - - - - - - - - - - - - - G C . C . . G C . . G C . . . G . G C C C C G C
S C C M C M ? ? ? T G C A C C G C A C G G A A - - - - - - - - - - - - - - - - -
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. . . . . . . C . . . . . . G C . C T . . . . . . . . . . . . . . . . . . . . .
. . T . . . . . . . . G . . . . . . . . . . . . . . C - - G C C . . G . . . . .
. - - C G G . A . . . . . . T . . . . . . . . . . G . G . . . T . . C . C . . .
- . . . . . . . . . . . . . A . . . . . . . C - . . . . . . . . G A . . . - - .
. . . . . . . M . . . . . . T . - . . . . . - . . - - - - - . C C T C - - - - - . .
. ? - - - - . . . G ? . - A A G . . . . . A . . T . . G. ? . . . . C - - . C .
G ? ? ? ? ? . . . C - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
721               730                 740                   751
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FIG. 2. ITS sequence data for *Senegalia paganuccii.*

TABLE 1. Distinguishing characteristics for *Senegalia paganuccii, S. monocantha, S. velutina,* and *S. tenuifolia.*

Characters/Species	*Senegalia paganuccii*	*Senegalia monocantha*	*Senegalia velutina*	*Senegalia tenuifolia*
Habit	shrub or tree	shrub or tree	liana	tree or liana
Prickles	paired and scattered	1–3 at nodes or scattered	scattered	scattered
Petiole length	6–19 mm	8–32 mm	25–55 mm	8–30 mm
Petiole gland length	0.6–1.5 mm	0.9–3.1 mm	1.7–6.1 mm	1.5–4.2 mm
Petiole gland position	just below pinna-pair	lower half of petiole	lower third of petiole	middle of petiole
Paraphyllidia	present, 0.3–0.7 mm	absent	present, 0.5–1.1 mm	absent
Pinna pairs/leaf	4–11 pairs	2–7 pairs	6–14 pairs	10–25 pairs
Pinna pair distance	4–10 mm	12–26 mm	7–15 mm	3–10 mm
Pinna length	25–45 mm	45–80 mm	50–100 mm	23–62 mm
Leaflet/pinna	25 to 40 pairs	7 to 22 pairs	37–68 pairs	42 to 80 pairs
Leaflet distance	0.7–1.1 mm	2–6 mm	0.8–1.7 mm	0.3–0.9 mm
Small gland on anther	absent	absent	present	present
Inflorescence	cylindrical spike	cylindrical spike	cylindrical spike	globose head
Fruit	not articulate	articulate	not articulate	not articulate

HRB). **Manga:** Jaiba, estrada Serraria e Mocambinho, 5 Sep 1974, *M. Magalhães & M.B. Ferreira 5021* (IPA). **PIAUÍ. São Raimundo Nonato:** entre São Raimundo Nonato e Anísio de Abreu, caatinga, 17 Nov 1981 (fl.), *M.R. Del'Arco & E. Nunes 2214* (IPA, TEPB).

Bentham (1842) in his discussion accompanying the description of *Acacia velutina* DC., first mentioned *A. monacantha* Willd. and concluded that if it were a true *Acacieae*, it would belong to this tribe. Under *A. velutina*, Bentham (1842) cited *Blanchet 2772* from Bahia and *Pohl s.n.* from Brazil, as possibly belonging to this species. However, our studies show that the type of *Acacia velutina* DC. (BRAZIL. RIO DE JANEIRO: [holotype: G, (photos F, MO, SI); isotype: G]), is distinct both from *Blanchet 2772* ("habitat ad Utinga in deserto fluminis S. Francisco provinciae Bahiensis") and the Pohl collection ("inter Praia et Bom Jardim Provinciae Minas Gerais"). Later, Bentham (1876) considered *Blanchet 2772* (and another collection, apparently from the same location (*Blanchet 3772*), the Pohl collection and a Lindberg collection ("ad Santos in provinceae São Paulo") to represent *Acacia monacantha* Willd. Additionally, he considered *Acacia velutina* Benth. (1842) to be a synonym of *A. monacantha* Willd. Today these species are regarded as distinct, namely, *Senegalia monacantha* (syn. *Aca-*

cia monacantha) and *Sengalia velutina* (syn. *Acacia velutina*), and the Blanchet and Pohl collections are referred to our new species, *S. paganuccii*.

The descriptions of Bentham (1875, 1876) and Lewis (1987) for *Acacia monacantha* and the description and illustrations (p. 201, H1, H2, and H3) of *Senegalia monacantha* of de Queiroz (2009) all appear to be based on *Blanchet* 2772 and similar collections and not on the original type material of *Acacia monacantha* Willd. We therefore consider these treatments referable to *S. paganuccii*.

Based on morphological similarities and limited analysis of ITS sequences (Fig. 2), *Senegalia paganuccii* appears to be most closely related to *S, tenuifolia* (L.) Britton & Rose. The characters used to distinguish *Senegalia paganuccii* from *S. monacantha, S. velutina* and *S. tenuifolia* are summarized in Table 1.

ACKNOWLEDGMENTS

The authors wish to thank several colleagues for advice concerning questions of nomenclature and general taxonomic advice, in particular, K.N. Gandhi. We wish to acknowledge support by the National Science Foundation (NSF DEB 04-15803), by the American Philosophical Society (1992) and by the CNPq for financial support to PGR, on her master's degree in the Postgraduate Program in Botany at the Universidade Estadual de Feira de Santana, Bahia, Brazil; also to the curators of the herbaria that were visited or provided loans of specimens for our study (ALCB, BHCB, CEN, CEPEC, F, G, H, HRB, HST, HUEFS, IBGE, IPA, K, MBM, MO, NY, RB, R, SP, SPF, TEX, UB). We thank Bruce R. Maslin and an anonymous reviewer for helpful comments.

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BOOK REVIEW

Welby R. Smith. Illustrations by Vera Ming Wong and Bobbi Angell. 2012. **Native Orchids of Minnesota.** (ISBN-13: 978-0-8166-7823-5, hbk.). University of Minnesota Press, 111 Third Ave. South, Suite 290, Minneapolis, Minnesota 55041, U.S.A. (**Orders:** www.upress.umn.edu; 612-627-1980 fax; 612-627-1970 phone). $34.95, 288 pp., 93 b/w illustrations, 174 color plates, 53 maps, 7" × 10".

Nineteen years after publishing *Orchids of Minnesota*, the author has published an updated, comprehensive, and beautifully illustrated new volume, *Native Orchids of Minnesota*. His Table of Contents, map of the counties in Minnesota where orchids are most likely to be found, and Preface provide an excellent "starting platform" for the Introduction and his gentle guidance into the descriptions and basic understanding of Minnesota's orchids.

After providing straightforward answers to the usual questions flower lovers ask, he provides a thorough and easily useful "Key to the Genera of Orchids Found in Minnesota." An unusual but very helpful addition to the keys is the author's careful inclusion of two or three simple line drawings of the described plant part at the end of each leg of the key. The reader has an immediate and accurate vision of where and what to look for as (s) he examines the plant.

Each genus is introduced on the left page and accompanied by a photo on the right page. The following pages provide thorough descriptions, explanations, photos, and illustrations of the individual species in each genus. Most orchid fanciers will find themselves totally enchanted by the "reading and admiring" process. Obviously, this book would be incredibly useful to have with you in the field—not only for identifications but also to have use of the accompanying maps of Minnesota counties, showing where each species is most likely to be found.

(This is such a beautiful book, I think I would need to buy two copies: one to take into the field for quick and accurate identification and one to keep safely at home in an easily available, beautiful "pristine condition!").—*Helen Jeude, Volunteer and Assistant Editor, Botanical Research Institute of Texas, 1700 University Dr., Fort Worth, Texas 76107-3400, U.S.A.*

TAXONOMY OF *LANTANA* SECT. *LANTANA* (VERBENACEAE): II. TAXONOMIC REVISION

Roger W. Sanders

Bryan College # 7802
721 Bryan Drive
Dayton, Tennessee 37321, U.S.A.
rsanders@bryan.edu

ABSTRACT

Twenty species of *Lantana* L. sect. *Lantana*, including thirteen subspecies and five varieties, are recognized and described, of which 15 species within four series are thought to have originated by divergence and five species are hypothesized to have originated by hybridization between species of different series. Keys are provided to all taxa. Six names are lectotypified and two are epitypified. Specimens documenting 115 putative hybrid combinations are cited. Newly described are ser. **Setosae**, ser. **Strigosae**, ser. **Spicatae**, and **Lantana hirsuta** subsp. **amazonica.** Nine new combinations are: **Lantana camara** subsp. **glandulosissima, Lantana camara** subsp. **moldenkei, Lantana camara** subsp. **moritziana, Lantana camara** subsp. **portoricensis, Lantana horrida** subsp. **tiliifolia, Lantana horrida** subsp. **zanonii, Lantana horrida** subsp. **zanonii** var. **sargentii, Lantana horrida** subsp. **zanonii** var. **subcordata,** and **Lantana paraensis. Lantana planaltensis** replaces *Lantana triplinervia* var. *hispida*.

RESUMEN

Se reconocen veinte especies de *Lantana* L. sect. *Lantana*, que incluyen trece subespecies y cinco variedades, de las que 15 especies incluidas en cuatro series se piensa que se han originado por divergencia y se hipotetiza que cinco especies se han originado por hibridación entre especies de diferentes series. Se aportan claves para todos los taxa. Se lectotipifican seis nombres y dos se epitipifican. Se citan especímenes que documentan 115 combinaciones de híbridos putativos. Se describen como nuevos ser. **Setosae**, ser. **Strigosae**, ser. **Spicatae**, y **Lantana hirsuta** subsp. **amazonica.** Se hacen nueve combinaciones nuevas: **Lantana camara** subsp. **glandulosissima, Lantana camara** subsp. **moldenkei, Lantana camara** subsp. **moritziana, Lantana camara** subsp. **portoricensis, Lantana horrida** subsp. **tiliifolia, Lantana horrida** subsp. **zanonii, Lantana horrida** subsp. **zanonii** var. **sargentii, Lantana horrida** subsp. **zanonii** var. **subcordata,** y **Lantana paraensis. Lantana planaltensis** reemplaza a *Lantana triplinervia* var. *hispida*.

Due to a long history of cultivation, hybridization, and invasiveness, the taxonomy of *Lantana* L. sect. *Lantana* resists partitioning into easily identified species (see Sanders 2006 for review). While some workers might prefer the convenience of recognizing a single highly variable species, *Lantana camara* L., previous biosystematic studies (Sanders 1987a, 1987b, 1987c, 1989) have shown the presence of morphologically discrete diploid taxa having coherent ecological and geographic ranges where they appear to have speciated *in situ*. These studies have been corroborated by a recent molecular analysis of the taxa in Florida (Maschinski et al. 2010). The present study attempts to delineate the indigenous taxa of sect. *Lantana*, even in the face of rampant hybridization due to human-induced ecological disturbance and the failure of odd polyploidy as a breeding barrier in this group. This second paper in the series builds on the first (Sanders 2006), which detailed the typification of species of sect. *Lantana*. As suggested by Sanders (2006), the identity of individual specimens constituting the hybrid plexus found growing outside cultivation today cannot be unraveled by morphology alone, and it may be recalcitrant even to molecular genome analysis. Thus, variation encompassing the indigenous species now connected by hybrids may appear to be constituted more of adaptive peaks rather than bell curves surrounded by discontinuity. Furthermore, no phylogenetic analysis has been attempted here because the outgroup relationships of sect. *Lantana* are not understood, and the significant trichome and inflorescence characters are homoplastic with regard to potential outgroups.

The rank of *series* is established only for grouping species of presumed origin by divergence from the ancestor of sect. *Lantana*. Species of interseries hybrid origin are not placed into series and are listed separately. These species are presumed to have originated by natural selection acting on the variable pool of original hybrids resulting in one or a few closely similar phenotypes and, thus, may not be strictly intermediate to the

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parental species. The surviving phenotype has become self-propagating and has attained a geographic range exceeding the original area of sympatry. Spontaneous and cultivated hybrids that have received Latin names but do not behave biologically as species are in a third separate list.

I view *varietas* as the least inclusive taxonomic rank composed of a minimum of one breeding population (as inferred from available ecological data) having geographic coherence in a limited part of the species range and imperfect discontinuity from similar, geographically adjacent taxa within the species. *Subspecies* is used either to group varieties or to recognize a taxon within a species with geographic coherence over an extensive geographic range (e.g., usually several islands or subcontinental areas) and having imperfect discontinuity or minor differences from similar, geographically adjacent subspecies. One impetus to employ subspecies in *Lantana* has been to avoid instability in infraspecific names that could be caused by the subsequent discovery of poorly known varietal names, of which there are many.

MORPHOLOGICAL TAXONOMIC CRITERIA AND ANALYTICAL CAVEATS

Caveats for identification and descriptions are given in italics.

Prickles.—Whereas a majority of species either lack prickles or bear only small weak straight or recurved prickles, pronouncedly stout recurved prickles are inconsistently present (varying among herbarium collections and field populations) in the remaining species, notably *Lantana camara* subsp. *aculeata*, *L. hirsuta* subsp. *amazonica*, *L. horrida*, *L. nivea*, *L. planaltensis*, *L strigocamara*, *L. urticoides*, and *L. viscosa*. The tendency to produce prickles appears more pronounced in hybrids than in most indigenous species.

Trichomes.—The form of trichomes on the abaxial leaf surfaces (filiform vs. setiform vs. strigiform) and their length are highly correlated with ecological and geographic coherence of indigenous taxa and provides one of the main criteria to delimit series. *Trichomes in the adaxial grove of the midrib and some secondary veins can be nearly twice as long as those on the remaining tissue. Therefore measurements in the key and descriptions for adaxial hairs are taken between the secondary veins. Likewise, hairs on the nodal lines of the stems are often about twice as long as other hairs along the stem and are excluded from measurements in the key and descriptions.*

Filiform hairs and setae are both erect from the base with the setae differing primarily by greater length and stouter, and a more conical proximal portion. Both types may be somewhat flexuous, arching or curly distally.

Strigae are stiff conical hairs that are geniculately bent in the proximal quarter or third with the remaining distal portion directed antrorsely. On the adaxial leaf surfaces, the antrorse portion is more or less ascending and arching. The broadened base emerges from a buttressing ring of epidermal cells that form a pustulate base. Especially in Ser. *Strigosae* or taxa of hybrid origin with genes of its species, the strigae often are deciduous leaving the pustulate bases as rough points. In some species the bases enlarge with age and become vitreous (clear or white). In taxa and hybrids with strigae on the abaxial surface, the strigae lack the buttress base, arising directly from the epidermis and the antrorse portion is held more or less parallel to the epidermis. In some *Lantana nivea*, they are so short that the antrorse portion is not well developed, appearing as a short point angling upwards. *In recognizing the abaxial strigae, one must also be aware that filiform or setiform hairs that are crushed against the surface during pressing can be mistaken for strigae, which occur consistently over the pertinent surfaces.*

The co-occurrence on the abaxial surfaces of filiform hairs or setae with strigae is a clear indication of the hybrid nature or heritage of the specimen at hand.

The presence of stipitate glands on the twigs, peduncles, petioles, and even leaf-blades is variable within several taxa, noteably *Lantana camara* subsp. *portoricensis*, *L. horrida* subsp. *zanonii* and subsp. *tiliifolia*, *L. micrantha*, *L. paraensis*, and *L. planaltensis*. While glands are consistent in *L. leonardiorum* and *L. viscosa*, those species are not delimited on the basis of glands. Therefore, the consistent presence of glandular hairs in *L. camara* subsp. *glandulosissima* is not used to segregate it as a species; *L. camara* is simply variable in this regard.

Leaves.—The lateral halves of the blades usually are not mirror images, with the widest point in many taxa in the proximal third on one half and middle third on the other half, making it difficult to characterize shape. Bases of the blades in almost all cases abruptly taper to a narrow wing onto the petiole distally. *Leafblades are considered to be triplinerved (as opposed to pinninerved) if the basal pair (or two pairs) of secondary veins are set at sharper angles than the more distal secondary veins, with the distance to the more distal veins greater than among them. Nigrescence refers to a distinct blackening of mature leaves occurring during drying for preservation, not normal senescence. While such blackening is diagnostic for certain species, newly emerging leaves can blacken in most species. Leaves atypical for size, shape, bases, apices, and venation are present on most plants. Leaf shape, size, and vestiture traits are measured only on fully developed, non-senescent leaves. Measurements for marginal teeth are taken mid-margin, avoiding the reduced teeth near the base and apices of the blades.*

Inflorescences.—The basic structure of the inflorescences has been discussed in detail (Sanders 2001). *Peduncle length in the key and descriptions are given for fully opened inflorescences and infructescences.*

Bracts generally decrease gradually in length and width from the proximal to the distal series that seemingly spiral up the receptacle. The distal (inner) bracts are about 2–4 mm long and about 0.3–1 mm wide in most species and, thus, are not detailed in the descriptions. The exceptions appear to be diagnostic in Ser. *Spicatae* and a few taxa in Ser. *Lantana* in which almost all the bracts are the same dimensions. In some taxa there is an abrupt diminution from the proximal (basal or outer) two or three series of bracts to the more distal series. Shape and size of the proximal bracts appear to be consistent and diagnostic, with the exception of *one or rarely two subfoliaceous bracts that develop sporatically in almost any taxon; hence, these atypical bracts are excluding from the measurements.*

Flowers.—Corolla color has been discussed by Sanders (2001, 2006). It often changes from bud to early opened flowers to late flowers to fading flowers, especially in plants that produce both yellow to carmin pigments and purplish pigments. The throat is often not only different but changes during flower maturation. This developmental variation is often further complicated by intraspecific variability. Unfortunately, detailed information is usually lacking from collection labels. Corolla shape is nearly uniform in the group, but size appears to be consistent within taxa when measured from fresh material. However, dried corollas are often shrivelled and difficult to measure; *in the descriptions, "fresh" size has been extrapolated from dried specimens.*

Cytology.—Chromosome numbers are not given in the descriptions because those for only a few taxa are known (See Sanders 1987a, 1987b, 1989).

Phenology.—Flowering time is not given in the descriptions because any species can flower anytime during the year whenever moisture is available. This is true even of species native of subtropical areas with frost seasons when the species are grown in frost-free areas.

TAXONOMIC TREATMENT

See Sanders (2001) and Sanders (2006) for further characterization of *Lantana* and comparison of sect. *Lantana* with other sections. Also, see Sanders (2006) for details of species typifications, which are supplemented here only as needed. Please note that, in the type and other specimen citations, the abbreviation "di" refers to a digital image made available online or as a courtesy by the cited herbarium. Many thousands of specimens representing this group are in herbaria awaiting identification. For this study only a small sample, primarily from major U.S. institutions, has been selected for annotation and citation here as these specimens will be most easily available for consultation by other professionals. Even so, annotations made during quick visits to herbaria may differ than those cited herein as a result of reflection and more careful study of digital images that I made or were sent to me. Selection of specimens was to establish only distribution limits of the species, as well as document as many hybrid combinations as possible, thus, resulting in a falsely apparent predominance of hybrids in some cases. To assist those attempting to identify specimens of sect. *Lantana*, a richly illustrated interactive key (in which vernacular names are also discussed and provided) has been made available online (Offutt & Sanders, 2012).

Lantana L. sect. **Lantana**

Shrubs or rarely treelets, erect to decumbent or subscandent, height (or length) (0.1–)0.5–3 m (to 4 or even 6 m in subscandent, especially aggressively naturalized forms); the internodes usually less than to almost twice as long as leaves (mostly twice to thrice as long in *L. splendens*), with or without weak to stout, conical to recurved prickles; vestiture antrorsely strigose to puberulent, pilose, setose, glabrescent, or stipitate-glandular and thus markedly viscid, the trichomes of twigs, peduncles, and petioles often noticeably longer and stiffer than those on remaining herbage. **Leaves** opposite or sporadically ternate, petiolate, simple; blades usually ovate or lanceolate to elliptic, usually hardly to moderately rugose, i.e., puckered between tertiary veins (strongly so in some *L. horrida* and usually bullate in *L. leonardiorum*, which is puckered between the secondary veins), usually longitudinally flat or somewhat undulate (incurved in *L. depressa*); base attenuate to cordate; apex attenuate, acuminate, acute, obtuse, or occasionally rounded; margin usually finely serrate-crenate but coarsely so in *L. urticoides* and some *L. hirsuta* and *L. kingii* or subentire in some *L. cujabensis*, flat to revolute, usually green (often purple-tinged in *L. kingii*); adaxial surface strigose (strigae typically ascending distally to antrorsely bent, ± appressed in *L. kingii*, flaccid and strongly appressed in *L. hodgei*), strigose-villous, setose-villous, or nearly glabrous; abaxial surface strigose, pilose, puberulent, setose, or glabrescent, with the veins green to pale brown or sometimes nigrescent or occasionally tinged with purple (frequently purplish in *L. kingii*). **Inflorescences** pedunculate, capituliform spikes, one (or sporadically two in several species) per subtending leaf; peduncles about a third to twice the length of leaves (up to four times in some *L. horrida*); *axis (common receptacle) ellipsoid or fusiform, spongy*; bracts nearly always subtending a flower, linear triangular or linear lanceolate to oblong, elliptic, or spatulate, ± appressed to spreading or reflexed. **Flowers** in several series, two to three series in anthesis at a time, zygomorphic; corolla salverform with inflexed tube and four unequal lobes, pigments either yellow to reddish or pink to purple or admixtures of both (in hybrids or taxa of hybrid origin) or lacking. **Drupes** *usually blue-black* (but sporadically described by collectors as dark violet-purple), usually with a metallic iridescence; *pulp watery-mealy; endocarp turbinate-obpyriform with an inflated commissure and external circumferential ridge below the seed chambers*. **x**=11.

KEY TO SPECIES OF *LANTANA* SECT. *LANTANA*

BEFORE ATTEMPTING TO USE THE IDENTIFICATION KEY OR DESCRIPTIONS, SEE CAVEATS ABOVE.

1. Abaxial leaf-surface antrorsely strigose-scabrous to nearly glabrous, consisting only of or strongly dominated by strigae.
   2. Proximal bracts 2–8 mm wide, with 5–7 veins from the base.
      3. Capitula not elongating by prolonged initiation of additional flowers, remaining hemispheric; bracts ± obtuse, acute and rounded at very tip, or briefly acuminate, appressed to spreading, appearing to form an involucre; cilia, if present on bracts, usually no more than 0.5 mm; corollas yellow or orange aging reddish (rarely intensely reddish purple) **13. L. cujabensis**
      3. Capitula elongating by prolonged initiation of additional flowers, becoming cylindric; bracts acuminate with a prolonged tip, spreading, causing the capitula to resemble spikes of *Carex lupulina*; cilia usually well developed on bracts, mostly 0.5–1 mm; corollas pink to purple or white aging purplish (rarely yellow to red-orange) **19. L. paraensis**
   2. Proximal bracts 0.5–1.5 mm wide (to 3 mm in *L. ovatifolia* and *L. kingii*, otherwise rarely one or two bracts in outermost series spatulate-subfoliaceous to about 2 mm wide), with 3 veins (rarely 4 or 5 in *L. splendens*) from the base.
      4. Leaf-blades ovate-elliptic to lanceolate-elliptic or trullate, averaging 1.7–2.5(–3) times longer than wide, the base attenuately tapering to petiole from middle or just below middle, or less commonly abruptly contracted and broadly cuneate onto petiole; blades triplinerved; herbage usually nigrescent (except in *L. kingii* and *L. splendens*); upper leaf-surface usually lustrous.
         5. Proximal bracts (excluding one or two subfoliar outermost ones or those of gall-transformed heads) widest near or just below middle or in distal half (sometimes so in *L. splendens*, see below), persistent in fruit.
            6. Leaf-blades bright, dark, or dull green abaxially, nigrescent, ovate-elliptic, induplicate or having halves incurved at maturity; larger strigae of the abaxial leaf-surface 0.5–1 mm; twigs setulose with spreading hairs about 0.5–1.5 mm; proximal bracts ca. 3–5 mm, elliptic-lanceolate **9. L. depressa**
            6. Leaf-blades distinctly whitish or pale green below (though not glaucous), not nigrescent, usually ovate or ovate-triangular, rarely (especially if less than 2 cm long) obovate or ovate-elliptic, ± flat, not having halves incurved at maturity; larger strigae of the abaxial leaf-surface 0.1–0.4(–0.6) mm; twigs glabrescent with antrorse hairs 0.3–0.7 mm; proximal bracts ca. 6–10 mm long, spatulate or oblanceolate **10. L. kingii**
         5. Proximal bracts (excluding one or two subfoliar outermost ones or those of gall-transformed heads) widest at or just above base, deciduous after flowering.
            7. Corollas white aging bluish to pink, or pink aging light purple, or with purple intermixed with creamy yellow to orange; hairs of abaxial leaf-surface moderately dense, ca. 15–60/mm^2 (under 10X magnification those on the higher order veins may be so small as to appear to be papillae); abaxial surface of leaf-blade not noticeably whitish-green; stems often with abundant, stout, recurved prickles **12. L. nivea**
            7. Corollas yellow to reddish orange without any pink or purple mixed in; hairs of abaxial leaf-surface moder-

ately to very sparse, ca. 0–12/mm² (under 10X magnification those on the higher order veins do not appear to be papillae); abaxial surface of leaf-blade whitish-green (but not glaucous); stems usually lacking stout, recurved prickles.

8. Leaf-blades mostly 1–5(–7) cm long, on adaxial surface of mature and older leaves the circular bases of strigae 0.3–0.5 or more mm in diam., conspicuously vitreous-pustulate, often nearly filling whole areole; corolla tubes ca. 5–8 mm long; proximal bracts mostly oblong-lanceolate (outermost 1 or 2 oblong-obovate or oblanceolate), 2–4(–5) mm long; virgate or divaricately branched shrubs **7. L. splendens**

8. Leaf-blades mostly 5–15 cm long, on adaxial surface the circular bases of strigae usually 0.2 mm or less in diam. (not exceeding 0.3 mm.), usually not conspicuously vitreous-pustulate, not filling whole areole; corolla tubes 7–12 mm long; proximal bracts narrowly lanceolate to linear-triangular, 4–10 mm long; rounded, lax, or subscandent shrubs.

9. Leaf-blades glabrescent, smooth and subsucculent or coriaceous; hairs of adaxial leaf-surface geniculately bent at very base, flaccid, strongly appressed to surface and often deciduous; peduncles a third or less as long as leaves **8. L. hodgei**

9. Leaf-blades strigose or scabrous, papery to subcoriaceous; hairs of adaxial leaf-surfaces geniculately bent about ¼ of length above base and held above surface; peduncles about equaling to half as long as leaves **6. L. scabrida**

4. Leaf-blades ovate to broadly ovate, averaging 1–1.7 times longer than wide, the base rounded, truncate, or cordate, usually briefly and narrowly cuneate onto petiole at very base of blade; blades pinninerved; herbage usually not nigrescent (if so, then only the young, expanding leaves); upper leaf-surface lustrous or not.

10. Adaxial leaf-surface dull, not vitreous-pustulate, the bases of the strigae only about 0.1–0.2 mm in diam.; bracts deciduous after anthesis, the proximal series lanceolate-triangular or lanceolate-linear (occasionally an outermost one or two spatulate-subfoliar); corollas opening yellow, cream, or white aging yellow to red-orange, purplish, orange plus purple, or white with yellow throat **20. L. strigocamara**

10. Adaxial leaf-surface lustrous, vitreous-pustulate or pustulate-scabridulous, the bases of the strigae (at least on the older leaves) about 0.3–0.5 mm or more in diam.; bracts persistent into fruit, the proximal series typically spatulate to elliptic-oblong; corollas yellowish to orange or red-orange.

11. Hairs on adaxial leaf-surface mostly 0.1–0.4 mm, appressed, often deciduous leaving only pustulate bases; leaf-blades abaxially distinctly whitish or pale green (seemingly but not actually glaucous); leaf-teeth sinuses 1–2.5 mm deep; stems upright; corollas opening yellow aging orange or red-orange **10. L. kingii**

11. Hairs on adaxial leaf-surface 0.2–1 mm, ascending, longer ones sometimes deciduous; leaf-blades abaxially bright, dark or dull green; leaf-teeth sinuses 0.7–1.5 mm deep; stems trailing or decumbent; corollas opening and ± remaining yellow **11. L. ovatifolia**

1. Abaxial leaf-surface not exclusively or dominantly antrorsely strigose-scabrous but setose, pilose, velutinous, puberulent, pannose, viscid, or glabrescent, the vestiture varying from having hairs that are exclusively erect (± erect from basal insertion, spreading from surface of lamina or vein from which they arise, filiform or setaceous, gland-tipped or not, distally arching-curved or flexuously curled) without strigae present to having a codominant mixture of erect hairs and strigae (occurs in hybrids and some species of hybrid origin).

12. Capitula elongating, becoming cylindric; corollas usually pink to deep reddish purple (sometimes pale yellow in throat only), occasionally white becoming infused with purple (rarely yellow to orange red in *L. paraensis*).

13. Corolla tubes briefly or not exerted beyond bracts, 2–4 mm; capitula elongating by expansion of nodes between flowers/fruits; bracts often deciduous after flowering, but if persisting, then usually rapidly becoming reflexed from base, without cilia, abaxial hairs 0.3–0.5 mm, apex acute to rounded, sometimes abruptly acuminate or briefly attenuate **15. L. micrantha**

13. Corolla tubes exerted well beyond bracts, (5–)7–12 mm; capitula elongating by prolonged initiation of flowers; bracts strongly persisting and spreading in fruit, with cilia or also abaxial hairs (0.5–)0.7–1.5 mm, apex acuminate with prolonged tip.

14. Hairs of leaf-surfaces 30–150/mm², longest ones 1–1.5 mm or more; twigs and peduncles densely stipitate-glandular with scattered setae **14. L. viscosa**

14. Hairs of leaf-surfaces 3–20/mm², longest ones 0.3–0.7 (rarely to 1.2) mm; twigs and peduncles glabrescent to thinly setulose, sometimes with scattered stipitate glands **19. L. paraensis**

12. Capitula not elongating, remaining hemispheric; corollas usually opening yellow or orange aging orange or red-orange (sometimes opening creamy white or pure white and/or becoming infused with pink or purple in *L. planaltensis*, or rarely opening white and remaining so).

15. Leaves-blades distinctly triplinerved, usually nigrescent; adaxial leaf-surface often lustrous; abaxial surface often with strigae mixed with filiform hairs (can be covered over by the latter).

16. Leaf-blades mostly 2–5 cm long, mostly ovate-triangular or lanceolate-triangular with straight tapering sides from proximal ⅓ (sometimes contracted to abruptly acute or obtuse apex); adaxial surface usually noticeably lustrous and vitreous-pustulate, with the hair bases 0.3–0.5 mm diam., thinly scabrous, the strigae 2–10/mm², about 0.3 mm or less giving the surface a sandpapery texture; abaxial surface with soft, straight hairs restricted to crevices between the leaf-surface and the midrib (or also secondary veins) **16. L. bahamensis**

16. Leaf-blades mostly 5–10 cm long, ovate, lanceolate or ovate-elliptic with curved sides and usually acuminate apex; adaxial surface lustrous or not, usually not pustulate, with the hair bases less than 0.3 mm diam., strigose-pilose, the hairs 20–80/ mm² or more, of mixed length up to 0.7 mm; abaxial surface with even vestiture of soft, straight hairs on surfaces of midrib to higher order veins or also areole tissue **17. L. planaltensis**

15. Leaves-blades pinninerved, not distinctly nigrescent (except in some *L. urticoides*); adaxial surface dull (except somewhat lustrous in some *L. urticoides*); abaxial surface lacking strigae (except in many interspecific hybrids), exclusively of filiform, glandular, or setiform hairs.

17. Leaves 1–1.5 times longer than wide, ± rotund, deltate or broadly ovate with conspicuous spreading acute teeth, the sinuses mostly 2–5 mm deep; adaxial leaf-surface, at least on older leaves noticeably vitreous-pustulate, the bases of the strigae mostly 0.3–0.5 mm in diam; abaxial leaf-surface with long setaceous hairs restricted to the midrib and secondary veins, these gradually reduced in length from base of midrib (where 1.5–2 mm long) toward margin (on midrib and secondary veins to ca. 0.7 mm long), shortest hairs (0.2–0.5 mm long) restricted to veinlets and areoles; proximal bracts mostly 7–12 mm long, oblanceolate or spatulate, mostly 1.5–3 mm wide, widest in distal half or near middle, conspicuously persistent and reflexed in fruit **18. L. urticoides**

17. Leaves mostly 1.5–2.5 times longer than wide (if less than 1.5, then lacking character combination of lead 17'), ovate, oblong-deltate, elliptic, or lanceolate with rounded or appressed-acute teeth, the sinuses mostly 0.3–2 mm deep (to 3 mm in some *L. hirsuta* subsp. *hirsuta*); adaxial leaf-surface not vitreous-pustulate (except in some *L. camara* subsp. *aculeata*), the bases of the strigae 0.1–0.2(–0.3) mm in diam.; abaxial leaf-surface with hairs all about the same length (either long setaceous hairs only on veins or short soft hairs on veins and areoles; longer hairs scattered among shorter hairs on midrib in some *L. horrida* and some *L. hirsuta*, but not in pattern of *L. urticoides*); proximal bracts mostly 2–10 mm long, linear-lanceolate (rarely linear-spatulate), lanceolate- or elliptic-oblong, mostly 0.5–1.5 mm wide, widest in proximal third (if oblanceolate- or obovate-spatulate and widest above middle, then mostly 2–6 mm long), deciduous or persistent (then sometimes reflexed) in fruit.

18. Hairs of abaxial leaf-surface setiform, ca. 0.7–1.5 mm, straight and erect, sinuous, or antrorsely arching, restricted mostly to midrib, secondary, and tertiary veins, without sparse understory of shorter (0.1–0.5 mm), softer filiform hairs; adaxial surface setose to villous dominated by antrorse setaceous hairs 1–2 mm between the secondary veins, sometimes these also accompanied by an understory of shorter hairs; young twigs (also petioles and peduncles) with spreading hairs (1.2–)1.5–2.5 mm.

19. Young twigs and peduncles usually viscid and sparsely setose, dominated by dense, conspicuous, stipitate glands to ca. 0.5 mm; proximal bracts mostly 4–6 mm long, oblong-elliptic or -lanceolate, covered with hairs ca. 1 mm and usually marginally ciliate with hairs (1–)1.5–2 mm **5. L. insularis**

19. Young twigs and peduncles sparsely to moderately setose, stipitate glands lacking (except in interspecific hybrids); proximal bracts mostly 5–10 mm long, linear-lanceolate or linear-spatulate, covered with hairs 0.3–1 mm, marginally ciliate with hairs 0.8–1(–1.5) mm or these lacking **4. L. hirsuta**

18. Hairs of abaxial leaf-surface weak and filiform, 0.1–0.5 mm (sometimes in *L. horrida,* scattered arching hairs on midrib to 1 mm among shorter hairs), spreading to curled, usually occurring on all vein orders including veinlets and areoles, occasionally deciduous and persisting only in crevices between major veins and leaf-surface; adaxial surface antrorsely strigillose to strigose villous with a covering of hairs of mixed length, these mostly 0.1–0.9 mm; young twigs (also petioles and peduncles) with spreading to appressed hairs only 0.1–1 mm (to 1.5 mm in some *L. horrida* subsp. *tilifolia*).

20. Adaxial leaf-surface with a canopy of hairs between secondary veins only 0.2–0.5 mm (in *L. camara* subsp. *aculeata* sparsely scattered hairs to 0.7 mm may occur), usually in the form of strigae or stalked glands; peduncles typically about a third the length of to about equaling their subtending leaves (up to twice as long in *L. camara* subsp. *glandulosissima*) **1. L. camara**

20. Adaxial leaf-surface with a moderately dense canopy of hairs between secondary veins mostly 0.7–0.8(–1) mm, in the form of arching or flexible setae, often with a well developed understory of shorter (≤ 0.5 mm) strigae, filiform hairs or stalked glands; peduncles typically longer to 3 times longer than subtending leaves.

21. Plants erect or trailing, laxly or openly branched, leaf-blades ovate to broadly elliptic to lanceolate-deltate, mostly 1–2 times longer than wide; teeth usually (6–)10–35 per side **2. L. horrida**

21. Plants erect, low and stiffly, densely branched; leaf-blades narrowly triangular to narrowly elliptic, mostly 2–3 times longer than wide; teeth usually 3–6 per side **3. L. leonardiorum**

SPECIES OF PRESUMED DIVERGENT ORIGIN

A. Lantana sect. Lantana series Lantana. TYPE: *Lantana camara* L.

Adaxial leaf surfaces strigose-villosulous, the hairs less than 1.0 mm; abaxial leaf surfaces pilose, often densely so, the hairs occurring on veins and non-innervated tissue, filiform, 0.1–05 mm. **Inflorescences** arrested and remaining hemispheric, prolate-globose in fruit.

1. Lantana camara L., Sp. Pl. 627. 1753. *Camara vulgaris* Benth., Bot. Voy. Sulphur 154. 1846. TYPE (See Sanders 2006): cult., probably Hort. Uppsala, *Herb. Linnaeus 783.4* (LECTOTYPE: LINN!).

Shrubs erect or rounded, open; stems 0.5–3 m; branches ascending and several; twigs, peduncles and often petioles puberulent, pilose, setulose, stipitate-glandular, or glabrescent, the hairs 0.1–0.5(–1) mm. **Leaf-blades**

broadly ovate or oblong-deltate to elliptic-lanceolate, (1–)3–8(–16) cm long, the length (0.9–)1.5–2.5 × width, usually not nigrescent, papery, pinninerved; base subcordate, truncate, rounded or broadly cuneate, usually very briefly, narrowly cuneate onto petiole at very base; apex acute to acuminate, occasionally attenuate or rounded; marginal teeth 6–35(–50) per side, rounded to acute, spreading to appressed, sometimes with tips recurved, with sinuses 0.2–2 mm deep; adaxial surface dull, antrorsely strigillose to strigose-pilose or with stipitate glands mixed in, the hairs occurring on veins and intervening tissue, thin canopy of hairs only 0.2–0.5 mm (occasional hairs 0.7 mm in subsp. *aculeata*) with understory of shorter hairs not well developed, 10–90(–120)/sq. mm, not noticeably vitreous-pustulate (except in some subsp. *aculeata*), the circular bases of the strigae ca. 0.1–0.2(–0.3) mm in diam.; abaxial surface duller green than adaxial surface, moderately densely (occasionally sparsely) pilose, the hairs on all veins and intervening tissue, 0.2–0.5 mm, all about same length, (10–)40–250/sq. mm. **Inflorescences** remaining hemispheric; peduncles 0.3–2 × leaf length. **Proximal bracts** linear-lanceolate or ovate-elliptic to obovate, 2–8(–10) mm long, 0.5–1.5(–2) mm wide, widest near base to above middle, with 3 veins from the base, appressed or spreading, deciduous after flowering; apex attenuate to rounded; indument pilose to strigillose, sometimes stipitate-glandular, somewhat or not ciliate, the longest hairs ≤ 0.5 mm. **Corolla** yellow to or aging reddish orange (infused with pink or purple in subsp. *aculeata*), rarely white; corolla tube 4–12 mm.

Distribution and habitat.—Mexico, Central America, West Indies, and northern South America; cultivated and escaped pantropically, especially in Australia; disturbance openings in tropical evergreen and deciduous forest, open pine forest, thorn shrubland, savanna; 0–2000 m.

KEY TO SUBSPECIES OF *LANTANA CAMARA*

1 Twigs, petioles, and peduncles densely stipitate-glandular and adaxial leaf surfaces with stipitate glands mixed with eglandular trichomes **e. subsp. glandulosissima**

1 Twigs, petioles, and peduncles without or occasionally with scattered stipitate glands but not densely and predominantly so and adaxial leaf surfaces without glandular trichomes.

  2 Corollas with admixture of yellowish or orange pigments with rose or purplish pigments or opening yellowish and aging to purplish, or all corollas pink to deep reddish purple; stems often with stout, recurved prickles (subspecies of complex hybrid origin, variable for characters that differentiate among other subspecies; plants with only yellow or orange pigments that do not fit the remaining subspecies should be placed here) **f. subsp. aculeata**

  2 Corollas yellow to reddish orange (rarely white) without admixture of rose or purple pigments; stems usually lacking stout, recurved prickles but weak, ± straight ones sometimes developed.

   3 Inflorescence bracts with all series about 2–4 mm long or only the proximal series 5–6 mm long and distal series abruptly shortened to about half that length; corolla tubes mostly 4–8 mm long in well pressed or fresh flowers.

   4 Inflorescence bracts consistently ovate to obovate, broadest near or above middle; leaf-blades mostly 3–8 cm long, finely serrate-crenate with mostly 15–30 appressed teeth per side, the teeth sinuses usually 0.2–0.7 mm deep (if leaf smaller with fewer teeth, then teeth very small); twigs and peduncles without stipitate glands mixed among the eglandular hairs **a. subsp. camara**

   4 Inflorescence bracts mostly lanceolate-linear to triangular-oblong, broadest near the base; leaf-blades mostly 1–3 cm long, rather coarsely serrate-dentate (for their size) with 6–12(–15) spreading teeth per side, the teeth sinuses usually 0.7–1.5 mm deep; twigs and peduncles often with stipitate glands mixed among the eglandular hairs **b. subsp. portoricensis**

   3 Inflorescence bracts with proximal series usually 5–10 mm long and gradually shortened to distalmost series; corolla-tubes mostly 8–12 mm long in well pressed or fresh flowers.

   5 Young stems and peduncles hispid with spreading or retorse, stiff setae 0.5–1 mm long (peduncles sometimes with stipitate glands mixed in); margins of leaves with teeth mostly fewer than 20 per side, the sinuses usually nearly 1 mm or more deep; dominant hairs of adaxial leaf surface ca. 0.5 mm **c. subsp. moldenkei**

   5 Young stems and peduncles puberulent with ascending soft hairs 0.1–0.5 mm long (mostly 0.3 mm); margins of leaves with teeth mostly 20–35 per side, the sinuses about 0.5 mm deep; dominant hairs of adaxial leaf surface ca. 0.3 mm or less **d. subsp. moritziana**

1a. Lantana camara subsp. **camara.** *Camara aculeata* (L.) Kuntze var. *subinermis* Kuntze, Revis. Gen. Pl. 2:503. 1891. *Lantana aculeata* L. var. *subinermis* (Kuntze) Voss, Vilm. Blumengärtn. ed.3, 1:823. 1894.

Lantana urticifolia Mill., Gard. Dict. ed. 8, Lantana 5. 1768. *Lantana camara* L. f. *urticifolia* (Mill.) I.E. Méndez, Willdenowia 32:295. 2002 (misapplied to *L. camara* subsp. *aculeata*). TYPE: MEXICO. VERACRUZ: Veracruz, 1731, *Houstoun s.n., Herb. Sloan 6:84* (LECTOTYPE: BM-SL[di!]).

Lantana crocea Jacq., Pl. Hort. Schoenbr. 4:t.473. 1804. *Camara aculeata* (L.) Kuntze [var. *subinermis* Kuntze] f. *crocea* (Jacq.) Kuntze, Revis. Gen. Pl. 2:503. 1891. *Lantana aculeata* L. f. *crocea* (Jacq.) Voss, Vilm. Blumengärtn. ed.3, 1:823. 1894. *Lantana camara* L. var. *crocea* (Jacq.) L.H. Bailey, Cycl. Amer. Hort. [L.H.Bailey] 884. 1900. Lectotype: icon in Jacq., Pl. Hort. Schoenbr. 4:t.473. 1804.

Lantana formosa K. Koch & Fintelmann, Wochenschr. Gärtnerei Pflanzenk. 1:322. 1858. nom. illeg. Type: Unknown.

Camara aculeata (L.) Kuntze f. *obtusifolia* Kuntze, Revis. Gen. Pl. 3:250. 1893. Type: ARGENTINA: Buenos Aires, *Hauthal 627* (lectotype: not designated, no material located at NY]).

Stems usually without prickles or with few weak, straight ones; twigs, peduncles and often petioles moderately to densely covered with antrorse to ascending, curled or straight filiform hairs, the hairs 0.1–0.5 mm. **Leaf-blades** ovate or ovate-triangular to lanceolate-triangular or elliptic-lanceolate, widest near base, near proximal third, or just below middle, (1–)3–8(–10) cm long, the length (1.2–)1.5–2.5 × width; marginal teeth (9–)15–35 per side (if leaf smaller with fewer teeth, then teeth very small), rounded or obtuse, usually appressed or only with tips spreading, with sinuses 0.2–0.7(–1.2) mm deep; adaxial surface antrorsely strigillose to strigose-pilose, the hairs 0.1–0.5 mm. **Peduncles** 0.5–1.2 × leaf length. **Bract series** all similar or proximal series almost twice the length of distal series; proximal bracts obovate to oblanceolate, ovate-ellliptic, or oblong, 2–4 or 5–6 mm long, 0.8–1.5(–2) mm wide, widest near or above middle; apex often obtuse to rounded, sometimes acute (rarely acuminate). **Corolla** yellow to or aging reddish orange; corolla tube 5–8 mm; corolla limb 4–7 mm in diam.

Distribution and habitat.—West Indies (Cuba, Jamaica, Hispaniola, Caymen Is., Bahama Is.), Gulf and Caribbean coast and foot hills of Mexico from Veracruz south to Nicaragua; thorn and sclerophyll shrubland/woodland, thickets, and pine woodland on thin calcareous soils; 0–400 m.

See comments under *Lantana camara* subsp. *glandulosissima* and in Sanders (2006).

Selected specimens examined: **BAHAMA ARCHIPELAGO. Acklins Island:** *Brace 4418* (NY). **CAYMAN ISLANDS. Grand Cayman:** *Correll & Correll 50996* (FTG, NY). **CUBA. Guantánamo:** *Britton & Cowell 12782* (NY). **Isla de la Juventud (Isle of Pines):** *Britton & Wilson 14818* (NY). **Pinar del Río:** *León et al. 19689*, possibly hybridized (NY). **DOMINICAN REPUBLIC. Azua:** *Mejía 145* (NY). **GUATEMALA. Sacatepéquez:** *Breedlove 11408*, possibly with genes of *L. scabrida* (LL[di]). **HAITI. Ouest:** *Leonard 418* (NY). **JAMAICA. St. Andrew:** *Clute 12* (NY); *Harris 10103* (NY); *Katsuro 167A* (TEX[di]); *Maxon & Killip 405* (NY); *Smith Jam. 4* (LL[di], NY); *Yuncker 17043* (NY). **St. Catherine:** *Yuncker 17352* (NY). **St. Thomas:** *Proctor 18266* (NY). **MEXICO. Veracruz:** *Martinez 168*, some images appear to have extra long hairs but these may be overlapping hairs (F, LL[di], MO[di]). **NICARAGUA. Masaya:** *Araquistain 213* (LL[di]).

Presumed hybrids with: **2a. L. horrida subsp. horrida. CUBA. Havana:** *León 2431* (NY). **2bi. L. horrida subsp. zanonii var. sargentii. CUBA. Guantánamo:** *Hioram 4845* (NY). **JAMAICA. St. Catherine:** *Smith Jam. 38* (LL[di]). **6. L. scabrida. CUBA. Matanzas:** *Beagel 158* (NY). **Pinar del Río:** *Shafer & Leon 13640* (NY); *Alain 2850* (NY); *Britton & Earle 6563* (NY). **Santiago de Cuba:** *Britton 2306* (NY). **Villa Clara:** *Britton et al. 5901* (NY). **DOMINICAN REPUBLIC. Peravia:** *Zanoni et al. 18065*, or alternatively × *L. strigocamara* (NY). **JAMAICA.** (locality not recorded.) *Harris & Britton s.n.* (K). **St. Andrew:** *Baars Lc1* (BRIT). **St. Ann:** *Kessler 3553* (VDB). **St. Elizabeth:** *Perraton 23* (NY). **Trelawny:** *Guilding s.n. 1822* (K). **MEXICO. Campeche:** *Krauss 250* (LL[di]). **Chiapas:** *Croat 40345* (LL[di]). **Veracruz:** *Gomez-Pompa 4019* (GH[di]). **NICARAGUA. León:** *Moreno 2304* (LL[di]). **7. L. splendens. BAHAMA ARCHIPELAGO. San Salvador:** *Correll 43825*, alternatively × *L. bahamensis* (FTG, NY). **9i-cv×20. L. Callowiana Hybrid Group cultivars (L. depressa–tetraploid × strigocamara). BAHAMA ARCHIPELAGO. Eleuthera:** *Correll & Hill 45204* (FTG, LL[di]). **10. L. kingii. MEXICO. Veracruz:** *Greenman 58*, alternatively × *L. strigocamara* (F, GH); *Greenman 88* (F, GH[di]); *Moreno et al. 1516*, alternatively × L. Callowiana Hybrid Group cultivar (TEX[di]); *Smith Mex.47*, alternatively × *L. scabrida* or both *L. kingii* and *L. scabrida* (LL[di]). **16. L. bahamensis. BAHAMA ARCHIPELAGO. Eleuthera:** *Correll & Hill 45100* (FTG, NY); *Correll 45202* (FTG, NY). **East Caicos:** *Millspaugh & Millspaugh 9063* (NY). **North Caicos:** *Correll 43303* (FTG, NY). **20. L. strigocamara. BAHAMA ARCHIPELAGO. Great Abaco:** *Correll & Meyer 44538* (FTG, NY). **JAMAICA. St. Ann:** *s. coll. 532*, alternatively × *L. scabrida* (K). **NICARAGUA. Masaya:** *Araguistain 410*, alternatively × L. Callowiana Hybrid Group cv. (LL[di]). See also taxon **4a** and section on hybrid synonymy: **1a×6, 1a×16**, and **10×1a/1e?**

1b. Lantana camara subsp. **portoricensis** (Moldenke) R.W. Sanders, comb. & stat. nov. Basionym: *Lantana arida* Britton var. *portoricensis* Moldenke, Phytologia 50:214. 1982. *Lantana urticifolia* subsp. *portoricensis* (Moldenke) R.W. Sanders, Amer. J. Bot. 74:915. 1987. *Lantana camara* L. f. *portoricensis* (Moldenke) I.E. Méndez, Willdenowia 32:294. 2002 (as "portorricensis"). Type: PUERTO RICO: Cayey, 3 Oct 1885, *Sintenis 2379* (holotype: US!; isotypes: NY!, P[2,di!]).

Stems usually without prickles or with few weak, straight ones; twigs, peduncles and often petioles moderately to densely covered with antrorse to spreading, curled or straight hairs often with stipitate glands mixed in, the hairs 0.1–1 mm. **Leaf-blades** lanceolate-triangular to elliptic-lanceolate, or sometimes ovate triangular to broadly elliptic, widest near base, near proximal third, or just below middle, 1–3(–4.5) cm long, the length (1.2–)1.7–2.5 × width; marginal teeth 6–12(–15) (coarse for the size of the blade) per side, usually acute or obtuse, sometimes rounded, usually spreading, with sinuses (0.5–)0.7–1.5 mm deep; adaxial surface antrorsely strigillose to strigose-pilose, the hairs 0.1–0.5 mm. **Peduncles** 1.2–2 × leaf length. **Bract series** all similar or proximal series almost twice the lenth of distal series; proximal bracts linear-lanceolate to triangular-oblong or oblanceolate-oblong, 2–4 or 5–6 mm long, 0.5–0.8(–1.3) mm wide, widest near the base or sometimes above middle; apex acute. **Corolla** yellow to or aging reddish orange; corolla tube 4–7 mm; corolla limb 4–7 mm in diam.

Distribution and habitat.—Puerto Rico (including Mona Island) and Virgin Islands; thorn and sclerophyll shrubland/woodland, thickets, and disturbance openings on thin calcareous soils, especially in karst topography; 0–600 m.

Selected specimens examined: **PUERTO RICO. Aibonito:** *Britton et al. 5874* (NY). **Coamo:** *Axelrod & Axelrod 3177* (UPRRP). **Mayaguez:** *Stimson 3085* (LL, NY). **Mona Island:** *Woodbury s.n. Apr 1977* (UPRRP). **Ponce:** *Axelrod & Axelrod 6579* (NY, UPRRP). **Sabana Grande.** *Spetzman & Diaz 168* (FTG).

Presumed hybrids with: **9i-cv×20. L. Callowiana Hybrid Group cultivars (L. depressa–tetraploid × strigocamara). PUERTO RICO. Dorado:** *Ackerman et al.1638* (NY). **20. L. strigocamara. PUERTO RICO. Salinas:** *Ross & Johnson SAN173* (BRIT).

1c. Lantana camara subsp. **moldenkei** (R.W. Sanders) R.W. Sanders, comb. nov. Basionym: *Lantana urticifolia* Mill. subsp. *moldenkei* R.W. Sanders, Moscosoa 5:202. 1989. Type: DOMINICAN REPUBLIC. Barahona: Paraíso, 23 Feb 1983, *Sanders et al. 1621* (holotype: JBSD!; isotypes: F!, FTG!, GH!, NY!, TEX!).

Stems usually without prickles or with few weak, straight or recurved ones; twigs, peduncles and often petioles moderately covered with spreading, antrorse, or retrorse, stiff or flexed setae or strigae, the hairs 0.5–1 mm, mostly ca. 0.8 mm. **Leaf-blades** broadly ovate or oblong-ovate to lanceolete, oblong-lanceolate or elliptic-lanceolate, sometimes distinctly constricted just distal to middle, widest mostly near proximal third, sometimes near base or near middle, (1–)3–8(–10) cm long, the length (0.9–)1.5–2.3 × width; marginal teeth 13–20(–25) per side, acute to obtuse, spreading or appressed, often with tips recurved, with sinuses 0.6–1.2(–2) mm deep; adaxial surface antrorsely strigillose to strigose-pilose, the hairs 0.1–0.5 (sometimes to 0.6) mm. **Peduncles** 0.3–0.9 × leaf length. **Bract series** gradually reduced in size; proximal bracts lanceolate, elliptic-lanceolate, triangular-lanceolate, oblong-lanceolate, or oblong, (3.5–)5–8 mm long, 1–1.5(–2) mm wide, widest near the base or proximal third, sometimes the outermost series slightly broader above middle (if 4 mm or less long, then widest near the base); apex acute or attenuate. **Corolla** yellow or yellow-orange aging reddish orange; corolla tube 7–12 mm; corolla limb 6–9 mm in diam.

Distribution and habitat.—Hispaniola and eastern Cuba; disturbance openings in tropical evergreen and deciduous forest, open pine forest, thorn shrubland, savanna; 0–1800 m.

Lantana camara subsp. *moldenkei* is enigmatic. The hispid twigs and sometimes longer hairs on the adaxial leaf surface suggest this subspecies may be a taxon that originated from hybrids between *L. camara* subsp. *camara* and *L. horrida*. Geographically the *L. horrida* parent should be subsp. *zanonii*, but *L. camara* subsp. *moldenkei* lacks stipitate glands. Sanders (1987b) demonstrated that subsp. *moldenkei* is widespread in Hispaniola and is uniformally tetraploid with normal segregation at meiosis, which is consistent with parentage from two closely related, probably diploid species. This might also explain the possible sympatry with *L. camara* subsp. *camara*. See further discussion and illustration in Sanders (1989).

Selected specimens examined: **CUBA. Holguin:** *Shafer 1199* (NY). **DOMINICAN REPUBLIC. Distrito Nacional:** *Dod & Zanoni 10047* (NY); *Zanoni 11614* (NY). **La Vega:** *Melo 100* (NY). **Peravia:** *Zanoni & Pimentel 25883* (NY). **Santiago:** *Zanoni 25967* (NY).

Presumed hybrids with: **2bi. L. horrida subsp. zanonii var. sargentii. DOMINICAN REPUBLIC. La Vega:** *Jiménez 8781* (LL[di]); *Mejía & Zanoni 5029* (NY). **Pedernales:** *Liogier & Liogier 23331* (NY). **2bii. L. horrida subsp. zanonii var. subcordata. DOMINICAN REPUBLIC. Santiago:** *Valeur 1002* (LL, NY). **3. L. leonardiorum. DOMINICAN REPUBLIC. Valverde:** *Liogier 11595* (NY). **12b. L. nivea subsp. mutabilis. CUBA. Holguin:** *Shafer 1548* (NY). **12b. L. strigocamara. DOMINICAN REPUBLIC. Barahona:** *Sanders 1623* (FTG, JBSD). **La Vega:** *Mejía et al. 10432* (NY).

1d. Lantana camara subsp. **moritziana** (Otto & A. Dietr.) R.W. Sanders, stat. nov. Basionym: *Lantana moritziana* Otto & A. Dietr., Allg. Gartenzeitung 9:369. 1841. *Lantana camara* L. var. *mortiziana* (Otto & A. Dietr.) López-Pal., Revista Fac. Farm. Univ. Andes 14:21. 1974. Type: VENEZUELA: Caracas, *Moritz 163* (lectotype: G[di!]; isotype: G[di!]).

Lantana armata Schauer f. *ternifolia* Moldenke, Phytologia 47:223. 1980. Type: VENEZUELA. Amazonas: confluence of Río Orinoco with Río Ventuaru, 4 May 1971, *Foldats 227-A* (holotype: NY!).

Stems usually without prickles or with few weak, straight ones; twigs, peduncles and often petioles moderately to densely covered with usually ascending, soft to somewhat stiff, curled or straight hairs, the hairs 0.1–0.5(–0.7) mm, mostly ca. 0.3 mm. **Leaf-blades** broadly ovate to oblong-deltate to elliptic lanceolate, widest usually in or near proximal third, sometimes near middle, (1.5–)3–7(–9) cm long, the length (1.1–)1.3–2 × width; marginal teeth 20–35(–50) per side, rounded, obtuse, or acute, often appressed, with sinuses 0.3–0.8(–1) mm deep; adaxial surface antrorsely strigillose to strigose-pilose, the hairs mostly about 0.3 mm or less. **Peduncles** 0.5–1.2 × leaf length. **Bract series** gradually reduced in size; proximal bracts linear-oblong, oblanceolate-oblong, linear-lanceolate, or linear-triangular, 4–8 mm long, 0.5–1.5 mm wide, widest near the base or the outermost series sometimes widest above middle (if 4 mm or less long, then widest near the base); apex acute to attenuate. **Corolla** yellow to or aging reddish orange; corolla tube 7–12 mm; corolla limb 6–9 mm in diam.

Distribution and habitat.—Southern Central America (Costa Rica, Panama), northern South America (Ecuador, Colombia, Venezuela, and the Guianas), and Lesser Antilles; disturbance openings in tropical evergreen and deciduous forest, shrubland, and savannas; 0–1800 m.

See comment under *Lantana camara* subsp. *glandulosissima*.

Selected specimens examined: **COLOMBIA. Antioquia:** *Barkley et al. 590* (NY). **Norte de Santander:** *López-Palacios 3594* (NY). **Valle del Cauca:** *Cuatrecasas 14456* (F). **ECUADOR. Tungurahua:** *Asplund 19924* (NY). **GUYANA. Pomeroon-Supenaam:** *De La Cruz 1054* (NY). **PANAMA. Panamá:** *Dwyer et al. 5095* (MO); *Garibaldi 111* (MO); *Jaén 36* (F); *Macbride 2601* (F). **VENEZUELA. Bolívar:** *Croizat 32* (F). **Lara:** *González & Campos L97* (LL). **Mérida:** *López-Palacios 2584* (LL). **Miranda:** *Ramírez 1090* (NY). **Trujillo:** *López-Palacios 2769* (LL).

Presumed hybrids with: **2a. L. horrida subsp. horrida. PANAMA. Colón:** *Witherspoon & Witherspoon 8352*, also × *L. scabrida*? (MO). **Los Santos:** *Croat 9731*, also × *L. strigocamara*? (MO). **Kuna Yala (San Blas):** *Kirkbride 183*, also × *L. scabrida*? (MO). **Veraguas:** *Rodrigues 75*, also × *L. scabrida*? (MO). **2c. L. horrida subsp. tiliifolia. COLOMBIA. Antioquia:** *Barkley et al. 17C410* (NY). **Huila:** *Bermúdez s.n. 21–26 Feb 1947* (F). **VENEZUELA. Mérida:** *Ruiz-Terán & López-Figueiras 106* (NY). **4a. L. hirsuta subsp. hirsuta. COSTA RICA. Guanacaste:** *Moldenke 1216* (LL). **4b. L. hirsuta subsp. amazonica. VENEZUELA. Nueva Esparta:** *Miller & Johnston 95* (F). **6. L. scabrida. COSTA RICA. Punarenas:** *Grant 91-01567* (US); *Burger et al. 4797* (NY). **GUYANA. Cuyuni-Mazaruni**: *De La Cruz 4223* (F). **Essequibo Islands-West Demerara:** *Dorsett et al. 34* (MO). **Mahaica-Berbice?:** *Persaud 169* (F). **Pomeroon-Supenaam:** *De La Cruz 2523* (MO). **PANAMA. Colón:** *Antonio 4786* (LL); *Lewis et al. 5371* (LL, MO); *Miller & Miller 908* (LL). **Veraguas:** *Knapp et al. 3355* (LL). **VENEZUELA. Zulia:** *Bunting et al. 7317*, alternatively × *L. nivea* subsp. *mutabilis* (LL[di]). **8. L. hodgei. LESSER ANTILLES. Saint Lucia:** *Beard 1015* (SMU). **9i-cv×20. L. Callowiana Hybrid Group cultivars (L. depressa–tetraploid × strigocamara). ECUADOR. Chimborazo:** cult., *Dodson & Dodson 11749* (LL). **13. L. cujabensis. ECUADOR. Guayas:** *Asplund 15327* (NY); *Asplund 16002*, alternatively × *L. nivea* subsp. *mutabilis* (NY); *Pearsall 66* (MO). **Los Ríos:** *Holm-Nielsen et al. 2745* (F). **19. L. paraensis. GUYANA. Cuyuni-Mazaruni:** *De La Cruz 2295* (NY). **20. L stigocamara. VENEZUELA. Sucre:** *Sandoval 8*, alternatively × *L. scabrida* (SMU). See also section on hybrid synonymy: **1d×2c, 1d×6,** and **1d×12b.**

1e. Lantana camara subsp. **glandulosissima** (Hayek) R.W. Sanders, comb. & stat. nov. Basionym: *Lantana glandulosissima* Hayek, Repert. Spec. Nov. Regni Veg. 2:161. 1906. Type: MEXICO. Jalisco: Tequila, 2 Jul 1893, *Pringle 4431* (holotype: W!; isotypes: BR, F!, MO!, NY!, P[2,di!]).

Lantana moritziana Otto & A. Dietr. f. *parvifolia* Moldenke, Phytologia 25:117. 1973. *Lantana camara* L. [var. *moritziana* (Otto & A. Dietr.) López-Pal.] f. *parvifolia* (Moldenke) López-Pal., Revista Fac. Farm. Univ. Andes 14:21. 1974. nom. illeg. [non Moldenke 1948] Type: VENEZUELA. Mérida: Tovar, 16 May 1971, *López-Palacios 2585* (holotype: LL!; isotype: MERF).

Lantana glandulosissima Hayek f. *albiflora* Moldenke, Phytologia 26:177. 1973. Type: GUATEMALA. Petén: Río Machaquila, 13 Mar 1970, *Contreras 9718* (holotype: LL!; isotype: LL!).

Lantana glandulosissima Hayek f. *flava* Moldenke, Phytologia 47:223. 1980. Type: MEXICO. Jalisco: Volcán Tequila, 25 Oct 1970, *Webster & Breckon 15971* (holotype: MEXU[di!]).

Stems usually without prickles or with few weak, straight to recurved ones; twigs, peduncles and often petioles densely covered with stipitate glands or also with eglandular filiform hairs mixed in, the hairs (and glands) 0.1–0.5 mm, mostly 0.2–0.3 mm. **Leaf-blades** broadly ovate or broadly elliptic to oblong-lanceoate or elliptic-lanceolate, widest usually near proximal third or middle, (1–)4–10(–16) cm long, the length (1.2–)1.5–2.1 × width; marginal teeth 10–30(–45) per side, usually rounded or obtuse, usually spreading, with sinuses (0.4–)0.7–1.5(–2) mm deep; adaxial surface mixed antrorsely strigillose to strigose-pilose and stipitate-glandular, the hairs 0.1–0.5 mm. **Peduncles** 0.5–1.8 × leaf length (often almost doubling in length in fruit). **Bract series** gradually reduced in size; proximal bracts oblanceolate-oblong (rarely obovate) to triangular-oblong or linear-lanceolate, (2.5–)4–8 mm long, 0.8–1.7(–2) mm wide, widest above or near the middle or near the base; apex acute to attenuate, often rounded at very tip. **Corolla** yellow to or aging reddish orange, rarely white; corolla tube (5–)7–12 mm; corolla limb 6–9 mm in diam.

Distribution and habitat.—Mexico (northwestern, central, and southern) and Central America to northern Colombia and Venezuela; open pine-oak forest, thorn and tropical deciduous shrubland and woodland, and savanna, especially in disturbance openings; 0–2000 m.

Lantana camara subsp. *glandulosissima* differs from subsp. *camara* only in the strong development of stipitate glands in place of filiform hairs on twigs, peduncles, petioles, and leaf surfaces and in the longer bracts and corollas. Because the development of glandular hairs is variable within several other taxa in sect. *Lantana*, this trait is viewed as insufficient grounds for recognition at the species level. The two subspecies appear to be parapatric or narrowly sympatric in the vicinity of Veracruz (as evidenced by the intermediate or hybrid specimen, *Gilly et al. 75*, MSC), perhaps due to human activity. Although no specimens of subsp. *glandulosissima* from Veracruz came to my attention, interspecific hybrids (see section below) further evidence its presence there. Furthermore, at least in Bocas del Toro Prov., Panama, subsp. *glandulosissima* intergrades with subsp. *moritziana* (*Peterson & Annable 868*, MO).

Lantana camara subsp. *glandulosissima* is broadly sympatric with *L. horrida*. The two "pass the test of sympatry" (Stebbins 1966, p. 95–96) despite occasional hybrids that are probably limited to disturbed areas. I take this as evidence that *L. camara* and *L. horrida* are distinct. On the other hand, if one considered the differences in length of the adaxial leaf-surface trichomes an inadequate species criterion and submerged *L. horrida* within *L. camara*, then subsp. *glandulosissima* would need to be segregated as a distinct species.

Selected specimens examined: **COSTA RICA. Puntarenas:** *Beetle 26235* (US). **EL SALVADOR. San Vicente:** *Standley 21405* (US). **GUATEMALA. Alta Vera Paz:** *Cook & Griggs 653* (US). **Huehuetenango:** *Skutch 1595* (US). **MEXICO. Chiapas:** *Breedlove 10653* (US); *Reyes et al. 1830* (TEX). **Durango:** *Rose 3489* (US); *Tenorio et al. 6312* (TEX). **Guerrero:** *Rose et al. 9277* (SMU). **Jalisco:** *Iltis et al. 821* (US); *Jones 27364* (US). **Michoacán:** *Nelson 6946* (US). **Puebla:** *Day 12* (BRIT). **Sonora:** *Gentry 2234* (US). **NICARAGUA. Managua:** *Chaves 87* (US). **Masaya:** *Robbins 5547* (SMU[di]). **PANAMA. Veraguas:** *Croat 37033* (MO). **VENEZUELA. Aragua:** *Pittier 14001* (F); *Steyermark et al. 127693* (MO). **Bolívar:** *Wurdock & Monachino 39982* (F). **Distrito Capital:** *Elias 493* (F). **Zulia:** *Bunting 10721* (LL[di]).

Presumed hybrids with: **2a. L. horrida subsp. horrida. BELIZE. Corozal:** *Crane 544* (BRIT). **GUATEMALA. Huehuetenango:** *Williams et al. 22274* (US). **Sololá:** *Day 14* (BRIT). **MEXICO. Chiapas:** *Breedlove 26489*, also × *L. kingii* (LL[di]); *Ton 1596* (US). **Chihuahua:** *Caddell s.n.* (BRIT); *Goldman 199* (US). **Guerrero:** *Rose et al. 9429* (US); *Schwabe et al. s.n. 22 Oct 1978*, specimen Moldenke had intended to be holotype of *L. glandulosissima* f. *aculeatissima*, see section on hybrid synonymy 1e×2a (MEXU[di]). **Jalisco:** (LL[di]); *Day 7* (BRIT); *McVaugh 17246* (US); *Pérez 728*, also × *L. kingii* (LL[di]); *Pringle 4481* (NY); *Pringle 9354* (US); *Santana & Cevallos 4574*, alternatively × *L.* Callowiana Hybrid Group cv. (BRIT). **México:** *Hinton 6829* (US). **Michoacán:** *Arsène 6941* (US). **Morelos:** *Langman 3672* (US). **Oaxaca:** *King 1224*, also × *L. kingii*? (NY); *Kral 25277* (VDB); *Nelson 2072* (US). **Veracruz:** *Hernández 566* (MO[di]). **Zacatecas:** *Mahler 5803* (SMU). **NICARAGUA. Managua:** *Croat 43718* (US). **PANAMA. Chiriquí:** *Croat 33086* (MO). **Coclé:** *Burch et al. 1141* (MO); *Folsom 2901* (MO). **Colón:** *Knapp & Sytsma 2452*, also × *L. scabrida*? (MO); *Sullivan 598*, also × *L. scabrida*? (MO). **Kuna Yala (San Blas):** *Stier 1* (MO). **Panamá:** *Knapp 1229*, also × *L. scabrida*? (MO). **Veraguas:** *Rodriguez 67* (MO). **2c. L. horrida subsp. tiliifolia. VENEZUELA. Bolivar:** *Elcoro 790* (MO). **Trujillo:** *Bunting 9928* (LL[di]). **4a. L. hirsuta subsp. hirsuta. BELIZE. Belize:** *Arvigo et al. 340* (US). **Corozal:** *Crane 239* (BRIT). **COLOMBIA. Chocó:** *Forero 461* (MO). **GUATEMALA. Petén:** *Contreras 1781* (SMU); *Contreras 5471* (NY). **MEXICO. Guerrero:** *McCorcle & Rowell 3493* (SMU); *Rowell 2914* (SMU). **Morelos:** *Duncan 12* (BRIT[di]); *Harris 49* (SMU[di]). **Nayarit:** *Flores-Franco 3311* (TENN). **Yucatán:** *Stewart 523* (LL[di]). **PANAMA. Bocas del Toro:** *Wedel 187*, also × *L. scabrida*? (MO). **Chiriquí:** *Stern et al. 1159*, also × *L. scabrida*? (MO). **Colón:** *Hunter & Allen 746* (MO); *Piper 5975* (US); *Stern et al. 71* (MO). **Darién:** *Duke 4889* (LL[di]); *Stern et al. 624* (MO). **Kuna Yala (San Blas):** *Herrera 602*, also × *L. scabrida*? (MO). **Panamá:** *Miller 1048* (MO). **6. L. scabrida. COSTA RICA. Guanacaste:** *Liesner 2308* (F). **GUATEMALA. Chimaltenango:** *Day 2* (BRIT). **HONDURAS. Francisco Morazán:** *Moldenke & Moldenke 19810* (SMU[di]). **MEXICO. Veracruz:** *Baars Lc6* (BRIT). **NICARAGUA. Chinandega:** *Moreno 1528* (LL). **Granada:** *Moreno 2705* (LL[di]). **Madriz:** *Moreno 2808* (LL). **Managua:** *Sandino 273* (LL[di]). **PANAMA. Colón:** *Nowicke et al. 3590* (LL[di]). **Kuna Yala (San Blas):** *Stier 72* (MO). **VENEZUELA. Falcón:** *Bunting 9340* (LL[di]). **9i-cv×20. L. Callowiana Hybrid Group cultivars (L. depressa–tetraploid × strigocamara). MEXICO. Guerrero:** cult., *Krauss 947* (LL[di]). **Quitana Roo:** *Cabrera 4273*, alternatively × *L. depressa* var. *depressa*, escapted cv. (TEX[di]). **Veracruz:** *Day 26* (BRIT). **12b. L. nivea subsp. mutabilis. GUATEMALA. Petén:** *Contreras 9287*, alternatively × *L. camara* subsp. *aculeata* (US). **10. L. kingii. GUATEMALA. Sololá:** *Day 4* (BRIT). **MEXICO. Chihuahua:** *Bye 3416* (TEX[di]). **Durango:** *Ortega 4315* (US). **Jalisco:** *Lott 3943* (TEX[di]). **Morelos:** *Piper 53* (SMU[di]). **Nayarit:** *Maltby 81* (NY). **Oaxaca:** *Torres 8404* (TEX[di]). **Puebla:** *Dwyer 14309* (LL[di]). **Sonora:** *Felger 96-75* (BRIT). **Veracruz:** *Ahshpanek 668*, alternatively × *L.* Callowiana Hybrid Group cv. (TEX[di]). **20. L. strigocamara. MEXICO. Morelos:** *Thomas 60* (BRIT[di]). See also taxa **2a** and **4b** and section on hybrid synonymy: **1e×2a, 1e×2a×10, 1e×4a, 1e×10, 1e×10/20, 4a×10**, and **10×1a/1e?**

1f. Lantana camara subsp. **aculeata** (L.) R.W. Sanders, Sida 22:394. 2006. Basionym: *Lantana aculeata* L., Sp. Pl. 627. 1753. *Camara aculeata* (L.) Kuntze, Revis. Gen. Pl. 2:503. 1891. *Camara aculeata* (L.) Kuntze var. *normalis* Kuntze, Revis. Gen. Pl. 2:503. 1891. *Lantana aculeata* L. var. *normalis* (Kuntze) Voss, Vilm. Blumengärtn. ed.3, 1:823. 1894. *Lantana camara* L. var. *aculeata* (L.) Moldenke, Torreya 34:9. 1934. Lectotype: icon in Plukenet, Phytographia t. 233, f.5. 1692.

Lantana sanguinea Medik., Hist. & Commentat. Acad. Elect. Sci. Theod.-Palat. 3. Phys. 229. 1775. *Camara aculeata* (L.) Kuntze [var. *subinermis* Kuntze] f. *sanguinea* (Medik.) Kuntze, Revis. Gen. Pl. 2:503. 1891. nom. illeg. (see synonyms below). *Lantana aculeata* L. f. *sanguinea* (Medik.) Voss, Vilm. Blumengärtn. ed.3, 1:823. 1894. *Lantana camara* L. var. *sanguinea* (Medik.) L.H. Bailey, Cycl. Amer. Hort. [L.H. Bailey] 884. 1900. *Lantana camara* L. f. *sanguinea* (Medik.) Moldenke, Phytologia 45:296. 1980. Type: Unknown.

Lantana mutabilis Salisb., Prodr. Stirp. Chap. Allerton. 107. 1796. nom. illeg. Type: None selected.

Lantana suaveolens Desf., Tabl. École Bot., ed. 3 (Cat. Pl. Horti Paris) 393. 1829. nom illeg. Type: Not determined.

Lantana coccinea C.E. Weigel, Physiogr. Salsk. Handl. 1:46. 1776. Type: Unknown.

Lantana coccinea Lodd. ex G. Don, Hort. Brit. [Loudon] 245. 1830. nom. nud. Type: Unknown.

Lantana variagata Otto & A. Dietr., Allg. Gartenzeitung 10:314. 1842. Type: Unknown.

Camara aculeata (L.) Kuntze [var. *subinermis* Kuntze] f. *varia* Kuntze, Revis. Gen. Pl. 2:503. 1891. *Lantana aculeata* L. f. *varia* (Kuntze) Voss, Vilm. Blumengärtn. ed.3, 1:823. 1894. *Lantana camara* L. f. *varia* (Kuntze) Moldenke, Phytologia 45:296. 1980. Type: JAVA: cult., Hort. Buitenzorg, (lectotype: not designated, no material located at NY).

Camara aculeata (L.) Kuntze [var. *normalis* Kuntze] f. *nivea* Kuntze, Revis. Gen. Pl. 2:503. 1891. nom. illeg. (see taxon 12a) Type: Unknown.

Camara aculeata (L.) Kuntze [var. *normalis* Kuntze] f. *mista* Kuntze, Revis. Gen. Pl. 2:503. 1891. nom. illeg. (see hybrid synonymy 1f×4) Type: Unknown.

Camara aculeata (L.) Kuntze [var. *normalis* Kuntze] f. *sanguinea* Kuntze, Revis. Gen. Pl. 2:503. 1891. nom. illeg. (see synonym *L. sanguinea* above). Type: JAVA: cult., Hort. Buitenzorg (lectotype: not designated, no material located at NY).

Stems usually with stout, recurved prickles, often abundant; twigs, peduncles and often petioles moderately covered with antrorse to ascending or retrorse, curled or straight hairs or also stipitate glands, the hairs 0.1–0.7 mm. **Leaf-blades** broadly ovate or oblong-deltate to elliptic lanceolate, widest usually in or near proximal third, sometimes near middle, 3–9 cm long, the length (1.1–)1.3–2 × width; marginal teeth 10–30(–45) per side, usually acute or obtuse, sometimes rounded, usually spreading, with sinuses 0.5–2 mm deep; adaxial surface antrorsely strigillose to strigose-pilose, the hairs 0.1 –0.5 mm (occasional ones to 0.7 mm). **Peduncles** 0.5–1.2 × leaf length. **Bract series** gradually reduced in size; proximal bracts linear-oblong, oblanceolate-oblong, linear-lanceolate, or linar-triangular, 4–8(–10) mm long, 0.5–1.5 mm wide, widest near the base or proximal third, sometimes the outermost one or two slightly broader above middle; apex usually attenuate. **Corolla** yellow to or aging red-orange and usually infused with purple or opening pink aging to deep reddish purple; corolla tube (5–)7–12 mm; corolla limb 6–10 mm in diam.

Distribution and habitat.—Historically cultivated worldwide and escaped pantropically, especially common in Africa and Australia; disturbance openings in tropical evegreen, deciduous, and thorn forest and savanna; 0–2000 m.

Selected specimens examined: **AUSTRALIA. Queensland:** *Day 8* (BRIT). **KENYA. Taita Taveta:** *Wakanene et al. 383* (MO). **ZAIRE. Haut-Katanga:** *Fabri 60415* (MO).

Presumed hybrids with: **9i-cv×20. L. Callowiana Hybrid Group cultivars (L. depressa–tetraploid × strigocamara). AUSTRALIA. Queensland:** *Day 64* (BRIT); *Riding 76* (BRIT); *Robazza & McAndrew 17* (BRIT). **12b. L. nivea subsp. mutabilis. AUSTRALIA. New South Wales:** *Day 38* (BRIT); *Day 42* (BRIT); *Day 71* (BRIT). **Queensland:** *Hannan-Jones 29* (BRIT); *McAndrew 48* (BRIT); *McAndrew 81* (BRIT); *McAndrew 84* (BRIT). **CHINA. Guangdong:** *Deng Lang 10459* (BRIT[di]). **RHODESIA. Guruve:** *Nyariri 167* (MO). **TANZANIA. Kilimanjaro:** *Mlangwa et al. 459* (BRIT). **Tanga:** *Mwangoka & Kayombo 113* (MO). **U.S.A. Hawai'i. Oahu:** *Degener 11467*, identification uncertain (SMU). **North Carolina. Forsyth Co.:** cult,. *Schallert 1352* (SMU). **20. L strigocamara. AUSTRALIA. Queensland:** *Day 69* (BRIT). **TANZANIA. Arusha:** *Kayombo 1495*, identification uncertain (BRIT). **Pwani:** *Kibure 26* (BRIT). **U.S.A. Hawai'i. Kauai:** *Krauss 1013* (SMU). See also taxon **1e** and section on hybrid synonymy: **1f×2, 1f×4,** and **1f×C.**

2. Lantana horrida Kunth, Nov. Gen. Sp. [H.B.K.] 2:261. 1817. Type: MEXICO. Distrito Federal: Chapultepeque, *Humboldt & Bonpland 4149* (lectotype: P-HBK, barcode P00307142[di!]).

Lantana antillana Raf., Sylva Tellur. 82. 1838. Type: Unknown.

Shrubs erect, rounded, lax, or trailing, dense to open; stems 0.5–3 m; branches ascending and normally several to decumbent and few; twigs, peduncles and often petioles puberulent, setose, glabrescent, or stipitate-glandular, the hairs 0.1–1.5 mm. **Leaf-blades** broadly ovate to rotund, elliptic or lanceolate-deltate, (0.5–)1–9(–

12) cm long, the length 1–2.2 × width, not nigrescent, papery, pinninerved; base usually rounded to truncate, sometimes broadly cuneate or cordate, briefly narrowly cuneate onto petiole at very base; apex acuminate, acute, obtuse, or rounded; marginal teeth (4–)6–25(–45) per side, acute, obtuse, or rounded, spreading or appressed, then sometimes with tips recurved, with sinuses 0.2–2.5 mm deep; adaxial surface dull, antrorsely strigose-velutinous or also stipitate-glandular, the hairs occurring on veins and intervening tissue, moderately dense canopy of hairs 0.6–0.8 (–1) mm with understory of hairs 0.2–0.5 mm, (5–)10–50(–150)/sq. mm, not noticeably vitreous-pustulate, the circular bases of the strigae ca. 0.1–0.2 mm in diam.; abaxial surface dull green, moderatly densely (occasionally sparsely) pilose, the hairs on all veins and intervening tissue, 0.3–0.5 mm, all about same length except for a few scattered arching hairs 0.7–1 mm on the midrib or secondary veins, 10–200/sq. mm. **Inflorescences** remaining hemispheric; peduncles (0.5–)0.8–4 × leaf length (usually about equalling to almost twice when mature). **Proximal bracts** lanceolate-triangular, lanceolate-linear or narrowly elliptic, narrowly oblanceolate, narrowly oblong to oblanceolate-spatulate, 2–12 mm long, 0.5–3 mm wide, widest in proximal, middle, or distal third, with 3(–5) veins from the base, appressed or spreading, persisting or not; apex acute, attenuate or obtuse to rounded; indument strigose-pilose or setose, often sessile- or stipitate-glandular, ciliate or not, the longest hairs mostly 0.3–1 mm. **Corolla** yellow to or aging reddish orange; corolla tube 4–12 mm.

Distribution and habitat.—Mexico and West Indies to subtropical South America; tropical savanna with gallery forest, montane humid, pine, or dry forest, and disturbed successional woodland, shrubland and grassland; 0–2500 m.

See also comments under *Lantana camara* subsp. *glandulosissima.*

KEY TO THE SUBSPECIES AND VARIETIES OF *LANTANA HORRIDA*

1\. Twigs, peduncles, petioles, and upper leaf sufaces with stipitate glands lacking or with a few mixed among the eglandular hairs.
  2\. Inflorescence bracts usually 0.5–1.5 mm wide, proximal series 5–10 mm long and gradually shorted to distalmost series that are 2–4 mm long, proximal bracts lanceolate, lanceolate-linear, narrowly elliptic, rarely narrowly obovate; apex attenuate ________ **a. subsp. horrida**
  2\. Inflorescence bracts mostly 1.5–3 mm wide, either all series about 2–5 mm or only the proximal series 5–8 mm long and distal series abruptly shortened to 2–5 mm, proximal bracts ovate to elliptic; apex acute ________ **c. subsp. tiliifolia**
1\. Twigs, peduncles, petioles, and/or upper leaf sufaces with stipitate glands densely mixed among or dominating the eglandular hairs.
  3\. Inflorescence bracts mostly 1.5–3 mm wide; leaf-blades generally 4–9 cm long, varying from nearly rotund or broadly ovate with an abruptly acuminate apex to broadly rounded at base and sides tapering from wide base straight to prolonged acute apex; marginal teeth mostly 20–35 per side ________ **c. subsp. tiliifolia**
  3\. Inflorescence bracts usually 0.5–1.5 mm wide; leaf-blades generally 0.5–4 cm long, ovate, oblong-triangular, ovate-elliptic or smallest ones rotund, apex rounded or abruptly acute; marginal teeth 6–20 per side ________ **4 (b. subsp. zanonii)**
    4\. Central axis of plant more or less developed, plant erect with ascending branches; leaf-blades usually 2–4 cm long; marginal teeth sinuses about 1–2 mm deep; proximal bracts mostly longer than 5 cm, lanceolate, narrowly oblong, narrowly elliptic, or spatulate ________ **b.i. subsp. zanonii var. sargentii**
    4\. Central axis of plant abortive or weak, plant more or less prostrate with trailing branches; leaf-blades usually about 0.5–2 cm long; marginal teeth sinuses 0.2–0.8 mm deep; proximal bracts mostly shorter than 5 cm, oblong to obovate ________ **b.ii. subsp. zanonii var. subcordata**

2a. Lantana horrida subsp. horrida

Lantana hispida Kunth, Nov. Gen. Sp. [H.B.K.] 2:260. 1817. Type: MEXICO. Veracruz: Jalapa, *Humboldt & Bonpland s.n.* (lectotype: P-HBK, barcode P00307143[di!]). Allowing for ambiguities in the digital image, this possibly could be a hybrid between *L. horrida* subsp. *horrida* and *L. hirsuta* subsp. *hirsuta.*

Lantana horrida Kunth var. *parviflora* Schauer, Prodr. [A.P. de Candolle] 11:598. 1847. Type: MEXICO. Distrito Federal: Chapultepeque, *Humboldt & Bonpland 4149* (lectotype, here designated: P-HBK, barcode P00307142[di!]). Remaining syntypes: MEXICO. Tamaulipas: Matamoros, *Berlandier 2310=880* (GH!, NY!); MEXICO. Tamaulipas: Matamoros, *Berlandier 2114=697* (GH!); Matamoros, *Ehrenberg 612* (not located). The two Berlandier collections are hybrids between *L. urticoides* Hayek and *L. strigocamara* R.W. Sanders. See 18×20 in section on hybrid synonymy.

Lantana horrida Kunth var. *grandiflora* Schauer, Prodr. [A.P. de Candolle] 11:598. 1847. Type: MEXICO: 1821, *Alaman s.n.* (lectotype, here designated: G-DC, mixed sheet upper right specimen, bar code G00219489[di!]).

Lantana camara L. var. *macrantha* Loes., Verh. Bot. Vereins Prov. Brandenburg 53:76. 1911. *Lantana camara* L. f. *macrantha* (Loes.) Moldenke, Phytologia 45:296. 1980. Type: MEXICO. Chiapas: Huiztán, *Seler 2142* (holotype?: B, destroyed).

Lantana camara L. var. *ternata* Moldenke, Phytologia 8:160. 1962. *Lantana camara* L. f. *ternata* (Moldenke) Moldenke, Phytologia 45:296. 1980. Type: CUBA. Isle of Pines: Siguanea, 21 May 1910, *Jennings 458* (holotype: NY!).

Shrubs erect, rounded, or lax, dense to open, the central axis ± developed, branches ascending or clambering and several; twigs, peduncles and often petioles moderately setose, rarely with stipitate glands mixed among the eglandular hairs. **Leaf-blades** ovate to broadly ovate or broadly elliptic, (1–)3–9 cm long, moderately to weakly rugose, puckered between tertiary veins; apex acute to acuminate, occasionally obtuse or rounded; marginal teeth (4–)10–25(–35) per side, with sinuses 0.5–2 mm deep; adaxial surface antrorsely strigose-velutinous, the hairs 10–50/sq. mm. **Peduncles** (0.5–)0.8–2 × leaf length (usually about equalling to almost twice when mature). **Bract series** gradually reduced in size and width; proximal bracts lanceolate, lanceolate-linear, narrowly elliptic or rarely narrowly oblanceolate, 5–12 mm long, 0.5–1.5 (rare outermost one subfoliar to 2.5) mm wide, widest in proximal third (often near base), sometimes near middle or distal third; apex attenuate; indument setose or pilose, ciliate or not; distal bracts 3–5(–8) mm long. **Corolla** yellow aging yellowish or reddish orange; corolla tube 7–12 mm; corolla limb 6–10 mm in diam.

Distribution and habitat.—Mexico (northwest, central, southern), Central America (Guatamala to central Panama), Cuba; cultivated and escaped in Old World tropics; littoral and thorn shrubland, open pine-oak and deciduous montane forest and woodland; disturbance openings in tropical evergreen, sclerophyll, and deciduous forest and woodland; tropical savanna; 0–2500 m.

Selected specimens examined: **CUBA. Santiago de Cuba:** *Havard 143* (NY). **Villa Clara:** *Britton & Wilson 4960* (NY). **MEXICO. Chiapas:** *Laughlin 1535* (LL). **Chihuahua:** *LeSueur 1197* (SMU). **Guanajuato:** *Rose & Hough 4853* (US). **Nayarit:** *Kral 27536* (VDB); *Maltby 81* (US). **Puebla:** *Torres 5267* (TEX). **Veracruz:** *Nelson 384* (US). **NICARAGUA. Carazo:** *Hamblett 531* (SMU). **PANAMA. Herrera:** *Stern et al. 1708* (MO). **Veraguas:** *Batista et al. 52* (MO); *Dwyer et al. 7554* (MO).

Presumed hybrids with: **4a. L. hirsuta subsp. hirsuta. COSTA RICA. Cartago:** *Cooper 5892* (US). **San José:** *Sidney 42*, also × *L. nivea* subsp. *mutabilis* (F); *Tonduz 3377* (US); *Tonduz 7035* (LL[di]). **GUATEMALA. Alta Vera Paz:** *Turckheim 39* (US). **MEXICO. Chiapas:** *Ton 7048* (TEX[di]). **Jalisco:** *Gregory & Eiten 209* (SMU). **Nayarit:** *Waterfall 16328*, also × *L. kingii* (SMU[di]). **Veracruz:** *Nee et al. 25132* (BRIT[di]). **Yucatán:** *Lundell 8205* (US). **Zacatecas:** *Taylor & Taylor 6070* (BRIT[di]). **PANAMA. Chiriquí:** *Croat 10685*, also × *L. camara* subsp. *glandulosissima*? (MO). **5. L. insularis. CUBA. Santiago de Cuba:** *Britton et al. 12624* (NY); *Ekman 7972* (NY); *Havard 125* (NY). **6. L. scabrida. COSTA RICA. Guanacaste:** *Tonduz 13630* (LL[di]). **Limón:** *Jiménez 1903* (NY). **CUBA. Havana:** *León 1744* (NY). **Matanzas:** *Britton et al. 234* (NY). **Santiago de Cuba:** *Britton et al. 12898* (NY). **HONDURAS. Comayagua:** *Wilson 478* (NY). **PANAMA. Bocas del Toro:** *Peterson & Annable 7269* (MO). **Coclé:** *González 23* (MO). **Colón:** *Blum & Dwyer 2119* (MO); *Miller & Miller 908* (MO). **Panamá:** *Ebinger 29* (MO); *Oliver & MacBryde 1898* (MO); *Varela 3* (MO). **9i-cv×20. L. Callowiana Hybrid Group cultivars (L. depressa–tetraploid × strigocamara). AUSTRALIA. New South Wales:** *Riding 77* (BRIT). **Queensland:** *Hannan-Jones 73* (BRIT). **10. L. kingii. MEXICO. Hidalgo:** *Carney 31* (BRIT[di]). **Oaxaca;** *King 1178* (NY). **Sinaloa:** *Gentry 7133* (NY). **Sonora:** *Frye & Frye 2308* (NY). **12b. L. nivea subsp. mutabilis** (*L. horrida* subsp. uncertain, could also be *L. horrida* subsp. *tiliifolia*). **AUSTRALIA. New South Wales:** *Day 70* (BRIT); *Day 72* (BRIT). **RWANDA. Butare:** *D'Arcy 8700* (MO). **20. L. strigocamara. AUSTRALIA. Queensland:** *Hannan-Jones 35* (BRIT). See also taxa **1a, 1d, 1e** and **10** and section on hybrid synonymy: **1e×2a, 1e×2a×10, 1f×2a, 2a×4a, 2a×10, 2a×20,** and **10×2a/4a?**

2b. Lantana horrida subsp. **zanonii** (R.W. Sanders) R.W. Sanders, comb. nov. Basionym: *Lantana urticifolia* Mill. subsp. *zanonii* R.W. Sanders, Moscosoa 5:206. 1989. *Lantana arida* Britton f. *zanonii* (R.W. Sanders) I.E. Méndez, Willdenowia 32:291. 2002. Type: DOMINICAN REPUBLIC. Pedernales: Oviedo, 1 Oct 1984, *Sanders et al. 1682* (holotype: JBSD!; isotypes: F!, FLAS!, FTG[2]!, GH!, NY!, TEX!, US!).

Shrubs erect, rounded, lax, or trailing, dense to open, the central axis well-developed to abortive, branches ascending to arching and several or decumbent and few; twigs, peduncles and/or petioles densely setose and stipitate-glandular. **Leaf-blades** ovate, ovate-elliptic, trullate, ovate-deltate, or broadly ovate, or smallest ones subrotund, (0.5–)1–4(–6) cm long, moderately to prominently rugose, puckered between tertiary and/or secondary veins, apex acute to rounded; marginal teeth 6–20 per side, with sinuses 0.2–2.5 mm deep; adaxial surface antrorsely strigillose to strigose-velutinous, viscidly stipitate-glandular or not, the hairs 10–150/sq. mm. **Peduncles** 1–4 × leaf length (usually about 2 when mature). **Bract series** gradually reduced in size and width or all similar; proximal bracts lanceolate, lanceolate-linear, narrowly oblong or oblong-obovate to spatulate, 2.5–10 mm long, 0.5–1.5 mm wide, widest in proximal, middle, or distal third; apex rounded, obtuse or acute; indument strigose-pilose or setose, often sessile- or stipitate-glandular, ciliate or not; distal bracts 2–4 mm long. **Corolla** yellow and aging yellow, orange or orange-red; corolla tube 4–10 mm; corolla limb 4–8 mm in diam.

Distribution and habitat.—Eastern Cuba, Jamaica, Hispaniola, Puerto Rico, Virgin Islands and northern Lesser Antilles; brushland and open tropical deciduous to semi-evergreen woodland or open pine woodland on rocky (often calcareous) slopes; 0–600 m.

When I originally described *L. urticifolia* subsp. *zanonii*, it initially appeared to differ from *L. arida* var. *sargentii* in leaf and bract shape and some vestiture traits (Sanders 1989). However, careful examination for the present study failed to produce consistent distinctions or geographic correlations. If *L. subcordata* had not proved to be partially continuous with *L. horrida* var. *sargentii*, there would have been no need to recognize varieties within the subspecies. However, there is overlap in bract shapes, and one gathering (Dominican Republic. Santiago: *Liogier 13272*, LL, NY), otherwise identical to *L. subcordata*, is an erect shrub as in var. *sargentii*. Recognition of only two varieties within *Lantana horrida* subsp. *zanonii* has resulted in the lack of a nominate variety because autonyms exist only for infraspecific taxa that include the type of the species (ICBN Art. 26, Note 1, McNeill et al. 2007). Because, "*sargentii*" has priority at the varietal level, I am not free to publish the name *L. horrida* var. *zanonii* for the variety that includes the type of *L. horrida* subsp. *zanonii* (ICBN Recommendation 26A, Example1).

2b.i. Lantana horrida subsp. **zanonii** var. **sargentii** (Moldenke) R.W. Sanders, comb. & stat. nov. Basionym: *Lantana arida* Britton var. *sargentii* Moldenke, Phytologia 50:214. 1982. *Lantana glandulosissima* Hayek f. *sargentii* (Moldenke) I.E. Méndez, Willdenowia 32:297. 2002. Type: PUERTO RICO: La Parguera, 24 Feb 1935, *Sargent 137* (holotype: US!).

Lantana arida Britton, Bull. Torrey Bot. Club 37:357. 1910. Type: JAMAICA: Fort Henderson, 2 Mar 1908, *Britton & Hollick 1824* (holotype: NY!).

Shrubs erect or rounded and open to dense, the central axis well-developed, branches ascending to arching and several; twigs, peduncles and/or petioles densely setose and stipitate-glandular. **Leaf-blades** ovate, ovate-elliptic, trullate, ovate-deltate, or broadly ovate, or smallest ones subrotund, (0.5–)2–4(–6) cm long, moderately to strongly rugose, puckered between tertiary and/or secondary veins; apex acute to rounded; marginal teeth 6–20 per side, with sinuses (0.5–)1–2.5 mm deep; adaxial surface with hairs 10–50/sq. mm. **Peduncles** 1–3 × leaf length (usually about 2 when mature). **Bract series** gradually reduced in size and width; proximal bracts lanceolate, lanceolate-linear, elliptic-lanceolate, narrowly oblong, oblong-oblanceolate, or spatulate, 5–10 mm long, widest in proximal, middle, or distal third; apex rounded, obtuse or acute; distal bracts 2–4 mm long. **Corolla** yellow aging orange or orange-red; corolla tube 5–10 mm.

Distribution and habitat.—Eastern Cuba, Jamaica, Hispaniola, Puerto Rico, Virgin Islands and northern Lesser Antilles; brushland and open tropical deciduous to semi-evergreen woodland or open pine woodland on rocky (often calcareous) slopes; 0–600 m.

See description and illustration in Sanders (1989).

Selected specimens examined: **CUBA. Guantánamo:** *Britton 2168* (NY). **Santiago de Cuba:** *Britton et al. 12622* (NY). **DOMINICAN REPUBLIC. Azua:** *Mejía et al. 1181* (NY, TEX[di]). **Pedernales:** *Liogier & Liogier 26739* (NY); *Liogier 16965* (LL[di]). **Peravia:** *Liogier & Liogier 22025* (NY); *Peláez 202* (NY). **Santiago:** *Jiménez 8607* (LL[di]). **Santiago Rodriguez:** *García & Pimentel 2284* (NY). **JAMAICA. St. Catherine:** *Proctor 32628* (NY); *Yunker 17476* (NY). **St. Thomas:** *Araque-Molina & Barkley 22J4* (LL[di]); *Baars Lc 5* (BRIT). **PUERTO RICO. Guánica:** *Britton et al. 5508* (NY). **Lajas:** *Smith P.R. 18* (LL[di]). **VIRGIN ISLANDS. St. Thomas:** *Woodbury s.n.* (NY). **Tortola:** *Fishlock 45* (NY); *Proctor 44899* (NY).

Presumed hybrids with: **6. L. scabrida. JAMAICA. St. Andrew**: *Baars Lc7* (BRIT). **St. Elizabeth**: *Baars Lc8* (BRIT). **LESSER ANTILLES. St. Maarten**: *Krauss 1670* (LL[di]). **7. L. splendens. CUBA. Guantánamo**: *Britton 2216*, identification uncertain (NY). **20. L. strigocamara. DOMINICAN REPUBLIC: Samaná**: *Zanoni 17698* (NY). See also taxa **1a** and **1c.**

2b.ii. Lantana horrida subsp. **zanonii** var. **subcordata** (Urb.) R.W. Sanders, comb. & stat. nov. Basionym: *Lantana subcordata* Urb., Symb. Antill. [Urb.] 7:351. 1912. Type: DOMINICAN REPUBLIC: near Santiago, *Schomburgh 5* (lectotype: K, barcode K000470761[di!]; isotype: P[di!]).

Shrubs trailing or sprawling, the central axis abortive or weakly developed, branches decumbent, few; twigs, peduncles and often petioles moderately puberulent, setose, or glabrescent, at least peduncles usually stipitate-glandular. **Leaf-blades** ovate, deltate, or ovate-oblong, 0.5–2 cm long, strongly rugose, puckered between veins and veinlets; apex abruptly rounded or acute; marginal teeth 8–15 per side, with sinuses 0.2–0.8 mm deep; adaxial surface with hairs 50–150/sq. mm. **Peduncles** 2–4 × leaf length. **Bract series** similar in size or distal series only partially, gradually reduced; proximal bracts oblong or oblong-obovate to -oblanceolate, 2.5–7 mm long, widest just above middle to distal third; apex rounded or obtuse, often reflexed; distal bracts 2–3 mm long. **Corolla** yellow aging to dark yellow or orange-yellow; corolla tube 4–8 mm.

Distribution and habitat.—San José de las Matas region of Cordillera Central, Dominican Republic, Hispaniola; open pine and deciduous montane forest; 100–600 m.

See further discussion and illustration in Sanders (1989).

Selected specimens examined: **DOMINICAN REPUBLIC. Inoa:** *Liogier 11179* (NY); *Liogier 15076* (LL, NY); *Liogier & Liogier 22525* (LL). **Santiago:** *Burch & Jiménez 5816* (LL, NY); *Ekman 16172* (LL[2], NY); *Jiménez 8144* (NY); *Liogier et al. 6443* (NY).

Presumed hybrids with: See taxon **1c.**

2c. Lantana horrida subsp. **tiliifolia** (Cham.) R.W. Sanders, comb. & stat. nov. Basionym: *Lantana tiliifolia* Cham., Linnaea 7:122. 1832 (as "*tiliaefolia*"). *Camara tiliifolia* (Cham.) Bentham, J. Bot. [Hooker] 2:53. 1840. Type: BRAZIL. Bahia: *Sieber s.n. (WILLD 11502)* (lectotype: B-WILLD[di!]). Remaining syntypes: BRAZIL. Bahia: *Lhotzky s.n.* (B, destroyed?); BRAZIL (southern): *Sellow s.n.* (B, destroyed?, BR[di!], K[di!], NY[2]!, W[2]!).

Lantana glutinosa Poepp. in Otto & A. Dietr., Allg. Gartenzeitung 10:315. 1842. Type: PERU: Sep 1829, *Poeppig 1375* (lectotype: G[di!]!; isotype: GH!). Sanders (2006) erred in citing G-DC as the herbarium when designating the lectotype.

Lantana tiliifolia Cham. var. *glandulosa* Schauer, Fl. Bras. [Martius] 9:257.1851. *Lantana tiliifolia* Cham. f. *glandulosa* (Schauer) R. Fern., Bol. Soc. Brot. sér. 2, 61:179. 1988. Type (Santos Silva 2001): BRAZIL. Bahia: 1840, *Blanchet 3136A* (lectotype: G-DC, barcode G00219530[di!]; isotypes: G[2,di!], P[di!],). Remaining syntypes: PERU: *Poeppig 1375* (B[destroyed], G[di!], GH!); BRAZIL. 1831, *Blanchet 20* (G-DC[di!]); BRAZIL. Bahia: 1830, *Salzmann s.n.*(G-DC[di!], MPU[di!], P[di!]).

Lantana cummingiana Hayek, Repert. Spec. Nov. Regni Veg. 2:161. 1906. Type: CHILE. [Probably in error, more likely Tacna, Peru, see Rotman & Múlgura de Romero 2010] *Cumming 1065* (holotype: W[Macbride Neg. 34339, MO!]; isotype: SI, fragment[di!]).

Lantana foetida Rusby, Bull. New York Bot. Gard. 4:431. 1907. Type: BOLIVIA: *Bang 2034=469* (holotype: NY!; isotypes: F!, GH!, MO!, NY!, US!, WU!).

Lantana glutinosa Poepp. var. *orientalis* Moldenke, Phytologia 2:411. 1948. Type: VENEZUELA. Mérida: Campo Ella, 14 Aug 1938, *Hanbury-Tracy 31* (holotype: K[di!]; isotype: NY [fragment]!).

Shrubs erect or rounded and open, occasionally lax and subscandent, the central axis well-developed, prominent, branches ascending and several, occasionaly clambering and few; twigs, peduncles and often petioles moderately to densely setose, or mixed setose and stipitate-glandular, or predominantly stipitate-glandular. **Leaf-blades** ovate to broadly ovate or broadly elliptic, (1–)3–9(–12) cm long, moderately to weakly rugose, puckered between tertiary veins, apex usually abruptly, briefly acuminate (triangular tip ca. 5 mm) to acute, occasionally obtuse or rounded; marginal teeth 15–35(–45) per side, with sinuses 0.3–1.2(–1.5) mm deep; adaxial surface antrorsely strigillose to strigose-velutinous and often viscidly stipitate-glandular, the hairs (5–)10–30(–50)/sq. mm. **Peduncles** (0.5–)0.8–2 × leaf length (usually about equalling to almost twice as long when mature). **Bract series** all small or proximal 2 or 3 series longer with distal series abruptly shortened; proximal bracts elliptic, narrowly ovate, oblong, or oblong-obovate, 2–5(–10) mm long, (0.8–)1.2–3 (rare outermost one subfoliar to 4) mm wide, widest just below middle or near proximal third, occasionally above middle; apex acute to obtuse, sometimes briefly, abruptly acuminate or, if bract is over 5 mm long, attenuate; indument thinly pilose, stipitate-glandular or not, ± ciliate; distal bracts 2–4 mm long. **Corolla** yellow to or aging reddish orange or dark red; corolla tube 7–12 mm; corolla limb 6–10 mm in diam.

Distribution and habitat.—The Guianas, Venezuela, Colombia, Ecuador, Peru, Chile, Bolivia, Paraguay, northern Argentina, and southeastern to eastern Brazil; cultivated and escaped in Old World tropics; tropical savanna with gallery forest, montane humid forest, and disturbed successional woodland, shrubland and grassland; 150–2400 m.

Andean plants are predominantly stipitate-glandular. Otherwise, I have been unable to discern any geographic or ecological patterns separating the eglandular, mixed eglandular-glandular, and predominantly stipitate-glandular plants, especially in the Brazilian Planalto. Extensive field work is needed.

Selected specimens examined: **ARGENTINA. Buenos Aires:** *Torres et al. 2154* (MO). **Córdoba:** *Botta & Miconi 314* (MO). **BRAZIL. Bahia:** *Harley 18478* (LL[di]); *Mori et al. 10635* (LL[di]); *Smith Braz. 33* (LL). **COLOMBIA. Boyacá:** *Cuatrecasas 1134* (F); *Cuatrecasas 1920* (F). **Cauca:** *Cuatrecasas 19542* (F). **Chocó:** *León 312* (MO). **Norte de Santander:** *Cuatrecasas & Rodriguez 27954* (F). **Santander:** *Cuatrecasas & Garcia 9855* (F); *Luteyn et al. 7619* (F). **Tolima:** *Cuatrecasas 10515* (F). **PERU. Cusco:** *Galiano et al. 6275* (MO); *Valenzuela et al. 4620* (MO).

Pasco: *Smith & Foster 2582* (MO). **San Martín:** *Belshaw 3267* (MO); *DeLuycker 31* (MO); *Schunke 9729* (LL[di]). **VENEZUELA. Aragua:** *Smith Venez. 8* (LL). **Lara:** *Cotton & Burandt VO797* (BRIT). **Nueva Esparta:** *Ferry s.n. Feb-Mar 1909* (F).

Presumed hybrids with: **4b. L. hirsuta subsp. amazonica. ARGENTINA. Misiones:** *Morrone et al.1476* (MO). **BOLIVIA. Beni:** *Rusby 924* (F). **La Paz:** *Brooke 6637* (F); *Buchtien 718* (F). **BRAZIL. Ceará:** *Dahlgren 869* (F). **Minas Gerais:** *Irwin 2046* (F). **Paraná:** cult., *James s.n. 10 Mar 1952* (TEX). **São Paulo:** *Mosén 1531* (MO). **CHILE.** ["Tacna Arnica Region", possibly Tacna, Peru, as the collection was made in 1922 prior to the Treaty of Lima]: *Shepard 282* (F). **COLOMBIA. Norte de Santander:** *Cuatrecasas et al. 12190* (F). **ECUADOR. Guayas:** *Cerón 18266* (MO); *Holm-Nielsen & Jeppesen 50* (LL[di]). **PERU. Cusco:** *Calatayud et al. 4165* (MO). **Huánuco:** *Woytkowski 150* (F). **Pasco:** *Macbride 4762* (F). **VENEZUELA. Aragua:** *Williams 10164*, also × *L. scabrida* (F). **Mérida:** *Ruiz-Terán & López-Figueiras 8574* (LL[di]). **6. L scabrida. GUYANA. Essequibo Islands-West Demerara:** *Dorsett et al. 32* (MO). **Upper Takutu-Upper Essequibo:** *Goodland 823* (LL[di]). **VENEZUELA. Miranda:** *Cotton 86* (BRIT). **12a. L. nivea subsp. nivea. BRAZIL. Bahia:** *Anderson et al. 37051* (F). **Goiás:** *Anderson 9931* (F); *Irwin et al. 14949* (MO). **Rio Grande do Sul:** *Wasum et al. 7573, L. nivea* parent probably cultivated or escaped (US). **12b. L. nivea subsp. mutabilis. ARGENTINA. Tucumán:** *Villa 532*, identification uncertain (SMU). **AUSTRALIA. New South Wales:** *Day 44* (BRIT); *Day 68* (BRIT). **Queensland:** *Day 45* (BRIT); *Day 51* (BRIT); *Day 85* (BRIT); *Hannan-Jones 61* (BRIT); *McAndrew 80* (BRIT). **ECUADOR. Imbabura:** *Acosta S. 13397* (F). **TANZANIA. Kagera:** *Festo et al. 1347* (BRIT). **13. L. cujabensis. COLOMBIA. Valle de Cauca:** *López-Palacios & Idrobo 3844* (LL[di]). **ECUADOR. Chimborazo:** *Cerón 17550* (MO). **Orellana:** *Herrera & Guerrero 145* (MO). **PERU. Cajamarca:** *Campos & Días 2010* (MO). **Cusco:** *Suclli et al. 2089* (MO). **Tumbes:** *Días & Peña 4023* (MO). **VENEZUELA. Mérida:** *López-Palacios 2574* (LL[di]). **14. L. viscosa. BOLIVIA. Chuquisaca:** *Peñaranda et al. 288* (MO). **Santa Cruz:** *Mendoza et al. 190* (MO). **BRAZIL. Pernambuco:** *Andrade et al. 74* (MO). **PERU. Apurímac:** *Galiano et al. 4596* (MO). **Cusco:** *Galiano et al. 5165* (MO); *Galiano et al. 6582* (MO); *Huamantupa et al. 3286* (MO); *Huamantupa 8269* (MO); *Valenzuela et al. 5320* (MO). **15. L. micrantha. ARGENTINA. Corrientes:** *Cowan 4090* (F). **BOLIVIA. Chuquisaca:** *Gutiérrez et al. 1349* (MO). **La Paz:** *Araujo et al. 1618* (MO). **Santa Cruz:** *Beck 12296* (LL[di]); *Saldías 532* (MO). **PARAGUAY. Caaguazú:** *Zardini & Velázquez 25993* (MO). **San Pedro:** *Soria 7062* (MO). **17. L. planaltensis . BRAZIL. Bahia:** *Mori et al. 10370* (LL[di]). **Ceará:** *Gentry et al. 50164A* (MO). **Minas Gerais:** *Irwin et al. 28707* (US). **Rio de Janeiro:** *Gentry et al. 49523* (MO). **19. L. paraensis. GUYANA. Cuyuni-Mazaruni:** *McDowell 2618* (F). **20. L. strigocamara. BRAZIL. São Paulo:** *Moldenke & Moldenke 19670* (SMU). **SURINAME. Commewijne:** *Lasseigne 4408* (LL[di]). **Paramaribo:** *Florschütz & Florschütz 982* (SMU, TEX[di]). **VENEZUELA. Mérida:** *López-Palacios 2565* (LL[di]). **Miranda:** *Moldenke & Moldenke 19561* (SMU). See also taxa **1d, 1e,** and **2a** and section on hybrid synonymy: **1d×2c, 2c×4b, 2c×12b, 2c×13,** and **2c×17.**

3. Lantana leonardiorum Moldenke, Caribbean Forester 2:17. 1940 (as "*leonardorum*"). TYPE: HAITI. NORD-OUEST: Jean Rabel, 6 Mar 1929, *Leonard & Leonard 13782* (HOLOTYPE: NY!; ISOTYPES: A!, GH!, US!).

Shrubs low and rounded, dense; stems 0.3–0.8(–1.5) m; branches stiffly divergent; twigs, peduncles and often petioles moderately puberulent to setose, viscid with conspicuous stalked glands, the hairs 0.1–1.5 mm. **Leaf-blades** ovate-elliptic to narrowly triangular or narrowly elliptic, 0.5–2.5 cm long, the length 1.8–3 × width, not nigrescent, papery to subcoriaceous, usually bullate (i.e., puchered between the secondary veins, unique in this species), pinninerved; base rounded to cuneate; apex abruptly rounded or acute; marginal teeth 3–6 per side, rounded to acute, spreading to ascending, with sinuses 0.5–1 mm deep; adaxial surface dull, antrorsely strigillose to strigose-velutinous and often viscidly stipitate-glandular, the hairs occurring on veins and intervening tissue, moderately dense canopy of hairs 0.6–0.8 (–1) mm with understory of hairs 0.2–0.5 mm, 30–80/sq. mm, not noticeably vitreous-pustulate, the circular bases of the strigae ca. 0.1–0.2 mm in diam.; abaxial surface dull green, moderatly densely (occasionally sparsely) pilose, the hairs on all veins and intervening tissue, 0.3–0.5 mm, all about same length, 30–200/sq. mm. **Inflorescences** remaining hemispheric; peduncles 2–4 × leaf length. **Proximal bracts** obovate to elliptic, 4–7 mm long, 1–2 mm wide, widest just above middle to distal third, with 3 veins from the base, spreading or recurved, persisting; apex rounded to obtuse or acute; indument evenly pilose and stipitate-glandular, ciliate or not, the longest hairs 0.3–0.8 mm. **Corolla** yellow aging to orange; corolla tube 4–8 mm.

Distribution and habitat.—North coast of Hispaniola; low shrubland on semi-arid littoral cliffs and slopes of coral limestone and associated savannas somewhat inland; 0–150 m.

See discussion and illustration in Sanders (1989).

Selected specimens examined: **DOMINICAN REPUBLIC. Monte Cristi:** *Jiménez & Liogier 5706* (NY); *Jiménez 8724* (NY); *Liogier 15600* (NY). **HAITI. Nord-Ouest:** *Leonard & Leonard 11930* (NY).

Presumed hybrids with: See taxon **1c.**

B. Lantana sect. **Lantana** series **Setosae** R.W. Sanders, ser. nov. TYPE: *Lantana hirsuta* M. Martens & Galeotti

Adaxial leaf surfaces setose-villous, the hairs 1–2.5 mm; abaxial leaf surfaces setose, usually sparsely so, the hairs occurring on veins but usually not on non-innervated tissue, setiform, 0.7–2.0 mm. **Inflorescences** arrested and remaining hemispheric, prolate-globose in fruit.

4. Lantana hirsuta M. Martens & Galeotti, Bull. Acad. Roy. Sci. Bruxelles 11:326. 1844. TYPE: MEXICO. VERACRUZ: Jalapa, Mirador, 1840, *Galeotti 749* (HOLOTYPE: BR[di!]; ISOTYPES: G[di!], P[di!]).

Shrubs erect, rounded, or subscandent; stems 0.7–3 m; branches ascending and several to clambering and few; twigs, peduncles and often petioles moderately to densely setose, the hairs (0.8–)1–2.5 mm, mostly all the same length. **Leaf-blades** broadly ovate, ovate, or ovate-elliptic, rarely lanceolate, (2–)4–12 cm long, the length 1–2 × width, not nigrescent, membranous to papery, pinninerved; base usually rounded to truncate, sometimes broadly cuneate or subcordate, briefly narrowly cuneate onto petiole at very base; apex usually acuminate; marginal teeth 10–35(–40) per side, acute to rounded, spreading to appressed, then sometimes with tips recurved, with sinuses 0.3–3 mm deep; adaxial surface dull, setose to villous, the hairs occurring on veins and intervening tissue, longer ones 1–1.5 mm or more, 1–40/sq. mm, not noticeably vitreous-pustulate, the circular bases of the setae ca. 0.1–0.2 mm in diam.; abaxial surface slightly lighter or duller green than adaxial surface, setose, with the setae restricted to midrib and veins, (0.5–)0.7–1.5 mm or more, usually without shorter hairs, 0.5–80/sq. mm. **Inflorescences** occasionally 2 per leaf axil, remaining hemispheric; peduncles 0.3–1(–2) × leaf length. **Proximal bracts** linear-lanceolate, -oblong, or -triangular, outermost series often linear spatulate, 5–10(–12) mm long, 0.7–2 (rare outermost one subfoliar to 4) mm wide, widest in proximal third or near base, othermost series often dilated in distal third and widest there or equalling broadest proximal portion, with 3 veins from the base, appressed or spreading, persisting or not; apex attenuate or acute or rarely rounded at very tip; indument setose or pilose, ciliate or not, the longest hairs 0.3–1.5 mm. **Corolla** yellow to or aging reddish orange; corolla tube 8–12 mm.

Distribution and habitat.—Mexico to Brazil and northern Argentina; cultivated and escaped in Old World tropics; openings in tropical semi-evergreen forest and montane evergreen forest on poor soils, open pine-oak woodland, tropical savanna with gallery forest, areas of dense woodland, shrubland, and grassland; 0–2000(–3000) m.

KEY TO THE SUBSPECIES OF *LANTANA HIRSUTA*

1. Leaf margin coarsely serrate-dentate with usually 10–25 teeth per side, the sinuses 1–3 mm deep; leaf trichomes usually sparse, adaxial and abaxial ones usually 0.5–7/sq. mm; peduncles usually 6–14 cm; leaf-blade apex generally acuminate with a triangular tip 3–8 mm long ____ **a. subsp. hirsuta**
1. Leaf margin finely serrate-dentate with usually 25–35 teeth per side, the sinuses 0.3–1.0(–1.5) mm deep; leaf trichomes usually less sparse, adaxial and abaxial ones usually 10–40/sq. mm or more; peduncles usually 2–5 cm; leaf-blade apex generally acuminate with a narrowly triangular point (5–)10–15 mm long ____ **b. subsp. amazonica**

4a. Lantana hirsuta subsp. **hirsuta.**

Lantana scorta Moldenke, Publ. Carnegie Inst. Wash. No. 522 (Bot. Maya Area): 161. 1940. TYPE: MEXICO. QUERÉTARO: San Juan del Río, 17 Aug 1905, *Rose et al. 9520* (HOLOTYPE: NY!; ISOTYPE: MEXU[di!]).

Leaf-blades broadly ovate, ovate, or rarely lanceolate or ovate-elliptic; apex acuminate (abruptly contracted to triangular tip 3–8(–15) mm long), acute or rarely obtuse or rounded (triangular tip lacking); marginal teeth 10–25(–40) per side, with sinuses (0.7–)1–3 mm deep; adaxial surface with the setae 1–7(–15)/sq. mm; abaxial surface with the setae erect and usually rigidly straight, 0.5–7(–15)/sq. mm. **Peduncles** (3–)6–14 cm, 0.8–1(–2) × leaf length (usually about equalling when mature). **Proximal bracts** with longest hairs 0.5–1.5 mm.

Distribution and habitat.—Mountains and coastal plains of Mexico (frequent in eastern Mexico but collections are known from a few disjunct localities in western Mexico from Guerrero to Baja California), Central America, and extreme northwest Colombia; cultivated and escaped in Old World tropics; open pine-oak woodland, openings in semi-evergreen tropical forest and brushland, thickets, and grasslands; (0–)1000–1600 m.

The few collections from western Mexico may represent another infraspecific taxon, as they tend to have smaller leaf-blades and denser trichomes. Further work on this variation is needed.

Selected specimens examined: **GUATEMALA. Petén:** *Contreras 42* (LL[2]); *Contreras 439* (LL[2]). **Quezaltenango:** *Skutch 1347* (NY, US). **Retalhuleu:** *Shannon 200* (US). **San Marcos:** *Grant 594* (LL[di]). **MEXICO. Baja California:** *Moran 7388* (US). **Chiapas:** *Cabrera 12430*

(TEX); *Ventura & López 1816* (BRIT); *Ventura & López 4632* (TEX). **Jalisco:** *Machuca 7373* (TEX[di]). **Nuevo León:** *Encina et al. 1509* (BRIT); *Hinton et al. 24099* (TEX); *Rodriguez et al. 931* (TEX[di]). **Oaxaca:** *Campos 967* (TEX); *Martínez-Calderón 72* (NY); *Torres 8472* (TEX). **San Luis Potosi:** *Kay & Higgins 234* (SMU); *King 4278* (NY). **Tamaulipas:** *Fearing & Thompson 182* (SMU). **Veracruz:** *Day 25* (BRIT); *Hernández & Hernández 596* (NY); *Ortega et al. 19650* (NY); *Sharp 44197* (TENN); *Vasquez 488* (NY). **U.S.A. Alabama. Mobile Co.:** cult., *Mohr s.n.* (US).

Presumed hybrids with: **6. L. scabrida. GUATEMALA. Retalhuleu:** *Maxon et al. 3523* (US). **MEXICO. Chiapas:** *Martinez 8949* (TEX[di]); *Ventura & López 1685*, alternatively × *L. kingii* (BRIT[di]). **Quintana Roo:** *Cabrera & Cabrera 4046* (TEX[di]). **PANAMA. Bocas del Toro:** *Lewis et al. 898* (MO). **Chiriqui:** *Churchill & Churchill 6136* (MO); *Lewis et al 616* (MO); *Tyson 897* (MO). **Kuna Yala (San Blas):** *McDonagh et al. 167* (MO). **Panamá:** *Knapp et al. 3298* (MO). **9i-cv×20. L. Callowiana Hybrid Group cultivars (L. depressa–tetraploid × strigocamara). TANZANIA. Kilimanjaro:** *Mlangwa 352* (BRIT). **10. L. kingii. MEXICO. Oaxaca:** *González 646*, alternatively × *L. scabrida* or *L.* Callowiana Hybrid Group cv. (TEX[di]). **Puebla:** *Arsène s.n. 3 Nov 1908* (US). **San Luis Potosí:** *Davis 244* (NY); *Kral 24812* (VDB); *Parry & Palmer 707* (NY). **Tamaulipas:** *Kral 24771* (VDB). **Veracruz:** *Martínez-Calderón 1489*, also × *L. camara* subsp. *camara* (SMU). **12b. L. nivea subsp. mutabilis** (*L. hirsuta* subsp. uncertain, could also be *L. hirsuta* subsp. *amazonica*). **AUSTRALIA. Queensland:** *Day 56* (BRIT); *Day 87* (BRIT). **MALAWI. South Region:** *La Croix 2707* (MO). **SOUTH AFRICA. Limpopo:** *Day 6* (BRIT). **18. L. urticoides. MEXICO. Nuevo León:** *Weaver 611* (NY). **20. L. strigocamara** (*L. hirsuta* subsp. uncertain, could also be *L. hirsuta* subsp. *amazonica*). **AUSTRALIA. Queensland:** *McAndrew 65* (BRIT). See also taxa **1d, 1e, 2a,** and **10** and section on hybrid synonymy: **1e×4a, 2a×4a, 4a×10,** and **10×2a/4a?**

4b. Lantana hirsuta subsp. **amazonica** R.W. Sanders, subsp. nov. (**Fig. 1**). Type: BRAZIL. Distrito Federal: Bacia do Rio São Bartolomeu, adjacencias do córrego Forquilha, 9 Feb 1981, *Heringer et al. 6150* (holotype: NY! [see The C. V. Starr Virtual Herbarium of The New York Botanical Garden, http://sciweb.nybg.org/science2/VirtualHerbarium.asp, barcode 842174]; isotypes: IBGE, NY!).

Leaf-blades broadly ovate-elliptic to ovate, oblong-ovate, or elliptic; apex acuminate (abruptly contracted to triangular tip (5–)10–15 mm long), acute or rarely obtuse or rounded (triangular tip lacking); marginal teeth (20–)25–35 per side, with sinuses 0.3–1.5 mm deep; adaxial surface with the setae (3–)10–40/sq. mm; abaxial surface with the setae erect and usually arching or sinuate, 10–80/sq. mm. **Peduncles** 2–5(–8) cm, 0.3–0.5(–1) × leaf length. **Proximal bracts** with longest hairs 0.3–1 mm.

Distribution and habitat.— Brazil (eastern Amazon Basin and Planalto), Paraguay, northern Argentina, Bolivia, Peru, Ecuador, and Colombia to western Venezuela; cultivated and escaped in Old World tropics; openings in tropical semi-evergreen forest and montane evergreen forest on poor soils, tropical savanna with gallery forest and areas of dense woodland, shrubland, and grassland; 0–2000(–3000) m.

Schauer (1847, 1851 [t. 42]) recognized *Lantana hirsuta* subsp. *amazonica* as a species but misapplied the name *L. mista* L. to it (see hybrid synonymy 1f×4).

Selected specimens examined: **AUSTRALIA. Queensland:** *Robazza 24* (BRIT). **BOLIVIA. La Paz:** *Fournet 521* (LL). **BRAZIL. Distrito Federal:** *Botelho 16* (MO); *Moldenke & Moldenke 19593* (SMU). **Maranhão:** *Balick et al. 1518* (LL). **Minas Gerais:** *Anderson et al. 35661* (F); *Irwin et al. 19747* (MO); *Irwin et al. 20924* (F); *Mexia 4734*, p.p. (F). **Pará:** *Tsugaru & Sano B-532* (MO). **Paraná:** *Hatschbach 32192* (LL). **Rio de Janeiro:** *Duarte 5633* (MO); *Hoehne 5698* (NY); *Hoehne 5906* (NY). **São Paulo:** *Houk & Carvalho 40* (F); *Houk & Carvalho 62* (NY, US). **ECUADOR. Manabí:** *Acosta S. 10615* (F).

Presumed hybrids with: **6. L. scabrida. COLOMBIA. Magdalena:** *Fonnegra et al. 7396*, also × *L. camara* subsp. *glandulosissima* (MO). **VENEZUELA. Distrito Capital:** *Lassingne 4443* (F). **12a. L. nivea subsp. nivea. BRAZIL. Distrito Federal:** *Moldenke & Moldenke 19596* (NY, SMU). **Minas Gerais:** *Hatschbach 31444* (F); *Lanna S. 684* (LL); *Mexia 4734*, p.p. (US). **Rio de Janeiro:** *Brade 18697* (F); *Duarte 5633*, p.p. (F); *Lems s.n. 19 Mar 1964* (NY); *Moldenke 19617* (BRIT); *Moldenke 19993* (NY, SMU). **São Paulo:** *Moldenke & Moldenke 19658*, alternatively × *L. nivea* subsp. *mutabilis* (SMU). **URUGUAY. Montevideo:** cult., *Moldenke & Moldenke 19701* (SMU). **12b. L. nivea subsp. mutabilis. BRAZIL. Distrito Federal:** *Heringer 15353*, alternatively × *L. nivea* subsp. *nivea* (NY). **Paraíba:** *Agra et al. 5009* (MO). **13. L. cujabensis. PERU. Madre de Dios:** *Núñez & Galiano 14621* (MO). **14. L. viscosa. BRAZIL. Minas Gerais:** *Irwin 2046* (SMU); *Machado 30* (F). **Paraná:** *Hatschbach 37868* (MO). **Rio Grande do Sul:** *Henz 29626* (F). **15. L. micrantha. ARGENTINA. Misiones:** *Zuloaga et al. 5033* (MO). **BOLIVIA. La Paz:** *Lewis 882132* (F). **17. L. planaltensis. BRAZIL. Paraná:** *Braga 92* (US); *Kumurow 345* (VDB); *Winder 013A* (BRIT); *Winder 066* (BRIT); *Winder 067* (BRIT). **Santa Catarina:** *Reitz 5303* (US). **19. L. paraensis. BRAZIL. Maranhão:** *Snethlage 112* (F). **Pará:** *Drouet 2090* (F); *Monteiro da Costa 25* (F); *Prance et al. 25022* (MO). See also taxon **1d, 2c,** and **4a** and section on hybrid synonymy: **2c×4b, 4b×12a, 4b×13,** and **4b×15.**

5. Lantana insularis Moldenke, Caribbean Forester 2:16. 1940. Type: JAMAICA: [location uncertain, see Sanders 2006] 9 Mar 1920, *Maxon & Killip 912* (holotype; NY!; isotype: US!).

Shrubs erect, apparently pyramidal and open; stems 1–3 m; branches ascending and several; twigs, peduncles and often petioles spasely setose but viscid with conspicuous, dense stalked glands, the setae 1.2–2 mm, stipitate glands, 0.3–0.7 mm. **Leaf-blades** ovate-triangular to ovate-elliptic or lanceolate, 4–10 cm long, the length

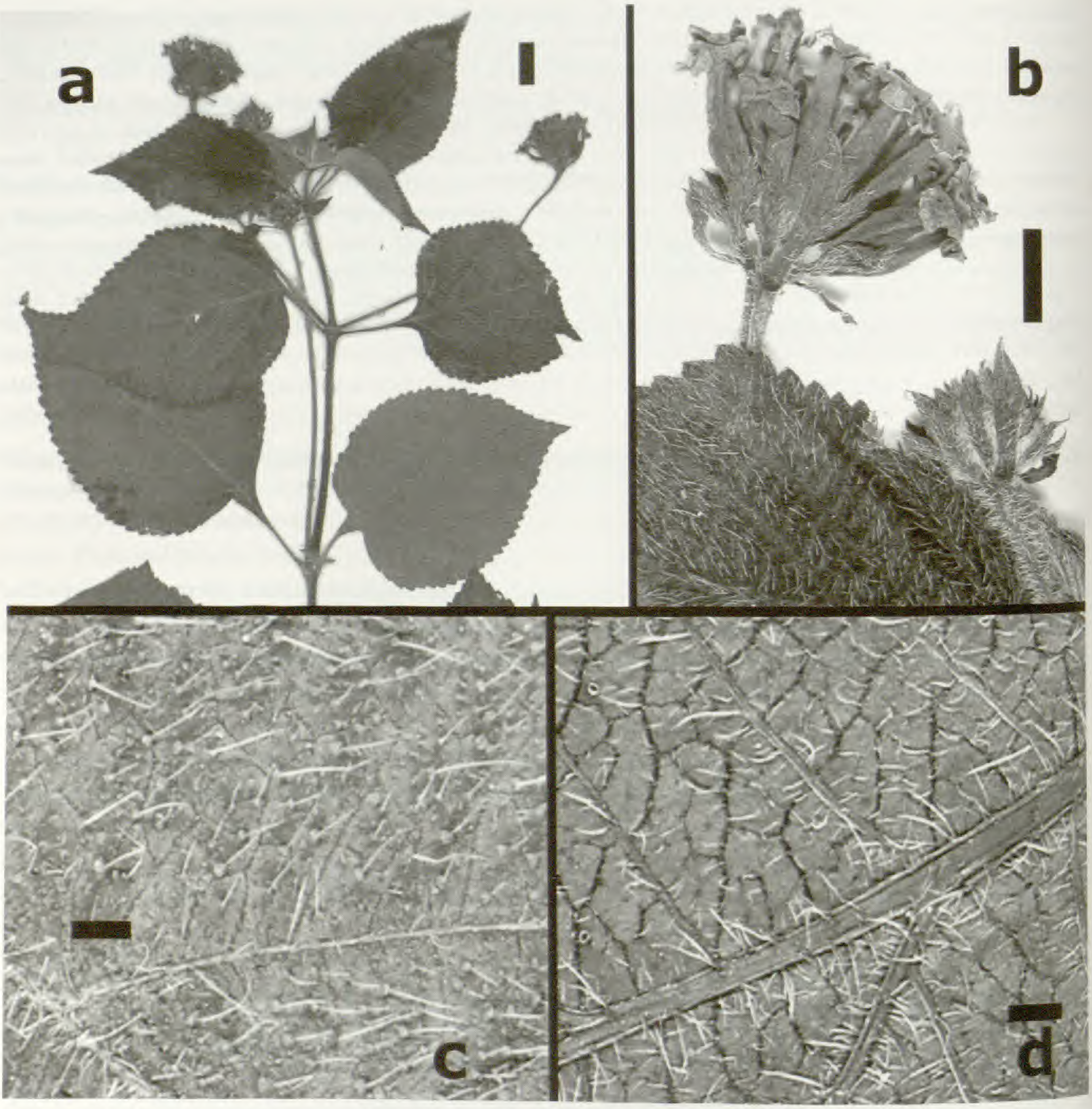

Fig. 1. *Lantana hirsuta* subsp. *amazonica*, holotype (*Heringer et al. 6150*, NY). **a.** twig with inflorescences. **b.** inflorescence. **c.** adaxial leaf surface. **d.** abaxial leaf surface. Scale bars: a = 1 cm; b = 5 mm; c & d = 1 mm.

(1.5–)1.7–2.5 × width, not nigrescent (although apparently drying dark due to dark green fresh color), membranous to papery, pinninerved; base usually rounded to truncate, sometimes broadly cuneate or subcordate, briefly narrowly cuneate onto petiole at very base; apex acuminate to attenuate; marginal teeth (20–)25–40 per side, mostly acute, appressed or ascending, tips sometimes recurved, with sinuses 0.2–0.7(–1) mm deep; adaxial surface dull, setose to villous, the hairs occurring on veins and intervening tissue, longer ones 1–1.5 mm or more, 1–10/sq. mm, not noticeably vitreous-pustulate, the circular bases of the setae ca. 0.1–0.2 mm in diam.; abaxial surface slightly lighter or duller green than adaxial surface, setose, with the setae restricted to midrib and veins, 1–1.5 (those on finer veins about 0.7) mm, 0.5–10/sq. mm. **Inflorescences** remaining hemispheric; peduncles 0.5–1 × leaf length. **Proximal bracts** oblong-lanceolate or -elliptic, 4–6 mm long, 1.5–2 mm wide, widest in proximal third or near middle, rarely above middle, with 3 veins from the base, appressed or spreading, ± persisting and reflexed in fruit; apex acute to obtuse or rounded; indument setose-pilose, ciliate, the longest hairs 1–2 mm. **Corolla** yellow to or aging reddish orange; corolla tube 7–12 mm.

Distribution and habitat.—Jamaica and Cuba; openings or disturbed areas in cloud or montane forest, moist savanna; 1000–3000 m.

Selected specimens examined: **JAMAICA. St. Andrew:** *Britton 108* (NY); *Nichols 5* (NY).

Presumed hybrids with: **6. L. scabrida. CUBA. Sancti Spíritus:** *Alain A1620* (NY). See also taxon **2a.**

C. Lantana sect. **Lantana** series **Strigosae** R.W. Sanders, ser. nov. Type: *Lantana scabrida* Sol.

Adaxial leaf-surfaces strigose, strigillose, or scabrid, the hairs (or their persistent bases) about 1 mm or less; abaxial leaf-surfaces strigose, usually sparsely so, the hairs occurring only on veins but usually not on non-innervated tissue, strigiform, 0.03–1 mm. **Inflorescences** arrested and remaining hemispheric, prolate-globose in fruit (continuing to initiate flowers somewhat in *L. nivea*, but flowers, bracts, and abortive fruits deciduous in lower portion leaving it more or less bare with only a hemisipheric cluster of flowers/fruits active).

6. Lantana scabrida Sol., Hortus Kew. [W. Aiton] 2:352. 1789. Type: cult., Royal Bot. Gard. Kew, 1777, *Solander s.n.* (lectotype: BM!).

Lantana crenulata Otto & A. Dietr., Allg. Gartenzeitung 9:363. 1841. Type: Unknown.

Lantana crocea Jacq. var. *guatemalensis* Loes., Verh. Bot. Vereins Prov. Brandenburg 53:76. 1911. Type: GUATEMALA. Huehuetenango: Nenton, *Seler 2805* (holotype?: B, destroyed).

Lantana scandens Moldenke, Phytologia 2:18. 1941. Type: MEXICO. Michoacán: Coalcomán, 3 Oct 1938, *Hinton 12315* (holotype: NY!; isotypes: F!, K[di!], LL!, MO!, NY!, US!).

Lantana brittonii Moldenke, Phytologia 2:52. 1941 (as "brittoni"). Type: JAMAICA. Tweedside: Moody's Gap, 10 Sep 1908, *Harris & Britton 10541* (holotype: NY!; isotype: US!).

Lantana flava Medik. f. *sandersii* I.E. Méndez, Willdenowia 32:296. 2002. Type: CUBA. Holguín: Sagua de Tánamo, 8 Apr 1987, *Méndez 3373* (holotype: HIPC[di!]).

Shrubs rounded and open, lax or subscandent; stems 0.5–6 m; branches ascending to clambering, often few; twigs, peduncles and often petioles thinly to moderately strigose or setose, the hairs 0.2–1 mm. **Leaf-blades** ovate to elliptic-lanceolate or lance-oblong, (2–)5–15 cm long, the length (1.5–)1.7–2.5(–3) × width, nigrescent, papery to subcoriaceous, triplinerved; base attenuately to abruptly tapering onto petiole from middle or just below middle; apex acuminate, acute, obtuse, occasionally rounded; marginal teeth (12–)17–25(–35) per side, obtuse, rounded, or acute, spreading to appressed, then sometimes with tips recurved, with sinuses 0.5–1.5 mm deep; adaxial surface lustrous, thinly strigose or scabrous, the hairs occurring on veins and center of areoles, 0.1–0.6(–1.2) mm (longest usually 0.2–0.4 mm, except in "scandens" morph where 0.6–1.2 mm), (4–)6–12/sq. mm, sometimes with conspicuous vitreous or whitened pustulate bases 0.1–0.3 mm in diam.; abaxial surface whitish or pale green but not glaucous, antrorsely strigose-scabrous, with the strigae scattered on veins and veinlets, (0.03–)0.1–0.5(–1) mm (longest mostly 0.3–0.5 mm, except in "scandens" morph where 0.5–1 mm), (4–)6–12(–25)/mm sq. ("scandens" morph 0–5)/sq. mm). **Inflorescences** remaining hemispheric; peduncles 0.5–1 × leaf length. **Proximal bracts** narrowly lanceolate, lance-elliptic or -oblong (including those with slight constriction in proximal third; occasionally 1 or 2 outermost bracts subfoliar or narrowly spatulate), 4–8 mm long, 1–2 mm wide, widest at very base, in proximal third, or in middle third (then often equally wide at base), with 3 veins from the base, appressed or spreading, usually deciduous after flowering; apex attenuate or acuminate; indument sparsely strigose, somewhat or not ciliate, the longest hairs 0.3–0.5(–1) mm. **Corolla** yellow to or aging reddish orange; corolla tube 7–12 mm.

Distribution and habitat.—West Indies (Cuba, Jamaica, possibly Hispaniola, Puerto Rico, possibly the Virgin Islands, and the northern Lesser Antilles), eastern coastal Mexico (Tamaulipas southward) with localized disjunction in southwestern Michoacán (long-haired, scandent morph), Central America, and Caribbean coast and slopes of Colombia, Venezuela, and the Guianas; disturbance openings, savanna and man-made grassland in tropical dry to humid forest; 0–1600 m.

Lantana scabrida is replaced in upland and western Mexico by *L. kingii*, but the two are apparently sympatric in Tamaulipas. Field work is needed to determine the status of the isolated scandent morph in Michoacán.

Sanders (1987b) reported the chromosome number ($2n = 44$) of *Lantana scabrida* in the Luquillo Mountains of Puerto Rico (*Sanders 1510*) as *L. camara* due to misapplication of the name and confusion with *L. strigocamara*.

Selected specimens examined: **BELIZE. Stann Creek:** *Gentle 7969* (LL[di]). **CUBA. Camagüey:** *Shafer 85* (NY). **JAMAICA. Manchester:** *Britton 975* (NY). **Portland:** *Britton 675* (NY); *Wight 4* (NY). **St. Ann:** *Crosby et al. 737* (NY). **St. Catherine:** *Nesbeth & Scott 38* (NY). **St. Elizabeth:** *Britton 1086* (NY); *Perraton 27* (NY). **Westmoreland:** *Britton & Hollick 1946* (NY). **MEXICO. Tamaulipas:** *Richardson 1253* (TEX[di]); *Sullivan 617* (TEX[di]). **PANAMA. Bocas del Toro:** *Gordon 52* (MO). **PUERTO RICO. Jayuya:** *Quinones 27* (UPRRP). **Luquillo:** *Howard 16122* (SMU). **Naguabo:** *Boom 9808* (NY). **Rio Grande:** *Sanders 1510* (FTG). **San Lorenzo:** *Axelrod 11854* (BRIT). **VENEZUELA. Miranda:** *Moldenke & Moldenke 19560* (SMU).

Presumed hybrids with: **18. L. urticoides. MEXICO. Tamaulipas:** *Mears 516a* (TEX[di]); *Mears 516e* (SMU[di]). **20. L. strigocamara. PUERTO RICO. Ponce:** *Axelrod & Fritsch 12526* (BRIT). See also taxa **1a, 1d, 1e, 2a, 2bi, 2c, 4a, 4b, 5,** and **10** and section on hybrid synonymy: **1a×6, 1d×6,** and **12×6/7?**

7. Lantana splendens Medik., Hist. & Commentat. Acad. Elect. Sci. Theod.-Palat. 3. Phys. 226. 1775. *Lantana camara* L. var. *splendens* (Medik.) Moldenke, Phytologia 33:130. 1976. *Lantana camara* L. f. *splendens* (Medik.) Moldenke, Phytologia 45:296. 1980. LECTOTYPE: icon in Dillenius, Hort. Eltham. t.57, f.67. 1732. EPITYPE, here redesignated: BAHAMA ARCHIPELAGO. SOUTH ANDROS: Smith's Hill, 24 Sep 1974, *Correll 43497* (LL[di]!; ISOEPITYPES: FTG!, NY!). As the author who first designated an epitype (*Herb Sherard 1269*, OXF) for *L. splendens* (Sanders 2006), I hereby revoke that designation. Problems with the Sherard specimen include gall-transformed capitula, structural and arrangement details of the abaxial leaf-blade strigae, and unexceptional luster intensity on the adaxial leaf surface. In my notes taken at OXF, I recorded the presence of some filiform hairs along the midrib (as in *L. bahamensis*), despite these not being visible in the images later sent to me by OXF (Sanders fig.6, 2006). Furthermore, *Correll 43497* is a closer match to the lectotype in leaf shape and branching than is the Sherard specimen. Since the lectotype very likely was illustrated from cultivated live plants, these may have been mixed as to genetic purity, the Sherard specimen being an impure sample. Because *L. splendens* would take priority should later workers combine it with other similar species, its extra-protologue reference specimen must be an unambiguous element of the indigenous taxon, as well as be the best match to the protologue, to avoid nomenclatural instability.

Shrubs erect, open or virgate; stems 0.5–2.5 m; branches ± divaricate, few to numerous, the internodes often wiry and 2–3 times as long as the subtending leaves (unique to this species); twigs, peduncles and often petioles glabrescent to thinly pubescent or scabridulous, the hairs 0.05–0.3 mm. **Leaf-blades** ovate, ovate-triangular, elliptic or lanceolate triangular, 1–5(–7) cm long, the length (1.5–)1.7–2.5 (–3) × width, nigrescent or not, coriaceous to subcoriaceous, triplinerved; base attenuately tapering onto petiole from middle or just below middle; apex attenuate, acute or obtuse; marginal teeth 9–21 per side, rounded to acute, often appressed, with sinuses 0.3–1 mm deep; adaxial surface lustrous to intensely so, thinly scabrous, the hairs occurring on veins and center of areoles, 0.1–0.2 mm, 1–7/sq. mm, noticeably vitreous-pustulate, the circular bases 0.3–0.5 mm or more in diam. on mature leaves, often filling whole areole; abaxial surface whitish or pale green but not glaucous, antrorsely strigose-scabrous to nearly glabrous, with the strigae scattered on veins and veinlets, 0.05–0.3 mm, 1–15/sq. mm (sometimes immature leaves with deciduous, mealy pubescence on veins). **Inflorescences** remaining hemispheric; peduncles 0.6–1.5 × leaf length. **Proximal bracts** oblong-lanceolate, elliptic, or 1 or 2 outermost ones oblong-obovate or-oblanceolate, 2–4(–5) mm long, 0.7–1.7 mm wide, widest usually near middle or distal third, sometimes proximal third, with 3(–5) veins from the base, appressed or spreading, usually deciduous after flowering; apex acute; indument strigillose, hardly ciliate, the longest hairs ≤ 0.3(–0.5) mm. **Corolla** yellow to orange probably aging with more reddish tints; corolla tube 5–8 mm.

Distribution and habitat.—Central Bahama Archipelago, Cuba (central northern coastal islands); disturbed sclerophyllous woodland, thickets, and savanna on pitted limestone; 0–50 m.

Selected specimens examined: **BAHAMA ARCHIPELAGO. Andros:** *Hill 3002* (NY). **Long Island:** *Coker 513* (NY); *Cerbin 138* (NY). **New Providence:** *Wilson 8425* (NY). **South Andros:** *Correll & Correll 50643* (NY); *Correll 43602* (FTG, SMU); *Pansegrau 103* (BRIT). **CUBA. Ciego de Ávila:** *Shafer 2694* (NY).

Presumed hybrids with: See also taxa **1a** and **2bi** and section on hybrid synonymy: **12×6/7?**

8. Lantana hodgei R.W. Sanders, J. Arnold Arbor. 68:343. 1987. TYPE: LESSER ANTILLES. DOMINICA: Fresh Water Lake, 10 Mar 1967, *Fosberg 48269* (HOLOTYPE: US!; ISOTYPES: F!, GH!, K[di!], MO!, NY!).

Shrubs lax or subscandent; stems 1–3 m; branches ascending or clambering, few; twigs, peduncles and often petioles thinly strigose, the hairs 0.2–1 mm. **Leaf-blades** ovate to elliptic-lanceolate, 5–15 cm long, the length 1.7–2.5(–3) × width, nigrescent, subsucculent or coriaceous, triplinerved; base attenuately to abruptly tapering onto petiole from below middle; apex abruptly acuminate; marginal teeth 20–40 per side, obtuse or acute, spreading to appressed, then sometimes with tips recurved, with sinuses 0.5–2 mm deep; adaxial surface intensely lustrous, strigose-glabrescent but smooth, the hairs occurring on veins (scattered) and center of areoles, 0.2–0.4(–0.8) mm, 0–2/sq. mm, flaccid and strongly appressed to surface (unique in this species), often deciduous, not pustulate based; abaxial surface whitish or gray-green (but not glaucous), weakly strigose and nearly glabrous, with the strigae scattered on veins and veinlets, 0.1–0.6 mm, 0–4/sq. mm. **Inflorescences** remaining hemispheric; peduncles ⅙–⅓ × leaf length. **Proximal bracts** oblanceolate to narrowly oblong to narrowly lanceolate, (4–)6–10 mm long, 1–1.7 mm wide, widest in proximal third to distal third, with 3 veins from the base, appressed or spreading, deciduous after flowering; apex attenuate; indument glabrescent, not ciliate, the longest hairs ≤ 0.5 mm. **Corolla** yellow to or aging reddish orange; corolla tube 7–10 mm.

Distribution and habitat.—Central Lesser Antilles (Dominica, Martinique, probably Saint Lucia); sunny slopes in borders and openings of montane rainforest; 400–1000 m.

See discussion in Sanders (1987c).

Selected specimens examined: **LESSER ANTILLES. Dominica:** *Lee 9* (NY); *Lloyd 201* (NY); *Smith 10216* (SMU). **Martinique:** *Bailey & Bailey 240* (NY).

Presumed hybrids with: **[9i-cv×20]. L. Callowiana Hybrid Group cultivars (L. depressa–tetraploid × strigocamara). LESSER ANTILLES. Dominica:** *Hill 23959*, alternatively × *L. strigocamara* (BRIT). See also taxon **1d.**

9. Lantana depressa Small, Bull. New York Bot. Gard. 3:436. 1905. TYPE: U.S.A. FLORIDA. Dade Co.: 4 Nov 1903, *Small & Carter 747* (HOLOTYPE: NY!; ISOTYPE: F!).

Shrubs trailing to erect, dense to ± open; stems 0.1–3 m; branches ascending, decumbent or prostrate, usually several to numerous; twigs, peduncles and often petioles thinly setose or strigose-setose, the hairs 0.5–1.5 mm. **Leaf-blades** ovate-elliptic to elliptic, 1–6(–8) cm long, the length 1.7–2.3(–3) × width, induplicately curved at maturity (unique to this species), nigrescent, papery, triplinerved; base obtuse or acute, tapering onto petiole from middle or just below middle; apex abruptly tapered, obtuse or acute; marginal teeth 3–15 per side, rounded to acute, often appressed, with sinuses 0.5–1.5 mm deep; adaxial surface lustrous, antrorsely strigillose to strigose, the hairs occurring on veins and center of areoles, 0.1–0.7(–1) mm, 2–8/sq. mm, not noticeably vitreous-pustulate, the circular bases of the strigae ca. 0.1–0.3 mm in diam.; abaxial surface slightly lighter or duller green, antrorsely strigose-scabrous, with the strigae scattered on veins and veinlets, longest ones 0.5–1 mm, 0.5–8/sq. mm. **Inflorescences** remaining hemispheric; peduncles 0.7–2 × leaf length. **Proximal bracts** elliptic-lanceolate, 4–7 mm long, 0.5–1.5 mm wide, widest at middle or just below, with 3 veins from the base, appressed or spreading, persisting and reflexed from base in fruit; apex acute to attenuate; indument strigose, ciliate or not, the longest hairs 0.1–1 mm. **Corolla** yellow aging to a dark yellow or dull, pale orange; corolla tube 5–11 mm.

Distribution and habitat.—Peninsular Florida; limestone pinelands, wet prairies, and dunes; 0–50 m.

See more complete discussion in Sanders (1987a) and Maschinski et al. (2010) and illustrations in Sanders (1987a).

KEY TO VARIETIES OF *LANTANA DEPRESSA*

1. Low-mounded shrubs, rarely exceeding 0.3 m, prominent stems prostrate or decumbent (to 1 m long); leaf-blades 1–3 cm long (to 4 or 5 cm in some cultivars) ________ **i. var. depressa**
1. Pyramidal to rounded shrubs, 0.5–3 m, prominent stems erect, ascending or arching; leaf-blades 3–6 cm long.
  2. Rounded shrubs without an erect central axis, all branches more or less spreading-arching; stem hairs 0.5–1 mm; corolla limb 8–10 mm across ________ **ii. var. floridana**
  2. Pyramidal shrubs with an erect central axis, stiffly ascending distal branches and some decumbent basal branches; stem hairs 1–1.5 mm; corolla limb 6–8 mm across ________ **iii. var. sanibelensis**

9i. Lantana depressa var. depressa

Lantana montevidensis (Spreng.) Briq. var. *aurea* Mattoon, Plant Buyer's Guide, ed. 6, 167. 1958. nom. nud. TYPE: none. Apparently a name of horticultural origin applied to *Lantana depressa* Small var. *depressa* (see Sanders 2001, p. 356).

Lantana ovatifolia Britton var. *reclinata* R.W. Long, Rhodora 72:34. 1970. TYPE: U.S.A. FLORIDA. Dade Co.: Homestead, 14 Oct 1962, *Cooley 9324* (HOLOTYPE: GH!; ISOTYPE: USF).

Lantana ovatifolia Britton f. *parvifolia* Moldenke, Phytologia 50:309. 1982. TYPE: U.S.A. FLORIDA. Dade Co.: Homestead, 27 Mar 1933, *Perkins 1625* (HOLOTYPE: BH[di!]).

Shrubs low mounded, dense, 0.1–0.3 (spreading to 1) m, the central axis abortive or hardly developed; branches prostrate or decumbent, twigs, peduncles and often petioles with hairs 0.5–1 .5 mm. **Leaf-blades** 1–3 cm long (to 4 or 5 cm in some cultivars). **Corolla** with tube 5–9 mm; corolla limb 5–8 mm in diam.

Distribution and habitat.—Peninsular Florida (Miami Ridge); cultivated and escaped in tropics and subtropics worldwide; limestone pinelands; 0–25 m.

Because of its drought tolerance, compact habit, and profuse flowering, *Lantana depressa* var. *depressa* has been cultivated widely since the 1950s. A tetrploid cultivar and *L. strigocamara* apparently are the parents of the currently popular Callowiana Hybrid Group cultivars, which have the floral colors of *L. strigocamara* and are cultivated worldwide and escaped pantropically (see Sanders 2001, specimen citations below, and **9i-cv×20** in the section on hybrid synonymy).

Selected specimens examined: **AUSTRALIA. Queensland:** cult., *McAndrew MJH-647* (BRIT). **U.S.A. Florida. Dade Co.:** *Deam 60894* (NY); *Demaree 10208* (SMU); *Kral 53943* (VDB); *Kral 53964* (VDB); *Kral 66236* (NY, VDB); *Kral 70742* (VDB); *Small et al. 3482* (NY); *Traverse 646* (SMU); **Texas. Blanco Co.:** cult., *Sanders 5190* (BRIT). **Harris Co.:** cult., *Traverse 2389* (BRIT).

Presumed hybrids with: **18. L. urticoides. U.S.A. Texas. Guadalupe Co**.: *Lu-Irving 08-2, L. depressa* parent cultivated (WTU). **20. L. strigocamara**. U.S.A. Florida. Monroe: *Moldenke 797* (NY).

Lantana Callowiana Hybrid Group cultivars [9i-cv×20] (See Howard 1969 and Sanders 2001). **AUSTRALIA. Queensland**: *Day 59* (BRIT). **CUBA. Havana**: *Moldenke 19862* (SMU). **GUATEMALA. Sololá:** *Day 18* (BRIT). **JAPAN. Funaura**: *Tanaka & Okamoto 020055* (BRIT). **MEXICO. Jalisco**: *Jiménez 357* (NY). **Sinaloa**: *Hutchison 2544* (NY). **Veracruz**: *Day 15* (BRIT). **TANZANIA. Kilimanjaro**: *Mlangwa 352*, possibly with genes of *L. hirsuta* (BRIT[di]). **Tanga** *Sallu 248* (BRIT). **TRINIDAD & TOBAGO. St. Augustine**: cult., *Smith Tr. 9* (LL). **U.S.A. Florida. De Soto Co.**: *Kral 57309* (VDB). **Lee Co.**: *Kral 11998*, alternatively a backcross into *L. strigocamara* (VDB). **Georgia. Camden Co.:** *Carter & Carter 13218* (FTG). **Louisiana. Iberia Par.:** *Webb 4764* (VDB). **Massachusetts**: cult., *Howard 16794* (SMU). **Missouri. Boone Co.**: cult., *Dunn 13828* (BRIT). **South Carolina. Beaufort Co.**: *Leonard & Radford 2743 p.p.* (VDB). **Tennessee. Davidson Co.**: cult., *Hackney s.n. 10 Oct 1990* (VDB). **Texas. Blanco Co.**: cult., *Sanders 5470* (BRIT). **Dallas Co.:** cult., *Shinners 8526* (SMU); cult., *Shinners 29844*, probably 'Cream Carpet' (SMU); cult., *Wansbrough 251* (SMU). **Galveston Co.:** cult., *Traverse 2515* (BRIT). **Harris Co.:** cult., *Traverse 2316* (BRIT); cult, *Traverse 2401* (BRIT). **Hidalgo Co.:** cult., *Greenfield 5* (BRIT). **Montgomery Co.:** *Sanders 6286* (BRIT). **Travis Co.:** *Green 22* (VDB).

Presumed further hybrids of [9i-cv×20] with: **10. L. kingii. MEXICO. Guerrero**: *Guerra 36* (LL[di]). **12b. L. nivea subsp. mutabilis. AUSTRALIA. Queensland**: *Day 86* (BRIT); *Horrocks 55* (BRIT). **TRINIDAD & TOBAGO. St. Augustine:** cult., *Nevling 255* (SMU). **17. L. planaltensis. BRAZIL. Bahia:** *Döbereiner & Tokarnia 1490* (LL[di]). **PARAGUAY. Central**: *Pérez 890* (MO). **18. L. urticoides. U.S.A. Texas. Anderson Co.:** cult., *Couch 73* (SMU). **Cameron Co.:** *Traverse 1030* (BRIT). **20. L. strigocamara. U.S.A. Florida. Lee Co.:** *Schallert 19640* (SMU[di]). **Leon Co.:** *Bratcher 57*, alternatively × *L. depressa* var. *depressa* (BRIT); *Godfrey 53542*, alternatively × *L. depressa* var. *depressa* (VDB). **Seminole Co.:** *Schallert 378* (BRIT[di]). See also taxa **1a**, **1b**, **1d**, **1e**, **1f**, **2a**, **4a** and **20** and section on hybrid synonymy: **9i-cv×20.**

9ii. Lantana depressa var. **floridana** (Moldenke) R.W. Sanders, Syst. Bot. 12:55. 1987. Basionym: *Lantana bahamensis* Britton var. *floridana* Moldenke, Phytologia 31:373. 1975. Type: U.S.A. Florida. Dade Co.: beach opposite Miami, Nov 1904, *Small 2101* (holotype: NY!).

Shrubs rounded, open, 0.4–1 m, the central axis ± developed, but not prominent; branches arching or ascending; twigs, peduncles and often petioles with hairs 0.5–1 mm. **Leaf-blades** 3–6(–8) cm long. **Corolla** with tube 7–11 mm; corolla limb 8–10 mm in diam.

Distribution and habitat.—Peninsular Florida; Atlantic barrier dunes and interior sand ridges, stabilized and relictual dunes; 0–50 m.

Selected specimens examined: **U.S.A. Florida. Brevard Co.:** *Moldenke 218* (NY). **Martin Co.:** *Kral 15385* (VDB); *Kral 57137* (NY, VDB). **Palm Beach Co.:** *Small 2134* (NY). **St. Johns Co.:** *Morton 4508* (SMU); *Small 2313* (NY). **Volusia Co.:** *Ray et al. 10817* (SMU). **Geogia:** cult., *Baldwin s.n.* (NY).

Presumed hybrids with: **20. L. strigocamara. U.S.A. Florida. Duval Co.:** *Curtiss 1968* (NY[2]). **Lake Co.:** *Small 8666* (NY[2]). **Volusia Co.:** *Kral 18406* (VDB); *Whetstone 14518* (VDB). See also section on hybrid synonymy: **9ii×20.**

9iii. Lantana depressa var. **sanibelensis** R.W. Sanders, Syst. Bot. 12:55. 1987. Type: U.S.A. Florida. Lee Co.: Sanibel Island, 11 May 1954, *Cooley 2674* (holotype: GH!; isotypes: USF[2]!).

Shrubs erect and pyramidal, proximally dense, distally open, 1–3 m, the central axis well-developed, prominent; proximal branches decumbent, distal ones ascending; twigs, peduncles and often petioles with hairs 1–1.5 mm. **Leaf-blades** 3–6 cm long. **Corolla** with tube 7–10 mm; corolla limb 6–8 mm in diam.

Distribution and habitat.—Peninsular Florida; wet limestone coastal prairies and calcareous dunes of Gulf barrier islands; 0–25 m.

Selected specimens examined: **U.S.A. Florida. Collier Co.:** *Correll 47737* (FTG, NY); *Sheehan s.n. 7 Mar 1919* (NY). **Lee Co.:** *Brumbach 9265* (BRIT, NY); *Hitchcock 268* (NY).

Presumed hybrids with: **20. L. strigocamara. U.S.A. Florida. Collier Co.:** *Ertter 2261* (NY); *Taylor & Taylor 5176* (BRIT). **Lee Co.:** *Brumbach 8182* (NY); *Brumbach 8283* (NY, US); *Brumbach 9058* (VDB).

10. Lantana kingii Moldenke, Phytologia 8:161. 1962. Type: MEXICO. Oaxaca: Isthmus of Tehuantepec, Niltepec, 17 Jul 1959, *King 1775* (holotype: TEX!; isotype: US!).

Shrubs erect or rounded, open; stems 0.5–2(–3) m; branches ascending and several; twigs, peduncles and often petioles glabrescent with scattered antrorse hairs, the hairs ca. 03–0.7 mm. **Leaf-blades** ovate, ovate-elliptic or ovate-triangular (rarely, especially if less than 2 cm long, obovate to rotund), 1–8 cm long, the length (0.8–)1.2–2(–2.5) × width, not nigrescent, papery to subcoriaceous or subsucculent, triplinerved to pinninerved; base attenuately tapering onto petiole from middle or just below middle to abruptly contracted and broadly cuneate, sometimes forming a short narrow petiolar wing; apex acute or acuminate (or abruptly to broadly rounded); marginal teeth (3–)6–15(–25) per side, obtuse or rounded, spreading to appressed, then sometimes with tips recurved, with sinuses 1–2.5 mm deep; adaxial surface lustrous, scabrous, the hairs occurring on veins and intervening tissue (sometimes just center of areoles), 0.1–0.5 mm, 3–7(–12)/sq. mm, mostly deciduous leaving the noticeably vitreous-pustulate circular bases, these 0.2–0.5 mm in diam.; abaxial surface whitish or pale green but not glaucous, antrorsely strigose-scabrous to nearly glabrous, with the strigae scattered on veins and veinlets, 0.1–0.7 (longest ones usually 0.3–0.4) mm, 1–8(–12)/sq. mm. **Inflorescences** remaining hemispheric; peduncles about 0.5 to 1.5 × leaf length. **Proximal bracts** spatulate, oblanceolate, or oblong-oblanceolate, occasionally oblong-elliptic to broadly elliptic, (3.5–)5–10 mm long, 1.2–3 mm wide, widest in distal half (often just above middle), occasionally at or just below middle, with 3 veins from the base, appressed or spreading, persisting and reflexed from base in fruit; apex obtuse to acute; indument strigose, hardly ciliate, the longest hairs ≤ 0.5 mm. **Corolla** yellow to orange aging orange to orange-red; corolla tube 6–10 mm.

Distribution and habitat.—Mexico (central highlands to eastern slopes of the Sierra Madre Oriental, Pacific slope, and Isthmus of Tehuantepec) to northern Central America (only to central Guatemala?); thorn forest and schrubland; 0–2000 m.

Selected specimens examined: **MEXICO. Coahuila:** *Johnston 9325* (LL[di]); *Henrickson 18926* (NY); *Waterfall 16661* (SMU). **Colima:** *Gregory & Eiten 334* (BRIT). **Guerétero:** *Flyr 623* (SMU). **Guerrero:** *Mocktord & Rowell 2790* (SMU). **Michoacán:** *Turner 2024* (BRIT, SMU). **Neuvo León:** *Garcia 10* (SMU); *Pennell 16860* (NY); *Waterfall 13187* (SMU); *Waterfall 15312* (SMU[di]). **Oaxaca:** *King 1328* (NY); *King 1464* (NY); *King 1598* (NY); *Purpus 7306* (NY). **Puebla:** *Chiang et al. F-2610* (TEX); *Davis 211* (NY); *Martínez 21705* (TEX[di]). **Sinaloa:** *Gentry 11454* (LL); *Palmer 1511* (NY); *Rose et al. 13366* (NY). **Sonora:** *Wiggins & Rollins 138* (NY). **Tamaulipas:** *Smith Mex. 94* (LL[di]).

Presumed hybrids with: **2a/4a. L. horrida subsp. horrida or L. hirsuta subsp. hirsuta. MEXICO. Hidalgo:** *Cawrey 3* (BRIT). **18. L. urticoides. MEXICO. Coahuila:** *Henrickson 11352* (LL[di]); *Muller 3069* (LL[di]); *Reveal et al. 2604* (NY); *Wehbe 052* (TEX[di]); *Wynd & Mueller 88* (NY). **Neuvo León:** *Frye & Frye 2447* (NY); *Meyer & Rogers 2686* (NY); *Pringle 11670* (SMU). **Tamaulipas:** *Meyer & Rogers 2499* (NY); *Stanford et al. 2302A* (NY). **20. L. strigocamara. MEXICO. Tamaulipas:** *Kral 24799*, alternatively × *L. scabrida* (VDB). See also taxa **1e, 2a, 4a,** and **9i (as cv × 20)** and section on hybrid synonymy: **1e×10, 1e×2a×10, 1e×10/20, 2a×10, 4a×10, 10×1a/1e?,** and **10×2a/4a?**

11. Lantana ovatifolia Britton, Bull. New York Bot. Gard. 4:123. 1905. Type: BAHAMA ARCHIPELAGO. Grand Bahama: Feb 1905, *Britton & Millspaugh 2450* (holotype: NY!; isotype: F!).

Shrubs lax and trailing, sparse; stems 0.3–1 m; branches prostrate, few; twigs, peduncles and often petioles moderately strigose, the hairs 0.2–1.5 mm. **Leaf-blades** ovate to ovate-elliptic, 2–6 cm long, the length 1.2–1.7 × width, not nigrescent, papery to subcoriaceous, pinninerved; base rounded to tapering onto petiole mostly from proximal third; apex acute to obtuse or rounded; marginal teeth 8–18 per side, rounded to acute, often appressed, with sinuses 0.7–1.5 mm deep; adaxial surface lustrous, antrorsely strigose to scabrous (due to loss of deciduous longer hairs), the hairs occurring on veins and intervening tissue (sometimes just center of areoles), 0.2–1 mm, 2–7/sq. mm, noticeably vitreous-pustulate, the circular bases 0.3–0.5 mm in diam.; abaxial surface slightly lighter or duller green than adaxial surface, antrorsely strigose-scabrous to nearly glabrous, with the strigae scattered on veins and veinlets, 0.2–1 (longest ones usually 0.4–0.8) mm, 2–7/sq. mm. **Inflorescences** remaining hemispheric; peduncles about 1–1.5 × leaf length. **Proximal bracts** spatulate or oblanceolate, 6–12 mm long, 1–3 mm wide, widest in distal half, with 3 veins from the base, appressed or spreading, persisting and reflexed from base in fruit; apex obtuse to acute; indument strigose, hardly ciliate, the longest hairs ≤ 0.6 mm. **Corolla** yellow aging to a dark yellow or yellow-orange; corolla tube 6–10 mm.

Distribution and habitat.—Northern Bahama Archipelago; limestone pinelands with open or low shrubby understory; 0–25 m.

In certain respects *Lantana ovatifolia* is rather similar to *L. kingii*. However, as a narrow endemic with a narrow range of variation, it is best kept as a distinct species. This is further supported by its distribution, which is oddly disjunct from that of *L. kingii*. See Sanders (1987a) for detailed discussion and illustration.

Selected specimens examined: **BAHAMA ARCHIPELAGO. Grand Bahama:** *Brace 3686* (NY); *Correll & Popenoe 45402* (FTG, NY, SMU); *Correll & Kral 42892* (FTG, VDB); *Correll & Kral 42946* (FTG, VDB).

12. Lantana nivea Vent., Jard. Malmaison t.8. 1804. LECTOTYPE: icon in Vent., Jard. Malmaison t.8. 1804.

Shrubs lax, rounded and open, sometimes forming treelets; stems 0.5–4 m; branches ascending or divaricate, several to numerous; twigs, peduncles and often petioles thinly to moderately strigillose, setulose, or scabridulous, the hairs 0.03–0.4(–0.7) mm. **Leaf-blades** ovate, lanceolate or elliptic, 3–12 cm long, the length sometimes of those subtending inflorescences distinctly reduced (unique to this species), (1.5–)1.7–3(–3.6) × width, nigrescent, membranous to papery, triplinerved; base attenuately tapering onto petiole from widest point or abruptly narrowed to an often asymmetric, attenuate or cuneate petiolar wing; apex attenuate, acuminate, or acute; marginal teeth (13–)18–40 per side, obtuse, rounded, or acute, usually appressed, sometimes spreading at tip, with sinuses 0.2–1 mm deep; adaxial surface lustrous, antrorsely strigose to scabrous or scabridulous, the hairs occurring on veins and intervening tissue, 0.03–0.5 mm, 10–60/sq. mm, often with conspicuous vitreous or whitened pustulate bases 0.1–0.3 mm diam.; abaxial surface slightly lighter or duller green than adaxial surface, antrorsely strigillose to strigose-scabrous, with the strigae scattered on veins and veinlets and sometimes on intervening tissue, 0.03–0.4(–0.7) mm, 10–60/sq. mm. **Inflorescences** sometimes 2 per leaf axil, hemispheric but receptacle often elongating by slight separation or prolonged initiation of nodes and becoming naked below the hemispheric flower cluster at apex; peduncles 0.5–1.2 × leaf length. **Proximal bracts** narrowly triangular, lanceolate or linear-lanceolate, occasionally oblanceolate, 2.5–7(–10) mm long, 0.6–1.5 mm wide, widest at very base, proximal third, or occasionally distal third, with 3 veins from the base, appressed or spreading, usually deciduous after flowering; apex acute, attenuate, or subulate; indument strigillose-scabridulous, hardly ciliate, the longest hairs ≤ 0.5 mm. **Corolla** white aging white, pale pink or light blue, or opening pink, cream or yellow aging cream, yellow or orange infused with purple, pale yellow throat usually developed and fading with age; corolla tube 7–12 mm.

Distribution and habitat.—Eastern and southeastern Brazil; cultivated world-wide, escaped pantropically; understory and disturbance openings and man-made grasslands in tropical humid forest, occasionally in dry forest; 0–1500 m.

KEY TO THE SUBSPECIES OF *LANTANA NIVEA*

1. Corollas opening white aging white, bluish, or pale pink, or opening pink aging light purple; strigae of adaxial leaf surface 0.03–0.3 mm long, those under 0.2 mm dominating and appearing as ascending conical rough points; strigae of abaxial surface 0.03–0.3 mm or less long, never with filiform straight hairs to 0.3 mm mixed in ________ **a. subsp. nivea**

1. Corollas opening pink, cream or yellow, aging cream, yellow or orange infused with purple; strigae of adaxial leaf surface 0.05–0.5 mm long, the longer ones dominating; strigae of abaxial surfaces 0.05–0.7 mm long (mostly 0.4–0.5 mm), often with scattered filiform straight hairs to 0.3 mm mixed in ________ **b. subsp. mutabilis**

12a. Lantana nivea subsp. **nivea.** *Camara aculeata* (L.) Kuntze [var. *subinermis* Kuntze] f. *nivea* (Vent.) Kuntze, Revis. Gen. Pl. 2:503. 1891. nom. illeg. (see taxon 1f). *Lantana aculeata* L. f. *nivea* (Vent.) Voss, Vilm. Blumengärtn. ed.3, 1:823. 1894. *Lantana camara* L. var. *nivea* (Vent.) L.H. Bailey, Cycl. Amer. Hort. [L.H.Bailey] 883. 1900.

Lantana triplinervia Turcz., Bull. Soc. Imp. Naturalistes Moscou 36:205. 1863. TYPE: JAVA. [MOJOKERTO:] Japan, cult., *Göring 225* (HOLOTYPE KW[di!]).

Lantana minasensis Moldenke, Phytologia 2:138. 1946. *Lantana triplinervia* Turcz. var. *minasensis* (Moldenke) Moldenke, Phytologia 28:403. 1974. TYPE: BRAZIL. MINAS GERAIS: Viçosa, 9 Mar 1930, *Mexia 4448a* (HOLOTYPE: NY!; ISOTYPES: K[di!], MO!, TEX!).

Lantana camara L. var. *alba* Moldenke, Phytologia 5:132. 1955. *Lantana camara* L. f. *alba* (Moldenke) Moldenke, Phytologia 45:296

1980. *Lantana aculeata* L. f. *alba* (Moldenke) I.E. Méndez, Willdenowia 32:289. 2002. (Misapplied probably to *Lantana* Callowiana Hyb. 'Cream Carpet') Type: INDIA. West Bengal: Kharacpur, cult., *Sahni s.n.* (holotype: LL!).

Lantana morii Moldenke, Phytologia 41:449.1979. Type: BRAZIL. Bahia: Camacã, 14 Jul 1978, *Santos & Mattos 3304* (holotype: LL!; isotype: NY!).

Leaf-blades with the indument of the adaxial surface composed of strigae and rough points, 0.03–0.3 mm; indument of the abaxial surface composed only of strigae 0.03–0.3 mm, never with short, straight fililform hairs to 0.3 mm mixed in. **Inflorescences** hemispheric but receptacle often elongating by slight separation or prolonged initiation of nodes and becoming naked below the hemispheric flower cluster at apex. **Corolla** white aging white, bluish or pale pink, or pink aging light purple.

Distribution and habitat.—Eastern and southeastern Brazil; cultivated world-wide, sometimes escaped pantropically; understory and disturbance openings and man-made grasslands in tropical humid forest, occasionally in dry forest; 0–1500 m.

Many of the native collections have narrowly elliptic leaf-blades. However, other native collections vary toward having the more ovate or lanceolate blades typically seen in cultivated plants of the species (e.g., the type specimens of *Lantana nivea* and *L. triplinervia*). There is a tendency, especially in the collections from Bahia, for a marked reduction in size of leaves subtending the inflorescences, resulting in a corymb-like arrangement of capitula.

Selected specimens examined: **AUSTRALIA. Queensland:** *McAndrew 32* (BRIT). **BRAZIL. Bahia:** *Mori et al. 10266* (LL); *Sieber s.n. 1826* (BR[di]); *Silva 58360* (NY, US). **Distrito Federal:** *Duarte & Pereira 4740* (US). **Minas Gerais:** *Hatschbach 31331* (US); *Irwin 2112* (NY, US). **Rio de Janeiro:** *Araujo 5054* (NY); *Brade 24153* (NY); *Carauta et al. (Herb. 18132)* (LL); *Nee 3389* (US); *Pereira et al. 4383* (NY). **MEXICO. Distrito Federal:** cult,. *Bonpland s.n.* (P[2di]). **SRI LANKA. North Central:** cult., *Moldenke et al 28233* (US).

Presumed hybrids with: **14. L. viscosa. BRAZIL. Bahia:** *Belena 3644* (F); *Harley 21362* (MO, NY); *Harley 21404* (NY); *Harley 21536* (NY); *Harley 21658* (NY); *Harley 21927* (NY); *Hatschbach 46372* (LL[di]); *Irwin et al. 27777* (LL[di]). **17. L. planaltensis. BRAZIL. Bahia:** *Harley et al. 21617* (US). **Minas Gerais:** *Anderson 9142* (F, US); *Mexia 5436* (F, NY). **Rio de Janeiro:** *Segadas-Vianna et al. 593* (SMU). **20. L. strigocamara. U.S.A. Hawai'i. Oahu:** *Topping 3009* (NY). See also taxa **2c** and **4b** and section on hybrid synonymy: **4b×12a, 12a×14.**

12b. Lantana nivea subsp. **mutabilis** (Hook.) R.W. Sanders, Sida 22:395. 2006. Basionym: *Lantana nivea* Vent. var. *mutabilis* Hook., Bot. Mag. n.s., 5:t. 3110. 1831. *Camara aculeata* (L.) Kuntze [var. *subinermis* Kuntze] f. *mutabilis* (Hook.) Kuntze, Revis. Gen. Pl. 2:503. 1891. nom. illeg. *Camara aculeata* (L.) Kuntze [var. *normalis* Kuntze] f. *mutabilis* (Hook.) Kuntze, Revis. Gen. Pl. 2:503. 1891. nom. illeg. *Lantana aculeata* L. f. *mutabilis* (Hook.) Voss, Vilm. Blumengärtn. ed.3, 1:823. 1894. *Lantana camara* L. var. *mutabilis* (Hook.) L.H. Bailey, Cycl. Amer. Hort. [L.H.Bailey] 884. 1900. *Lantana camara* L. f. *mutabilis* (Hook.) Moldenke, Phytologia 45:296. 1980. Lectotype: icon in Hook., Bot. Mag. n.s., 5:t. 3110. 1831. Epitype, here designated: SRI LANKA. Central Prov.: Dambulla, roadsides and fencerows, 23 Jan 1974, *Moldenke et al. 28218* (US!; isoepitype: LL!).

Lantana incarnata Raf., Sylva Tellur. 83. 1838. Type: Unknown.

Lantana amethystina Otto & A. Dietr., Allg. Gartenzeitung 9:370. 1841. Type: Unknown.

Lantana triplinervia Turcz. f. *armata* Moldenke, Phytologia 36:49. 1977. Type: BRAZIL. São Paulo: Pariquera-açu, 18 Feb 1965, *Eiten & Clayton 6194* (holotype: US!; isotype: K[di!]).

Leaf-blades with the indument of the adaxial surface composed of strigae, 0.05–0.5 mm; indument of the abaxial surface composed of strigae, 0.05–0.7 (longest ones mostly 0.4–0.5) mm, often with short, straight fililform hairs to 0.3 mm mixed in but not dominant or codominant. **Inflorescences** remaining hemispheric; receptacle rarely elongating and becoming naked below. **Corolla** opening creamy white or pink, aging cream, yellow or orange infused with purple or opening yellow aging purple.

Distribution and habitat.—Probably of cultivated hybrid origin, cultivated world-wide and escaped pantropically (especially in Australia), but also collections from southeastern Brazil apparently of natural hybrid origin; understory and disturbance openings and man-made grasslands in tropical humid forest, occasionally in dry forest; 0–1500 m.

Selected specimens examined: **AUSTRALIA. Queensland:** *Day 53* (BRIT). **BRAZIL. Goiás:** *Irwin et al. 25204* (NY). **Rio de Janeiro:** *Carauta & Araujo 2244* (LL[di]); *Góes 64* (NY); *Sarahyba 80* (NY); *Segadas-Vianna 4053* (SMU). **BURUNDI. Bujumbura:** *Lewalla 5717* (MO). **COLOMBIA. Caldas:** cult., *López-Palacios 4023* (LL). **DOMINICAN REPUBLIC. La Vega:** *Ososki & Rodriguez 249* (BRIT). **GOLD COAST. Kumari:** *Darko 598* (MO). **TRINIDAD & TOBAGO.** *Smith Tr. 2* (LL[di]); *Smith Tr. 24* (LL[di]). **MEXICO. Tabasco:** *Taylor & Taylor 12574* (BRIT). **PARAGUAY. Canendiyú:** *Zardini 48550* (MO). **SIERRA LEONE. Freetown:** *Johnston s.n. 31 Jan 1882* (MO); *Morton SL185* (MO).

SOUTH AFRICA. Free State: *Day 5* (BRIT). **Mpumalanga** *Day 19* (BRIT). **SRI LANKA. Central:** *Moldenke et al 28159* (US); *Moldenke et al. 28262* (LL). **TANZANIA. Tanga:** *Sallu 383* (BRIT). **U.S.A. Florida. Dade Co.:** cult., *Avery 1867* (NY).

Presumed hybrids with: **2/4. L. horrida or L. hirsuta. AUSTRALIA. Tasmania:** *Crosby & Doore 162* (SMU). **13. L. cujabensis. AUSTRALIA. Queensland:** *Day 50*, identification uncertain (BRIT). **BRAZIL. Bahia:** *Hage 365* (LL[di]). **17. L. planaltensis. BRAZIL. Minas Gerais:** *Heringer & Eiten 15237* (F, US); *Mexia 5440* (US). **São Paulo:** *Hoehne 2759* (US); *Hoehne 6168* (US); *Moldenke & Moldenke 19905* (SMU). **20. L. strigocamara. AUSTRALIA. Queensland:** *Day 28* (BRIT). See also taxa **1c, 1d, 1e, 1f, 2a, 2c, 4a, 4b,** and **9i (as cv.)** and section on hybrid synonymy: **1d×12b, 2c×12b,** and **12b×17.**

13. Lantana cujabensis Schauer, Prodr. [A.P. de Candolle] 11:599. 1847. Type: BRAZIL. Matto Grosso: Cuiabá, Jul 1833, *Manso s.n., Martius Fl. Bras. 1026* (lectotype: M, barcode M0111650[di!]; isotypes: BR[2,di!], G[di!], G-DC[di!], MO!, NY!,). Remaining syntypes: BRAZIL.:Rio Negro, *Martius s.n.* (M[di!]). PERU: *Poeppig 1485* (G[di!]).

Lantana riedeliana Schauer, Prodr. [A.P. de Candolle] 11:601. 1847. Type: BRAZIL [probably from western Matto Grosso, 1826–1828 (Urban 1906)], *Riedel s.n.* (holotype: LE, n.v.).

Lantana tenuifolia Rusby, Phytologia 1:74. 1934. Type: BOLIVIA. [La Paz:] Bopi River, 11 Sep 1921, *Rusby 653* (holotype: NY!).

Lantana cujabensis Schauer var. *parvifolia* Moldenke, Phytologia 9:186. 1963. Type: PERU. La Libertad: Otuzco, 1 Jul 1951, *Ángulo & López 1346* (holotype: LL, not located).

Lantana cujabensis Schauer f. *scabrifolia* Moldenke, Phytologia 46:58. 1980. Type: BOLIVIA. La Paz: cataracts of Bopi River, 6 Sep 1921, *Rusby 715* (holotype: NY!).

Shrubs rounded and ± open, lax, or subscandent; branches ascending or clambering, several to few, occasionally herbaceous; twigs, peduncles and often petioles glabrescent to thinly setose or scabrous, the hairs (0.1–)0.3–0.5(–1) mm. **Leaf-blades** ovate, lanceolate, elliptic, or narrowly oblong, (3–)4–12(–16) cm long, the length 1.3–2.5(–4) × width, nigrescent or not, papery to subcoriaceous, triplinerved to pinninerved; base rounded or truncate and abruptly tapered onto petiole or cuneate and often forming an attenuate wing; apex acute, abruptly acuminate, or attenutate; margin with the teeth (15–)25–40 per side, rounded to acute, often appressed to strongly so and barely discernable, the sinuses 0.1–1.5 mm deep; adaxial surface dull to occasionally lustrous, antrorsely strigillose to strigose-pubescent, the hairs occurring on veins and intervening tissue, 0.1–0.4(–0.7) mm, 3–20/sq mm, not noticeably vitreous-pustulate, the circular bases of the strigae ca. 0.1–0.2 mm in diam; abaxial surface slightly lighter or duller green than adaxial surface, sometimes whitish green but not glaucous, antrorsely strigose-scabrous to nearly glabrous, with the strigae scattered on veins and veinlets, 0.1–0.6 mm, 3–10/sq mm. **Inflorescences** with peduncles 0.5– 2 × leaf length. **Proximal bracts** lanceolate, oblong, or ovate-elliptic, often subfoliaceous, (4–)6–20 mm long, 2–8 mm wide, widest in proximal to middle third, occasionally distal third, with 5–7 veins from the base, appressed to spreading, persisting and recurved or reflexed in fruit; apex acute, briefly acuminate, or obtuse, often rounded at very tip; indument thinly strigose, usually not distinctly ciliate, with longest hairs 0.1–0.6(–1) mm. **Corolla** yellow, orange, or light red aging reddish orange to bright red (or occasionally intense reddish purple); corolla tube 7–12 mm.

Distribution and habitat.—Brazil (westernmost Amazonia, southern and central Planalto), the Guianas, Venezuela, Colombia, Ecuador, Peru, Bolivia and Paraguay; understory and disturbance openings in tropical humid forest, occasionally in dry forest or hard-pan savannas; 100–3000 m.

Lantana cujabensis is variable with respect to leaf-blade shape and width (broadly ovate to narrowly elliptic-oblong) and marginal serration, outer bract length and width, and altitude preference. Apparently the type specimens of *L. cujabensis* and *L. riedeliana* represent the broad-leaved, toothed vs. narrow-leaved, subentire extremes, respectively; that of *L. tenuifolia* is intermediate. Different specimens exhibit all possible combinations, which do not correlate with geography, therefore, no infraspecific taxa are justifiable based on the sample studied.

Selected specimens examined: **BOLIVIA. Cochabamba:** *Jaramillo et al. 1212* (MO); *Ritter 1644* (MO); *Steinbach 644* (F, MO, NY, SMU); *Terán et al. 1927* (MO). **Santa Cruz**: *Guillén & Roca 3334* (F); *Steinbach 347* (NY, SMU); *Steinbach 794* (SMU). **BRAZIL. Acre:** *Albuquerque et al. 1366* (MO); *Santos et al. 49* (NY). **Amazonas**: *Maas & Maas 273* (MO). **Bahia:** *dos Santos & Barreto 65* (LL[di]). **Rondônia**: *Teixeira et al. 331* (MO). **COLOMBIA. Amazonas**: *Gillett & Sampson 16497* (MO). **Boyacá**: *Lawrance 209* (F). **Chocó:** *Díaz 3478* (MO). **Meta**: *Betancur 1336* (MO); *Ohba et al. 671* (MO). **Putamayo:** *Cuatrecasas 11189* (F). **ECUADOR. Cotopaxi**: *Holm-Nielsen et al. 2877* (F); *Holm-Nielsen et al. 3016* (F). **Napo:** *Abbott 15637* (MO); *Campos 135* (F); *Cerón 278* (MO); *Croat & Hannon 93505* (MO); *Ponce & Ghia 320* (MO). **PERU. Amazonas:** *Castro et al. 18843* (MO); *Castro et al. 18983* (MO); *Lewis et al. 18100* (MO). **Cusco:** *Huamantupa et al. 4024* (MO). **Huánuco:** *Macurdy 1007* (F, MO); *Schunke 2992* (F). **Loreto:** *Fosberg 29017* (F); *Fosberg 29104* (F); *Gentry et al. 15599* (F); *Rimachi 6589* (F, MO). **Madre de Dios:** *Gentry et al.*

26739 (F). **Pampayacu:** *Macbride 5052* (F). **Pasco:** *Smith 2081* (F). **VENEZUELA. Amazonas:** *Fernández & Yáñez 745* (MO); *Guánchez 2132* (MO); *Liesner 4021* (MO); *Liesner 7454* (MO). **Guárico:** *Ramírez 2027* (NY). **Mérida:** *López-Palacios 2695* (LL).

Presumed hybrids with: **15. L. micrantha. BOLIVIA. Chuquisaca:** *Jiménez & Flores 777* (MO). **17. L. planaltensis. BRAZIL. Minas Gerais:** *Gentry et al. 49588* (MO), identification uncertain. **PARAGUAY. Itapúa:** *Pérez 179* (MO). **19. L. paraensis. SURINAME: Sipaliwini:** *Miller et al. 9367* (MO). **VENEZUELA. Bolívar:** *Sanoja 2343* (MO). See also taxa **1d, 2c, 4b, 9i (as cv.)** and **12b** and section on hybrid synonymy: **2c×13, 4b×13,** and **15×13/20?**

D. Lantana sect. **Lantana** series **Spicatae** R.W. Sanders, ser. nov. Type: *Lantana viscosa* Pohl ex Schauer

Adaxial leaf surfaces strigose-villosulous to setose-villous, the hairs up to 2.5 mm; abaxial leaf surfaces setose or pilose, often densely so, the hairs occurring on veins and non-innervated tissue, setiform or filiform, 0.2–2.0 mm. **Inflorescences** initially hemispheric becoming short-cylindric by prolonged initiation of flowers or elongation of internodes.

14. Lantana viscosa Pohl ex Schauer, Prodr. [A.P. de Candolle] 11:601. 1847. *Camara viscosa* (Pohl ex Schauer) Kuntze, Revis. Gen. Pl. 2:504. 1891. Type: BRAZIL: Goiás, *Pohl 1876 & 2680 (D.n. 181), left hand specimen* (lectotype: W[photo id. 1506]!). Remaining syntypes: BRAZIL: Goiás, *Pohl 1876 & 2680 (D.n. 181), right hand specimen* (W[photo id. 1506]!); BRAZIL: Goiás, *Pohl s.n.* (B, destroyed [Macbride Neg. 17492!], BR[photo at F!], F!, K[2,di!], W[photo id. 1505]!).

Shrubs erect or rounded and open to lax and subscandent; stems 1–3 m; branches ascending and numerous to clambering and few; twigs, peduncles and often petioles sparsely setose but viscid with dense understory of conspicuous stalked glands mixed with short hairs, the setae 1–2 mm, the stipitate glands and short hairs, ca. 0.5 mm. **Leaf-blades** broadly ovate, ovate, or ovate-elliptic, 2–8 cm long, the length 1.4–1.8(–2.2) × width, not nigrescent, papery, pinninerved; base usually rounded to truncate, sometimes broadly cuneate or subcordate, briefly narrowly cuneate onto petiole at very base; apex usually abruptly acuminate, sometimes acute; marginal teeth (10–)20–35 per side, acute to rounded, spreading to ascending, rarely appressed with tips recurved, with sinuses (0.3–)0.6–1.5 mm deep; adaxial surface dull, setose to villous, the hairs occurring on veins and intervening tissue, longer ones 1–1.5 mm or more (shorter ones ±. 0.5 mm, often mixed glandular and eglandular), 30–70/sq. mm, not noticeably vitreous-pustulate, the circular bases of the hairs ca. 0.1–0.2 mm in diam.; abaxial surface slightly lighter or duller green than adaxial surface, setose to villous, the hairs on all veins and intervening tissue, longer ones 1–1.5 mm or more (understory hairs 0.3–0.8 mm, these often mixed glandular and eglandular), 50–150/sq. mm. **Inflorescences** occasionally 2 per leaf axil, becoming short-cylindric by prolonged initiation of flowers; peduncles 0.5–1.3 × leaf length. **Proximal bracts** lanceolate or elliptic to ovate-elliptic, (2.5–)4–7 mm long, 1.5–3 mm wide, widest in proximal or middle third, with 3 veins from the base, ± spreading, persisting (proximally ± cupped around enlarging fruit) and becoming reflexed (± distally only) in fruit; apex abruptly acuminate with prolonged tip to caudate; indument setose-pilose, usually ciliate, often also stipitate-glandular, the longest hairs 0.7–1.5 mm. **Corolla** reddish purple to pale pink, often with white or yellow throat, occasionally white; corolla tube 5–10 mm.

Distribution and habitat.—Venezuela, Brazil (northern, eastern, and southern), Paraguay, Bolivia, and Peru, possibly also Ecuador, Colombia, and the Guianas; widely distributed but infrequent; openings in tropical evergreen forest, tropical savanna with gallery forest, and areas of dense woodland, shrubland, and grassland; 100–1200 m.

Selected specimens examined: **BRAZIL. Distrito Federal:** *Heringer et al 7087* (NY). **Pará:** *Strudwick & Sobel 4236* (LL[di], NY). **Pernambuco:** *Figueiredo et al. 38* (US). **PARAGUAY. Amambay:** *Zardini & Guerrero* (NY). **VENEZUELA. Bolívar:** *Steyermark et al. 115523* (NY).

Presumed hybrids with: **15. L. micrantha. PARAGUAY. Cordillera:** *Mereles & Degen 5522* (MO). See also taxa **2c, 4b,** and **12a** and section on hybrid synonymy: **12a×14.**

15. Lantana micrantha Briq., Annuaire Conserv. Jard. Bot. Gèneve 7–8:299. 1904. Type: PARAGUAY: Ascunción, Apr 1874, *Balansa 1039* (holotype: G[di!]; isotypes: K[di!], P[2,di!]).

Shrubs erect or rounded, open; stems 0.5–2 m; branches ascending and several; twigs, peduncles and often petioles moderately to densely setulose, setose, pilose, or also stipitate-glandular, the hairs usually 0.5–1.2 mm (these sometimes lacking), mixed with shorter glandular and eglandular hairs about 0.2–0.3 mm. **Leaf-blades**

broadly ovate, ovate-deltate, elliptic-ovate, or elliptic-lanceolate, (1.5–)3–9 cm long, the length 1.3–2 × width, not nigrescent, papery, usually pinninerved, sometimes triplinerved; base usually rounded to truncate, sometimes broadly cuneate or cordate, briefly narrowly cuneate onto petiole at very base; apex usually acute, sometimes abruptly acuminate or rounded; marginal teeth 10–35 per side, rounded, obtuse, or sometimes acute, usually spreading, with sinuses 0.4–1 mm deep; adaxial surface dull, antrorsely strigillose to strigose-pilose, the hairs occurring on veins and intervening tissue, the thin canopy of hairs only 0.2–0.5(–0.9) mm with understory of shorter hairs sometimes developed, 20–100/sq. mm, not noticeably vitreous-pustulate, the circular bases of the strigae 0.05–0.2 mm in diam.; abaxial surface duller green than adaxial surface, moderately densely (occasionally sparsely) pilose, the hairs on all veins and intervening tissue, 0.3–0.5 mm, all about same length, 40–250/sq. mm. **Inflorescences** occasionally 2 per leaf axil, elongating in fruit by expansion of internodes; peduncles 0.5–1.2 × leaf length. **Proximal bracts** ovate-elliptic to oblong-elliptic or -lanceolate, (2.5–)3–4.5(–6) mm long, (1–)1.5–2 mm wide, widest usually near middle, with 3 veins from the base, appressed or ascending, deciduous in fruit or persisting and becoming reflexed from base; apex acute to obtuse, sometimes abruptly acuminate to briefly attenuate; indument pilose to strigillose, not ciliate, the longest hairs 0.2–0.5 mm. **Corolla** pink to rose-red or reddish purple, yellowish throat developed at least in some cases; corolla tube 2–4 mm (briefly or not exserted beyond bract).

Distribution and habitat.—Central Bolivia, Paraguay, northern Argentina, and possibly southern Brazil; savanna, thickets, shrubland, thorn forest, tropical semi-evergreen forest, gallery forest; sandy or alluvial soil; 150–1500 m.

Selected specimens examined: **ARGENTINA. Corrientes:** *Pedersen 1328* (NY). **Formosa:** *Morel 781* (F). **Jujuy:** *Aroque & Barkley 19Ar525* (F); *Burkart et al. 30582* (MO). **Salta:** *Novara 3333* (MO). **BOLIVIA. Chuquisaca:** *Flores & Jiménez 69* (MO). **Santa Cruz:** *Nee 40029* (BRIT, NY); *Nee 46550* (BRIT); *Nee 47725* (BRIT). **Tarija:** *Fiebrig 2169* (F). **PARAGUAY. Central:** *Zardini & Velázquez 18174* (MO). **Cordillera:** *Molas & Brunner 948* (MO); *Schinini 9211* (F); *Zardini & Velázquez 20996* (MO). **Paraguarí:** *Zardini & Velázquez 15584* (MO). **San Pedro:** *Zardini et al. 48269* (MO); *Zardini et al. 48432* (MO).

Presumed hybrids with: **17 L. planaltensis. PARAGUAY. Paraguarí:** *Zardini & Pérez 2844* (MO). See also taxa **2c, 4b, 13, 14** and **17**, and section on hybrid synonymy: **4b×15,** and **15×13/20?**

SPECIES OF PRESUMED HYBRID ORIGIN BETWEEN SPECIES OF DIFFERENT SERIES

16. Lantana bahamensis Britton, Bull. New York Bot. Gard. 3:450. 1905. TYPE: BAHAMA ARCHIPELAGO. NEW PROVIDENCE: near Ft. Montague, 23 Aug 1904, *Britton & Brace 174* (HOLOTYPE: NY!; ISOTYPES: F!, US!).

Shrubs erect or rounded, open; stems 0.5–2.5 m; branches ascending or spreading, several; twigs, peduncles and often petioles glabrescent to strigose, the hairs 0.05–0.5 mm. **Leaf-blades** ovate-triangular, lanceolate-triangular, or elliptic, (1–)2–7 cm long, the length (1.3–)1.7–3.3 × width, often nigrescent, papery to subcoriaceous, triplinerved; base rounded or tapering from below middle of blade, usually shortly, narrowly cuneate onto petiole at very base; apex attenuate, acute or obtuse, or rarely rounded; marginal teeth 9–25 per side, rounded to acute, often appressed, with sinuses 0.3–0.5(–1) mm deep; adaxial surface lustrous, thinly scabrous, the hairs occurring on veins and center of areoles, 0.1–0.3 mm, 2–10/sq. mm, noticeably vitreous-pustulate, the circular bases 0.2–0.5 mm in diam.; abaxial surface slightly lighter or duller green than adaxial surface, mixed strigose-scabrous and pilose to nearly glabrous, with the strigae scattered on veins and veinlets, with filiform hairs in crevises along midrib and main veins, 0.1–0.3 mm, 3–40(–60)/sq. mm. **Inflorescences** remaining hemispheric; peduncles 0.5–1.2 × leaf length. **Proximal bracts** elliptic- or oblong-lanceolate to oblanceolate or spatulate (occasionally 1 or 2 outermost bracts subfoliar), 2–6 mm long, 0.5–1.5(–2.0) mm wide, widest in distal or middle third, or at proximal third, with 3 veins from the base, spreading or recurved, usually deciduous after flowering; apex acute to rounded; indument strigillose-scabridulous, hardly ciliate, the longest hairs 0.2–0.3(–0.5) mm. **Corolla** opening yellow or yellow-orange aging orange or red-orange; corolla tube 4–9 mm.

Distribution and habitat.—Central and southern Bahama Archipelago; thorn and sclerophyll shrubland/woodland, thickets and disturbance openings on thin calcareous soils; 0–70 m.

Morphological near intermediacy suggests that *Lantana bahamensis* originated from hybridization between the more or less sympatric taxa *L. camara* subsp. *camara* and *L. splendens*, probably prior to European colonization or perhaps human habitation. Moreover, the range of variation is narrower than expected for a hybrid swarm, and the distribution extends beyond the area of sympatry.

Selected specimens examined: **BAHAMA ARCHIPELAGO. Cat Island:** *Britton & Millspaugh 5763* (NY); *Correll 46083* (FTG, NY); *Correll 46098* (FTG, SMU). **Eleuthera:** *Lewis 7232 pp.* (FTG). **Grand Caicos:** *Gillis 12317* (LL). **Great Exuma:** *Correll & Correll 42298* (FTG, NY); *Correll & Correll 42465* (FTG, NY). **Long Island:** *Correll 48177* (FTG, LL); *Hill 2205* (LL, NY). **New Providence:** *Britton 3441* (NY); *Correll 45798* (FTG, NY); *Gillis 8364* (LL).

Presumed hybrids with: **20. L. strigocamara. BAHAMA ARCHIPELAGO. Eleuthera:** *Lewis 7232 pp.* (NY). **Watling's Island:** *Wilson 7331.* (NY). See also taxon **1a** and section on hybrid synonymy: **1a×16.**

17. Lantana planaltensis R.W. Sanders, nom. & stat. nov. *Lantana minasensis* Moldenke var. *hispida* Moldenke, Phytologia 23:454. 1972. *Lantana triplinervia* Turcz. var. *hispida* (Moldenke) Moldenke, Phytologia 28:402. 1974. Type: ARGENTINA. Corrientes: Santo Tomé, 3 Dec 1970, *Krapovickas et al. 17030* (holotype: LL!).

Shrubs erect or rounded, open; stems 0.5–4 m; branches ascending, several; twigs, peduncles and often petioles moderately to densely puberulent or setulose, sometimes with stipitate glands intermixed, the hairs mostly 0.1–0.4 mm, occasionally up to 0.8, rarely to 1 mm. **Leaf-blades** ovate, lanceolate or elliptic, 2–10 cm long, the length (1.4–)1.7–2.7 × width, ± nigrescent, papery, triplinerved; base attenuate onto petiole from widest point or rounded and abruptly narrowed to an often attenuate or cuneate petiolar wing; apex usually acuminate, sometimes acute; marginal teeth (14–)20–35(–50) per side, rounded, obtuse, or acute, spreading to appressed, then sometimes tip recurved, with sinuses 0.3–1.2 mm deep; adaxial surface dull to somewhat lustrous, antrorsely strigillose to strigose-pilose, the hairs occurring on veins and intervening tissue, forming a thin canopy of hairs only 0.3–0.5(–0.8) mm with understory of shorter hairs often well developed, (2–)20–80(–200)/sq. mm, sometimes vitreous-pustulate, the circular bases of the strigae ca. 0.1–0.3 m in diam.; abaxial surface slightly lighter or duller green than adaxial surface, moderately densely to sparsely pilose, if some strigiform hairs mixed in, then filiform hairs dominating, the hairs on all veins and intervening tissue, 0.05–0.5 mm, all about same length (or those on areoles evenly much shorter), occasionally a few along midrib to 0.8 mm, 20–150/sq. mm. **Inflorescences** occasionally 2 per leaf axil, remaining hemispheric; peduncles 0.2–0.7(–1.3) × leaf length. **Proximal bracts** linear-, narrowly elliptic-, or lanceolate-oblong (occasionally 1 or 2 outermost bracts subfoliar or narrowly spatulate and distinctly longer), 4–7 mm long, 0.5–1.5 mm wide, widest in proximal or middle third, with 3 veins from the base, appressed or spreading, usually deciduous after flowering; apex acute to attenuate, often rounded at very tip; indument pilose to strigillose, hardly ciliate, the longest hairs 0.2–0.3(–0.5) mm. **Corolla** opening yellow or white with yellow throat, aging to dark yellow, orange, or red, or opening white becoming infused with pink, blue, or purple, or opening pink, aging pink, purple, or white with yellow throat (those opening with yellowish pigments becoming infused with purple also expected); corolla tube 7–12 mm.

Distribution and habitat.—The Planalto of eastern and southern Brazil, northeastern Argentina, and eastern Paraguay; openings in tropical semi-evergreen forest, tropical savanna with gallery forest or areas of dense woodland, shrubland, and grassland; 0–1000 m.

The intermediacy and rather wide variation in characters that are less variable in other species suggests *Lantana planaltensis* to have arisen by hybridization between *L. horrida* subsp. *tiliifolia* and *L. nivea* subsp. *nivea*. Furthermore its geographic distribution far exceeds the zone of contact of the probable parental species, verifying its status as an independent species. The new name is required because *L. hispida* Kunth (= *L. horrida*) already exists. Most of the plants annotated by H.N. Moldenke and me as "*Lantana triplinervia*" are included here.

Selected specimens examined: **ARGENTINA. Buenos Aires:** *Cabrera 7020* (SMU, VBD); *Krapovickas 2891* (SMU). **Misiones:** *Ekman 1985* (F); *Schwarz 3635* (SMU); *Schwarz 4074* (F); *Zuloaga et al. 6633* (MO). **BRAZIL. Distrito Federal:** *Heringer 13834* (NY); *Heringer et al. 4253* (NY). **Goiás:** *Anderson 9479* (NY). **Mato Grosso do Sul:** *Hatschbach 49116* (LL[di]); *Salvador 3094* (US). **Minas Gerais:** *Hatschbach 25966* (US); *Hatschbach 46673* (NY); *Mexia 5436 p.p.* (US). **Paraná** *Hatschbach 11224* (F); *Hatschbach 16038* (VBD); *Hatschbach 24154* (US); *Hatschbach 41549* (NY); *Wasum 2498* (BRIT); *Winder 001* (BRIT). **Peranambuco:** *Silva et al. 82* (MO, US). **Rio de Janeiro:** *Carauta 3430* (LL[di]). **Rio Grande do Sul:** *Macedo 5507* (NY); *Sehnen 9562b* (US); *Wasum et al. 1425* (US); *Winder 006* (BRIT). **Santa Catarina:** *Reitz & Klein 1778* (F);

Winder 005 (BRIT). **São Paulo:** *Handro 2173* (NY); *Joly et al. 6778* (F); *Kuhlmann s.n. 25 Aug 1939* (US); *Romanic 689* (US). **PARAGUAY. Caazapá:** *Degan 99*, possibly with genes of *L. micrantha* (MO); *Mereles 2178* (MO). **Central:** *Fiebrig 954* (F). **Guairá:** *Jorgensen 3765*, location uncertain (F).

Presumed hybrids with: See also taxa **2c, 4b, 9i (as cv.), 12a, 12b, 13** and **15** and section on hybrid synonymy: **2c×17** and **12b×17.**

18. Lantana urticoides Hayek, Repert. Spec. Nov. Regni Veg. 2:162. 1906. Type: U.S.A. Texas: 1845–1846, *Lindheimer Fl. Tex. Exsic. No. 503* (lectotype, here designated: W[access. no. not recorded]!). Because *Exsic. No. 503* consists of two collection numbers (usually not identified on the sheets), which were mass collections, themselves mixed as to possibly including some hybrids, the duplicates should not be regarded as isotypes but as syntypes. Remaining syntypes: U.S.A. Texas. Kerr Co?: "Upper Guadalupe River," Jun 1845 (*Lindheimer 384*) and Comal Co.: New Braunfels, Aug 1856 (*Lindheimer 306*), *Lindheimer Fl. Tex. Exsic. No. 503* (CAN, n.v., F!, GH[2]!, MO[2]! SMU!, UC!, W[access. no. 93332]!). U.S.A. Texas. Comal Co.: *Matthes N. Amer. Pl. 19* (W, not found).

Lantana horrida Kunth f. *latibracteata* Moldenke, Phytologia 38:498. 1978. Type: U.S.A. Texas. Jim Hogg Co.: 23 Mar 1962, *Alvarez et al. 7782* (holotype: LL!).

Lantana urticoides Hayek var. *hispidula* Moldenke, Phytologia 39:424. 1978. Type: U.S.A. Texas. Medina Co.: 28 Oct 1952, *Correll 15206* (holotype: US!; isotype: LL!).

Shrubs erect or rounded, open; stems 0.6–2 m; branches ascending, several to numerous; twigs, peduncles and often petioles thinly to densely setose, the hairs 0.1–1.8 mm, the longest 0.8–1.8 mm. **Leaf-blades** broadly ovate or ovate-deltate to rotund, (1–)2–9 cm long, the length 1–1.5 × width, not nigrescent or only somewhat so, membranous to papery, pinninerved; base rounded, truncate, or cordate; apex rounded to abruptly acute; marginal teeth 5–15 per side, acute to obtuse, spreading, with sinuses (1–)1.5–5 mm deep; adaxial surface dull to occasionally lustrous, scabrous-setose to villous, the hairs occurring on veins and intervening tissue, 0.1–1.5 (longest ones usually 0.7–1.5) mm, (2–)5–20/sq. mm, noticeably vitreous-pustulate or not, the circular bases of the hairs ca. 0.1–0.5 mm in diam.; abaxial surface slightly lighter or duller green than adaxial surface, thinly to moderately densely setose or setulose to pilose, the hairs on most veins and some intervening tissue, longest ones 1.5–2 mm on proximal portions of major veins, those increasingly distal gradually reduced (near margin ca. 0.7 mm), those on intervening tissue mostly 0.2–0.5 mm, 5–20/sq. mm. **Inflorescences** remaining hemispheric; peduncles 0.8–2.3 × leaf length (usually nearly twice when mature). **Proximal bracts** narrowly oblanceolate or spatulate to elliptic-oblong, (5–)7–12 mm long, (1–)1.5–3 (rare outermost one subfoliar to 5) mm wide, widest in distal half or near middle, with 3 veins from the base, appressed or spreading, persisting and reflexed from base in fruit; apex obtuse or acute; indument strigose, ciliate or not, the longest hairs 0.3–0.7 mm. **Corolla** opening yellow, aging to red-orange; corolla tube 7–12 mm mm.

Distribution and habitat.—Central and southern Texas, Mexico (Coahuila, Nuevo León, Tamaulipas), apparently cultivated and naturalized across the southwestern and southeastern United States from northern Texas to California and to Florida and North Carolina; open woodlands, brushland, thickets, and grasslands on calcareous clays or sandy soils; 0–1000 m.

Lantana urticoides likely originated by hybridization between *L. hirsuta* subsp. *hirsuta* and *L. kingii*, having developed greater frost tolerance and a more northerly distribution than either parental species.

Selected specimens examined: **MEXICO. Tamaulipas:** *Dominguez & McCart 8231* (SMU). **U.S.A. Texas. Aransas Co.:** *Uzzell 51* (US). **Comal Co.:** *Lindhemer 334 (May 1850)* (SMU). **Duval Co.:** *Mahler 5287* (SMU). **Live Oak Co.:** *Whitehouse 18366* (SMU). **Medina Co.:** *Chaves et al. 99* (SMU); **San Patricio Co.:** *Jones 83* (SMU). **Somervell Co.:** *Helm s.n. 9 May 1948* (SMU). **Starr Co.:** *Garza et al. 8470* (SMU). **Travis Co.:** *Hansen 26* (VDB); *Lundell & Lundell 8928* (SMU). **Uvalde Co.:** *Dickey 70* (SMU). **Willacy Co.:** *Lundell & Lundell 8751* (SMU).

Presumed hybrids with: **20. L. strigocamara. MEXICO. Coahuila:** *Havard s.n. May 1883* (US). **Nuevo León:** *Rodriguez 62* (SMU); *Dodge 100* (NY). **Tamaulipas:** *Berlandier s.n. 1836* (NY). **U.S.A. Alabama. Baldwin Co.:** *Kral 39530* (NY, VDB). **Crenshaw Co.:** *Diamond 11455* (BRIT[di]). **Florida. Citrus Co.:** *Kral 4542* (SMU). **Marion Co.:** *Slaughter 13954* (BRIT[di], SMU). **Monroe Co.:** *Kral 53896* (VDB). **Georgia. Charlton Co.:** *Duncan 22077* (VDB). **Louisiana. Beauregard Par.:** *Thomas 153436* (BRIT, NY). **Winn Par.:** *Thomas 159711* (BRIT[di], NY). **South Carolina. Orangeburg Co.:** *Leonard et al. 5001* (VDB). **Texas. Blanco Co.:** *Sanders 5143* (SMU). **Cameron Co.:** *Hotchkiss 6244* (US). **Dallas Co.:** cult. *Niblack 50* (SMU). **Fayette Co.:** *Kral 68519* (VDB). **Galveston Co.:** *Waller 2579* (US). **San Saba Co.:** *Oliver 12* (SMU). **Tarrant Co.:** *Kral 91937* (VDB); *Whitehouse 16027* (SMU). **Val Verde Co.:** *Spjut & Marin 15152* (BRIT). See also taxa **4a, 6, 9i, 9i (as cv),** and **20** and section on hybrid synonymy: **18×20.**

19. Lantana paraensis (Moldenke) R.W. Sanders, comb. & stat. nov. Basionym: *Lantana cujabensis* Schauer var. *paraensis* Moldenke, Phytologia 48:290. 1981. Type: BRAZIL. Pará: Tucuruí, 17 Mar 1980, *Plowman et al. 9686* (holotype: LL!; isotypes: NY!, US!).

Lantana armata Schauer var. *guianensis* Moldenke, Phytologia 51:244.1982. TYPE: FRENCH GUIANA: Grand-Santi, 26 Aug 1961, *Schnell 11475* (HOLOTYPE: NY!).

Lantana cujabensis Schauer f. *albiflora* Moldenke, Phytologia 55:115. 1984. TYPE: BRAZIL. PARÁ: 0° 55'S, 54° 26'W, 23 Jul 1981, *Strudwick & Sobel 3404* (HOLOTYPE: LL!; ISOTYPES: MO!, NY!).

Shrubs rounded and ± open, lax, or subscandent; stems 0.5–5 m; branches ascending and several or clambering and few, occasionally herbaceous; twigs, peduncles and often petioles moderately setose or pilose, often with stipitate glands mixed in, or occasionally glabrescent, the hairs (0.1–)0.3–0.6(–1) mm. **Leaf-blades** broadly to narrowly ovate or ovate-elliptic, 3–9 cm long, the length 1.4–2.2 × width, nigrescent or not, papery, usually pinninerved; base rounded to subcordate and abruptly tapered onto petiole or cuneate; apex acuminate, sometimes with a prolonged narrow tip, or acute; marginal teeth 15–35 per side, rounded or acute, often appressed, then sometimes with tips recurved, with sinuses 0.5–1.5 mm deep; adaxial surface dull to occasionally lustrous, antrorsely strigose or strigose-setose, the hairs occurring on veins and intervening tissue, 0.1–0.6(–1.2) mm, 3–20/sq. mm, usually not noticeably vitreous-pustulate, the circular bases of the hairs ca. 0.1–0.2 mm in diam.; abaxial surface slightly lighter or duller green than adaxial surface, sometimes whitish green but not glaucous, antrorsely strigose to spreading-setose, with the hairs frequent on veins and veinlets, 0.1–0.7 mm, 3–10/sq. mm. **Inflorescences** often 2 per leaf axil, becoming short-cylindric (resembling spikes of *Carex lupulina*) by prolonged initiation of flowers; peduncles 0.5–1(–2) × leaf length. **Proximal bracts** lanceolate to lanceolate-elliptic, (4–)6–8(–10) mm long, (1.5–)2–3 mm wide, widest in proximal third to just below middle, with 5–7 veins from the base, spreading, persisting and recurved or reflexed (± distally) in fruit; apex acuminate with prolonged tip; indument setose or strigose to glabrescent, usually distinctly ciliate, the longest hairs (0.3–)0.5–1 mm. **Corolla** rose-pink or white with pale yellow throat and aging pinkish purple, rarely yellow to red-oranage; corolla tube 7–12 mm.

Distribution and habitat.— Brazil (central and eastern Amazonian), the Guianas, Venezuela (Amazonian) Colombia (Amazonian),and Bolivia (Amazonian); disturbance openings, savannas and man-made grasslands in tropical humid forest; 50–300 m.

Lantana paraensis exhibits characters of both *L. cujabensis* and *L. viscosa*, suggesting that it arose from natural hybrids of the two. Its species status is suggested by greater consistency in the expression of its traits than expected of a hybrid swarm and the much wider distribution than the area of sympatry of the proposed parental taxa.

Selected specimens examined: **BOLIVIA. Santa Cruz:** *Guillén & Roca 3523* (F). **BRAZIL. Amapá:** *Fróes & Black 27459* (LL[di]). **Amazonas:** *Croat 62252* (MO); *Tsugaru. & Sano B-598* (MO). **Pará:** *Ginzberger 822* (F); *Plowman et al. 9685* (F); *Secco et al. 198* (US). **Rondônia:** *Teixeira et al. 664* (F, NY). **COLOMBIA. Vichada:** *Davidse 5196* (MO). **FRENCH GUIANA. Saint-Laurent du Maroni:** *Marshall & Rombold 195* (MO). **SURINAME. Paramaribo:** *Florschütz & Florschütz 1693* (SMU). **Sipaliwini:** *Koemar et al. 18* (MO).

Presumed hybrids with: See also taxa **1d, 2c, 4b,** and **13.**

20. Lantana strigocamara R.W. Sanders, Sida 22:392. 2006. TYPE: U.S.A. FLORIDA. Dade Co.: Coral Gables, 23 Sep 1981, *Sanders 1450* (HOLOTYPE: FTG!; ISOTYPE: NY!).

Lantana mutabilis Lippold ex Otto & A. Dietr., Allg. Gartenzeitung 10:314. 1842. nom. illeg. TYPE: Unknown.

Shrubs erect or rounded, open; stems 0.3–3 m; branches ascending, several to numerous; twigs, peduncles and often petioles thinly to moderately strigose, setose, or pilose, the hairs 0.1–1.2(–1.5) mm, the longest mostly 0.5–1 mm. **Leaf-blades** ovate to broadly ovate, (2–)5–10 cm long, the length 1–1.7 × width, usually not nigrescent, papery, pinninerved; base rounded, truncate, or cordate, shortly and narrowly cuneate onto petiole at very base; apex usually acuminate; marginal teeth 15–40 per side, rounded to acute, often appressed, sometimes spreading at tip, with sinuses 0.5–1.5 mm deep; adaxial surface usually dull, antrorsely strigose or strigose-setose, the hairs occurring on veins and intervening tissue (sometimes just center of areoles), 0.2–1.2 (longest mostly 0.5–0.8) mm, 1–12/sq. mm, not noticeably vitreous-pustulate, the circular bases of the strigae ca. 0.1–0.2 mm in diam.; abaxial surface slightly lighter or duller green than adaxial surface, antrorsely strigose-scabrous, with the strigae scattered to moderately dense on veins and veinlets, 0.1–0.6 (longest ones usually 0.4–0.6) mm (sometimes accompanied by scattered short [mostly ≤ 0.3 mm] erect filiform hairs along major veins), 4–20/sq. mm. **Inflorescences** remaining hemispheric; peduncles 0.5–1.2 × leaf length. **Proximal bracts** narrowly triangular, linear-lanceolate, or linear-oblong (including those with slight constriction in proximal third; occasionally 1 or 2 outermost bracts subfoliar or narrowly spatulate), (3–)5–8(–10) mm long, 0.8–1.5 (rarely an occasional subfoliar bract up to 2) mm wide, widest at or just above the base, with 3 veins from the base, appressed or spreading, deciduous after flowering; apex acute to attenuate; indument strigose or strigillose, hardly ciliate, the longest hairs 0.2–0.6 mm. **Corolla** opening yellow or creamy white (rarely pure white) with yellow throat, aging to cream, dark yellow, orange, or red (rarely remaining white), often infused with pink or purple; corolla tube 7–12 mm.

Distribution and habitat.—Of cultivated origin; cultivated worldwide and escaped pantropically (especially southern United States, Caribbean Basin, India, Sri Lanka, Southeast Asia, and tropical Africa); open woodland, thickets, disturbance openings and man-made grassland, calcareous or sandy soils; 0–2000 m.

Sanders (2006) discussed *Lantana strigocamara* at length, and Sanders (1987a) illustrated the species (as "*camara*").

Selected specimens examined: **AUSTRALIA. Queensland:** *McAndrew 49* (BRIT). **BANGLADESH. Sylhet:** *Huq 10517* (BRIT). **CUBA. Havana:** *Curtis 754*, possibly hybridized (NY); *Wilson 9548* (NY). **EQUATORIAL GUINEA. Bata-Monte Alen-Engon:** *Carvalho 5528* (TEX). **FRENCH GUIANA. Cayenne:** *Ildeman B. 782* (LL). **GERMANY. Berlin:** cult., Bot. Gard. Berlin-Dahlem, *Wagenitz W387* (LL). **LESSER ANTILLES. Montserrat:** *Krauss 1270* (LL[2]). **St. Lucia:** *Krauss 1239* (LL[2]). **MEXICO. Chiapas:** *Matuda 18550* (NY). **Veracruz:** *Alexander 1594* (seed cult. at New York Bot. Gard.) (NY). **PUERTO RICO. San Juan:** cult., *Smith P.R. 49* (LL). **SRI LANKA. Central:** *Silva 2264* (SMU). **SURINAME. Para:** *Moldenke & Moldenke 19573* (SMU). **THAILAND. Chantaburi:** *Larsen et al. 1848* (LL). **TRINIDAD & TOBAGO. St. Augustine:** cult., *Smith Tr. 10* (LL). **U.S.A. Alabama. Mobile Co.:** *Rogers 4224* (VDB); *Taylor & Taylor 15246* (BRIT). **Arizona. Puma Co.:** *Rill 7147* (BRIT[di]). **Florida. Broward Co.:** *Churchill s.n. 18 Jun1968* (SMU); *Kasarijan 2* (BRIT). **Dade Co.:** *Kral 53927* (VDB); *Moldenke 5803* (NY). **Duval Co.:** *Curtiss 5692* (NY). **Flagler Co.:** *Longbottom & Williams 11286* (NY). **Lee Co.:** *Moldenke 947* (NY). **Palm Beach Co.:** *McCart 9369*, possibly × *L.* Callowiana Hybrid Group cv. (BRIT). **Polk Co.:** *Kral 63258* (VDB). **Seminole Co.:** *Longbottom & Williams 11027* (NY). **Louisiana. Vermilion Par.:** *Reese 6085*, possibly × *L. urticoides* (SMU). **Mississippi. Harrison Co.:** *Demaree 30705* (SMU[di]). **South Carolina. Beaufort Co.:** *Leonard & Radford 2743 p.p.*, possibly × L. Callowiana Hybrid Group cv. (SMU[di]). **Orangeburg Co.:** *Leonard et al. 5001* (SMU). **Texas. Blanco Co.:** *Sanders 5211* (BRIT). **Cameron Co.:** cult., *Lundell & Lundell 8626* (SMU). **Dallas Co.:** cult., *Stewart 135* (SMU). **VENEZUELA. Distrito Capital:** *Novo 2* (NY); *Scholtz 01* (LL). **VIRGIN ISLANDS. Tortola:** *Krauss 1667* (LL).

Presumed hybrids with: **L. (Callioreas) montevidensis. U.S.A. California: Los Angeles Co.:** cult., *Towner s.n. 1957-63*, see comment under 9i-cv×20 (BRIT). See also taxa **1a, 1b, 1c, 1d, 1e, 1f, 2a, 2bi, 2c, 4a, 6, 9i, 9i (as cv.), 9ii, 9iii, 12a, 12b, 16,** and **18** and section on hybrid synonymy: **1e×10/20, 2a×20, 9i-cv×20, 9ii×20, 10×20, 15×13/20?,** and **18×20.**

SYNONYMY OF PUBLISHED TAXA BASED ON PRESUMED INTERSPECIFIC HYBRIDS

1×2×12. Lantana camara × L. horrida × L. nivea

Lantana antidotalis Schumach. & Thonn. in Schumach., Beskr. Guin. Pl. 276. 1827. Type: GHANA: *Thonning 125* (lectotype: C!; isotype: C!).

1a×6. Lantana camara subsp. camara × L. scabrida

Lantana camara L. f. *caffertyi* I.E. Méndez, Willdenowia 32:294. 2002. Type: CUBA. Guantánamo: Yateras, 23 Jan 1996, *Méndez & Romano 8630* (holotype: HIPC[di!]).

1a×16. Lantana camara subsp. camara × L. bahamensis

Lantana bahamensis Britton f. *canescens* Moldenke, Phytologia 31:26. 1975. Type: BAHAMA ARCHIPELAGO. North Caicos Island: 1 Sep 1974, *Correll 43382* (holotype: NY!; isotypes: FTG!, LL!).

1d×2c. Lantana camara subsp. moritziana × L. horrida subsp. tiliifolia

Lantana tiliifolia Cham. var. *scabra* Schauer, Fl. Bras. [Martius] 9:257.1851. Type: GUYANA: 1837, *Schomburgh Pl. Guian. exs. 196* (lectotype, here designated: G-DC, mixed sheet, left specimen, barcode G00219524[di!]; isotypes: K, barcode:K000470755 [di!], W!).

Lantana camara L. [var. moritziana (Otto & A. Dietr.) López-Pal.] f. *aculeifera* Moldenke, Phytologia 52:129. 1982. Type: COLOMBIA. Boyacá: Boavita, 16 Sep 1938, *Cuatrecasas 1920* (holotype: US!).

1d×6. Lantana camara subsp. moritziana × L. scabrida

Lantana armata Schauer var. *velutina* Moldenke, Phytologia 23:180. 1972. Type: VENEZUELA. Táchira: Ureña, 8 Dec 1971, *López-Palacios 2616* (holotype: LL!; isotypes: NY[2]!).

1d×12b. Lantana camara subsp. moritziana × L. nivea subsp. mutabilis

Lantana camara L. f. *rubello-flavescens* Moldenke, Phytologia 50:309. 1982. Type: ECUADOR. Azuay: Chullabamba, cult., 10 Oct 1981. *Dodson & Dodson 11750* (holotype: LL!; isotype: MO!).

1e×2a. Lantana camara subsp. glandulosissima × L. horrida subsp. horrida

Lantana horrida Kunth f. *microphylla* Moldenke, Phytologia 40:260. 1978. Type: MEXICO. Durango: El Salto, 6 Jun 1967, *A. Moldenke 1495* (holotype: AAU!).

Lantana glandulosissima Hayek f. *aculeatissima* Moldenke, Phytologia 47:223. 1980. nom. illeg., publ. without type. Type: none.

1e×2a×10. Lantana camara subsp. glandulosissima × L. horrida subsp. horrida × L. kingii

Lantana urticoides Hayek f. *aculeata* Moldenke, Phytologia 49:182. 1981. Type: MEXICO. Puebla: Tehuacán, 4 Aug 1966, *Smith & Corona Mex-28* (holotype: MEXU[di!]).

1e×4a. Lantana camara subsp. glandulosissima × L. hirsuta subsp. hirsuta

Lantana glandulosissima Hayek var. *grandis* Moldenke, Phytologia 52:230. 1982. Type: PANAMA: Fort Sherman, 14 Jun 1923, *Maxon & Valentine 6988* (holotype: US!).

1e×10. Lantana camara subsp. glandulosissima × L. kingii

Lantana glandulosissima Hayek f. *parvifolia* Moldenke, Phytologia 49:182. 1981. Type: MEXICO. San Luis Potosí: 3 Aug 1956, *Rzedowski 7933* (holotype: MEXU[di!]).

1e×10/20. Lantana camara subsp. glandulosissima × L. kingii or L. strigocamara

Lantana camara L. [var. moritziana (Otto & A. Dietr.) López-Pal.] f. *albiflora* Moldenke, Phytologia 47:223. 1980. Type: MEXICO. Morelos: Yantepec, 14 Aug 1950, *Wyatt 45* (holotype: MEXU[di!]).

1f×2. Lantana camara subsp. aculeata × L. horrida (probably subsp. horrida)

Lantana mutabilis C.E. Weigel, Physiogr. Salsk. Handl. 1:46. 1776. Type: cult., Greifswald Bot. Gard., Aug 1774, *Pyl s.n.* (lectotype: JE[di!]).

1f×4. Lantana camara subsp. aculeata × L. hirsuta

Lantana mista L., Syst. Nat., ed. 12. 2:417. 1767. *Camara aculeata* (L.) Kuntze [var. *subinermis* Kuntze] f. *mista* (L.) Kuntze, Revis. Gen. Pl. 2:503. 1891. nom. illeg. (see taxon 1f) *Lantana aculeata* L. f. *mista* (L.) Voss, Vilm. Blumengärtn. ed.3, 1:823. 1894 (as "mixta"). *Lantana camara* L. var. *mista* (L.) L.H. Bailey, Cycl. Amer. Hort. [L.H.Bailey] 884. 1900. *Lantana camara* L. f. *mista* (L.) Moldenke, Phytologia 45:296. 1980. Lectotype: icon in Dillenius, Hort. Eltham. t.56, f.64. 1732.

Lantana albopurpurea Desf., Tabl. École Bot., ed. 3 (Cat. Pl. Horti Paris) 392. 1829. Type: cult., Hort. Paris. *s. coll.* (lectotype: FI[di!]).

1f×C. Lantana camara subsp. aculeata × L. sp. Ser. Strigosae

Lantana purpurea Hornem., Hort. Bot. Hafn. 2:583. 1815. Type: cult., Hort. Hafniensis 1814, *s. coll.* (holotype: C!).

2×C. Lantana horrida (probably subsp. horrida) × L. sp. Ser. Strigosae

Lantana flava Medik., Hist. & Commentat. Acad. Elect. Sci. Theod.-Palat. 3. Phys. 225. 1775. *Lantana camara* L.f. *flava* (Medik.) Moldenke, Phytologia 45:296. 1980. Lectotype: icon in Dillenius, Hort. Eltham. t.57, f.66. 1732.

2a×4a. Lantana horrida subsp. horrida × L. hirsuta subsp. hirsuta

Lantana polyacantha Schauer, Prodr. [A.P. de Candolle] 11:597. 1847. Type: MEXICO: *Schiede s.n.* (holotype: B, destroyed [Macbride Neg. 17481, F!]; lectotype, here designated: P, barcode P00713484[di!])

Lantana horrida Kunth f. *inermis* Moldenke, Phytologia 52:130.1982. Type: MEXICO: Yucatán, *Gaumer 808* (holotype: US!).

2a×10. Lantana horrida subsp. horrida × L. kingii

Lantana urticoides Hayek f. *macrophylla* Moldenke, Phytologia 49:431. 1981. Type: MEXICO. Sonora: San Bernardo, 13 Jul 1967, *Hernández 424* (holotype: MEXU[di!]).

2a×20. Lantana horrida subsp. horrida × L. strigocamara

Lantana camara L. var. *rubella* Moldenke, Phytologia 3:61. 1949. *Lantana camara* L. f. *rubella* (Moldenke) Moldenke, Phytologia 45:296. 1980. *Lantana aculeata* L. f. *rubella* (Moldenke) I.E. Méndez, Willdenowia 32:290. 2002. (Misapplied to *Lantana* Callowiana Hybrid Group pink-flowered cvs.) Type: CUBA. Havana: Guanabacoa, 27 Nov 1948, *Moldenke & Moldenke 19861* (holotype: NY!; isotype: US!).

2c×4b. Lantana horrida subsp. tiliifolia × L. hirsuta subsp. amazonica

Lantana armata Schauer, Linnaea 20:480. 1847. Type: VENEZUELA. Caracas, *Moritz 292* (lectotype: BM, barcode BM000992637[di!]; isotype: W!).

Lantana weberbaueri Hayek in Urb., Bot. Jahrb. Syst. 42:166. 1908. Type: PERU. Junín: Tarma, *Weberbauer 2017* (holotype?: B, destroyed [Macbride Neg. 17493, LL!, US!]).

Lantana micrantha Briq. f. *eitenorum* Moldenke, Phytologia 32:334. 1975. Type: BRAZIL. São Paulo: Muji-Gauçu, 31 Jul 1964, *Eiten & Eiten 5629* (holotype: US!; isotype: K[di!]).

2c×12b. Lantana horrida subsp. tiliifolia × L. nivea subsp. mutabilis

Lantana camara L. f. *glandulosa* R. Fern., Bol. Soc. Brot. sér. 2, 61:132. 1988. Type: ANGOLA. Malanje: Pungo Andongo, *Welwitsch 5676* (holotype: COI, n.v.; isotypes: BM[di!], K[di!], LISU p.p.).

2c×13. Lantana horrida subsp. tiliifolia × L. cujabensis

Lantana glutinosa Poepp. var. *rugosa* Moldenke, Phytologia 46:58. 1980. TYPE: PERU. JUNÍN: Latipo, Aug 1945, *Soukup 2862* (HOLOTYPE: NY!).

2c×17. Lantana horrida subsp. tiliifolia × L. planaltensis

Lantana tiliifolia Cham. f. *albiflora* Moldenke, Phytologia 3:311. 1950. TYPE: ARGENTINA. MISIONES: San Ignacio, 7 Mar 1946, *Schwarz 2185* (HOLOTYPE: NY!). Alternatively *nivea* subsp. *mutabilis* could possibly be the second parent of this specimen.

2/4×? Complex hybrid involving Lantana horrida or L. hirsuta

Lantana hybrida Hort. ex Neubert, Deutsch. Mag. Garten-Blumenk. 10:98. 1857. nom. illeg. *Lantana aculeata* L. var. *hybrida* (Hort. ex Neubert) Voss, Vilm. Blumengärtn. ed.3, 1:823. 1894. nom. illeg. LECTOTYPE: icon in Neubert, Deutsch. Mag. Garten-Blumenk. 10:t. facing p. 112. 1857.

4a×10. Lantana hirsuta subsp. hirsuta × L. kingii

Lantana hirta Graham f. *ternata* Moldenke, Phytologia 8:160. 1962. TYPE: MEXICO. NUEVO LEÓN: Cañon Diente, 8 Dec 1939, *Muller 2686* (HOLOTYPE: UC[di!]). Name based on a teratological specimen.

Lantana horrida Kunth f. *bracteosa* Moldenke, Phytologia 52:231. 1982. TYPE: MEXICO. PUEBLA: Puebla, 15 Sep 1910, *Arsène 5426* (HOLOTYPE: US!). May also include hybridization with *L. camara* subsp. *glandulosissima*.

4b×12a. Lantana hirsuta subsp. amazonica × L. nivea subsp. nivea

Lantana robusta Schauer, Prodr. [A.P. de Candolle] 11:601. 1847. TYPE: BRAZIL: Rio de Janeiro, *Pohl 40-5955 (D.n. 182)* (LECTOTYPE: W[photo id. 1504]!; ISOTYPE: W[photo id. 1503]!). Remaining SYNTYPES: BRAZIL: *Raben 509* (BR [photo at F!, LL!], NY[fragment]!).

Lantana minasensis Moldenke var. *longibracteata* Moldenke, Phytologia 13:242. 1966. *Lantana triplinervia* Turcz. var. *longibracteata* (Moldenke) Moldenke, Phytologia 28:403. 1974. TYPE: BRAZIL. MINAS GERAIS: Muriaé, 7 Jul 1964, *Castellanos 24984* (HOLOTYPE: LL!).

4b×13. Lantana hirsuta subsp. amazonica × L. cujabensis

Lantana cujabensis Schauer var. *hispida* Moldenke, Phytologia 46:58.1980. TYPE: ECUADOR. ESMERALDA: Lita, 8 Jun 1978, *Madison et al. 5016* (HOLOTYPE: AAU!; ISOTYPES: F, QCA, SEL).

4b×15. Lantana hirsuta subsp. amazonica × L. micrantha

Lantana micrantha Briq. var. *armata* Moldenke, Phytologia 2:468.1948. TYPE: BOLIVIA. COCHABAMBA: Arani ["Arami"], Feb 1944, *Cárdenas 2380* (HOLOTYPE: NY!).

9i-cv×20. L. Callowiana Hybrid Group cultivars (derived from tetraploid cv. L. depressa var. depressa × L. strigocamara)

Lantana callowiana Monrovia Nursery, Monrovia Nursery Catalog 1952–1953:44. 1952. nom. illeg. TYPE: none.

Lantana camara L. var. *nana* Moldenke, Phytologia 28:402. 1974. *Lantana camara* L. f. *nana* (Moldenke) Moldenke, Phytologia 45:296. 1980. TYPE: U.S.A. NEW YORK: cult., New York. Bot. Gard., 14 Oct 1941, *Moldenke & Moldenke 11903* (HOLOTYPE: NY!). This is either an early development release from Monrovia Nursery or an independent cultivation of a wild-collected hybrid between *L. depressa* var. *depressa* and *L. strigocamara*.

Lantana bahamensis Britton f. *albiflora* Moldenke, Phytologia 31:360. 1975. TYPE: U.S.A. GEORGIA: Glynn Co.: Jekyll Island, 20 May 1975, *Moldenke & Moldenke 29885* (HOLOTYPE: LL, n.v.; ISOTYPE: LL!). *Lantana* Callowiana Hybrid Group 'Cream Carpet'.

Sanders (2001) argued that the parents of the Callowiana Hybrid Group were *Lantana strigocamara* and *L. depressa* var. *depressa* rather than *L. strigocamara* and *L. montevidensis* (as claimed by Monrovia Nursery, see Howard 1969) based on character intermediacy and chromosome number incompatability of the latter combination. However, one likely hybrid of *L. montevidensis* with *L. strigocamara* was seen for this study (see taxon **20**), but it is very different in character details from the Callowiana Hybrid Group cvs, as well as appears to be sterile.

9ii×20. Lantana depressa var. floridana × L. strigocamara

Lantana floridana Raf., Atlantic J. 148. 1832. TYPE: unknown.

Lantana bartramii Baldwin, Reliq. Baldw. 247. 1843. TYPE: unknown. Besides items noted in Sanders (2006), "foliis ovatis" and "caule aculeato" in the very brief protologue suggest hybridity.

10×1a/1e? Lantana kingii hybrid (× L. camara subsp. camara or subsp. glandulosissima?)

Lantana camara L. f. *parvifolia* Moldenke, Phytologia 2:467. 1948. *Lantana aculeata* L. f. *parvifolia* (Moldenke) I.E. Méndez, Willdenowia 32:290. 2002. (Misapplied to *Lantana* Callowiana Hybrid Group multicolored cvs.) TYPE: U.S.A.: cult., New York. Bot. Gard., 27 Mar 1948, *Without collector* (HOLOTYPE: NY[di!]) Seeds vouchered by *Alexander & MacDougall 1580* (MEXICO. OAXACA: Tehuantepec); wild-collected specimen not found.

10×2a/4a? Lantana kingii hybrid (× L. horrida subsp. horrida or L. hirsuta subsp. hirsuta?)

Lantana hispida Kunth var. *ternata* Moldenke, Phytologia 2:225. 1947. TYPE: MEXICO. PUEBLA: Necaxa, Apr 1946, *Aguirre & Reko 172* (HOLOTYPE: NY!).

12×6/7? Lantana nivea × L. scabrida or L. splendens?

Lantana multiflora Otto & A. Dietr., Allg. Gartenzeitung 9:370. 1841. *Lantana camara* L. var. *multiflora* (Otto & A. Dietr.) Moldenke, Phytologia 2:18. 1941. *Lantana camara* L. f. *multiflora* (Otto & A. Dietr.) Moldenke, Phytologia 45:296. 1980. Type: cult., Hort. Berlin, *Otto s.n.* (lectotype: B, destroyed).

12a×14. Lantana nivea subsp. nivea × L. viscosa

Lantana pohliana Schauer, Prodr. [A.P. de Candolle] 11:601. 1847. *Camara pohliana* (Schauer) Kuntze, Revis. Gen. Pl. 2:504. 1891. Type: BRAZIL. Goiás: "Inter Pirapora et Jenipapa," *Pohl 3088 (D.n. 188)* (lectotype, here designated: W[photo id. 1501]!; isotypes: B, destroyed [Macbride Neg. 17480 at BRIT!, F!, GH!], F [fragment]!, K[2,di!], W [photo id. 1502]!,).

The collections known to me combine the reduced leaves subtending inflorescences typical of some *Lantana nivea* subsp. *nivea* (see comments, taxon **12a**) and the stipitate glands, bracts, and elongating receptacles of *L. viscosa*. They are geographically restricted near the type locality of *L. pohliana*, which is the area of sympatry of the two species. For a narrowly endemic taxon, they exhibit a pronounced inconsistency in structure, length, and density of trichomes compared to other natural taxa. These data suggest that the collections represent independent spontaneous hybrids, or at most, an unstable hybrid swarm. Thus, *L. pohliana* is not recognized as a taxon.

12b×17. L. nivea subsp. mutabilis × L. planaltensis

Lantana minasensis Moldenke var. *puberulenta* Moldenke, Phytologia 25:220. 1973. *Lantana triplinervia* Turcz. var. *puberulenta* (Moldenke) Moldenke, Phytologia 28:403. 1974. Type: BRAZIL. Bahia: Cocos, 17 Mar 1972, *Anderson et al. 37123* (holotype: LL!).

15×13/20? L. micrantha × L. cujabensis or L. strigocamara

Lantana micrantha Briq. f. *violacea* Moldenke, Phytologia 2:468.1948. Type: ARGENTINA. Chaco: Colonia Benitez, Nov 1935, *Schulz 1459* (holotype: NY!).

18×20. L. urticoides × L. strigocamara

Lantana rubra Berland. in Terán & Berland., Mem. Comisión Límites 15. 1832. Lectotype: icon in Berlandier in Ohlendorf et al., transl. Journey Mex., t.5 (top, facing p. 410). 1980. (see Sanders 2006)

EXCLUDED AND DUBIOUS NAMES

Lantana asperata Hort. ex Vis., Orto Bot. Padova 142. 1842. nom. nud. Type: unknown.

Lantana bahiensis Turcz., Bull. Soc. Imp. Naturalistes Moscou 36:206. 1863. Type: BRAZIL. Bahia: *Salzmann s.n.* (holotype: KW[di!]). Species of *Lantana* sect. *Callioreas*. (Misapplied to *L. planaltensis* by Moldenke in sched.)

Lantana camara L. var. *rosea* Mattoon, Plant Buyer's Guide, ed. 6. 167. 1958. nom. nud. *Lantana camara* L. f. *rosea* (Mattoon) Moldenke, Phytologia 45:296. 1980. nom. illeg. Type: none.

Lantana camara L. var. *rubra* Mattoon, Plant Buyer's Guide, ed. 6. 167. 1958. nom. nud. *Lantana camara* L. f. *rubra* (Mattoon) Moldenke, Phytologia 45:296. 1980. nom. illeg. Type: none.

Lantana cujabensis Schauer var. *punctata* Moldenke, Phytologia 2:411. 1948. ≡ *Lantana lopez-palacii* Moldenke, Phytologia 27:359. 1973. Type: COLOMBIA. Antioquia: Ceja, 1 Nov 1947, *Barkley et al. 1536* (holotype: MEDEL, n.v.). Species of *Lantana* sect. *Callioreas*.

Lantana hispida Kunth f. *alba* Moldenke, Phytologia 9:99. 1963. Type: GUATEMALA. Petén: Tikal ruins, 9 Jun 1960, *Contreras 1056* (holotype: LL!). Aff. *L. hirta* Grah. of sect. *Callioreas*.

Lantana hispida Kunth f. *parvifolia* Moldenke, Phytologia 52:130.1982. Type: HONDURAS. Morazán: Ciudad Universitaria, 26 May 1978, *Romero 71* (holotype: MO!). Aff. *L. velutina* M. Martens & Galeotti of sect. *Callioreas*.

Lantana micrantha Briq. var. *beckii* Moldenke, Phytologia 50:13. 1981. Type: BOLIVIA. Beni: Ballivián, 12 Apr 1981, *Beck 5339* (holotype: LL!). Aff. *L. fucata* Lindl. of sect. *Callioreas*.

Lantana multicolor Lem., Fl. Serres Jard. Eur. 3:239. 1847. nom. dub. Type: unknown.

Lantana notha Moldenke, Phytologia 1:422. 1940. Type: MEXICO. Sinaloa: Fuerte, 27 Mar 1910, *Rose et al. 13573* (holotype: NY!). Aff. *L. hirta* Grah. of sect. *Callioreas*.

Lantana pulchra Larrañaga, Escritos Dámaso Antonio Larrañaga 1:406. 1922 [Pub. Inst. Geog. Urag.]. nom. dub. Type: Destroyed.

Lantana purpurea (Jacq.) Benth. & Hook.f., Gen. Pl. [Benth. & Hooker f.] 2(2):1142. 1876. nom. illeg. (non Hornem.) Species of *Lippia* or *Lantana* sect. *Callioreas*.

Lantana riedeliana Schauer var. *pubescens* Moldenke, Phytologia 19:435. 1970. Type: BRAZIL: Rio de Janeiro, *Pabst 9310* (holotype: LL!). Aff. *L. fucata* Lindl. of sect. *Callioreas*.

Lantana rosea Raf., Sylva Tellur. 83. 1838. Type: unknown. Probably a species of *Lantana* sect. *Callioreas*.

EPITHET INDEX (USING TAXON AND HYBRID SYNONYMY CODES; EDN=EXCLUDED AND DUBIOUS NAMES)

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BOOK REVIEW

Craig Pittman. 2012. **The Scent of Scandal: Greed, Betrayal, and the World's Most Beautiful Orchid.** (ISBN: 978-0-8130-3974-9, hbk.). University Press of Florida, 15 Northwest 15th St., Gainesville, Florida 32611-2079, U.S.A. (**Orders:** http://www.upf.com). $24.95, 299 pp., b/w photos, 6" × 9".

After carefully reading this book, I turned to the back cover, and read the small heading: "TRUE CRIME/GARDENING." The first review stated: "FANTASTIC. If I did not know most of the main players I would have thought the author had a vivid and twisted imagination."—Paul Martin Brown, author of *Wild Orchids of Florida*"—(and also a number of other orchid books and papers.) I was delighted. AND I had had about the same reaction as he did. I had worked with Paul when I was Sr. Technical Editor for the *Flora of North America North of Mexico* project and had edited some of his contributions to the Orchidaceae. I also edited some of his other orchid manuscripts separately. I have tremendous respect for his contributions—AND his knowledge of orchids.

Long, long ago, I had married the son of a well-known African Violet (and companion plants) family. After college and a stint in the Air Force, we moved back to Illinois and settled down in a nearby small town. We immediately got involved with the plants (Gesneriaceae and Orchidaceae, especially)—AND my mother and I were quickly introduced to the monthly African Violet Club. (My father lovingly considered us all "a bunch of delightful screwballs.")

People who REALLY love orchids, African violets, and companion plants really do tend to get very involved, and often competition can get pretty nasty. Of course, there are local shows, state shows, regional, and national shows. Ribbons are nice to earn, but tempers can really skyrocket at times. The more involved one is—and the more competition gets heated—well, it can wreak havoc, even at the local level. When you get involved enough to go to the state shows and the national shows, most people are really committed to doing their best. However, while competition for new varieties is always a big challenge, when it comes to finding beautiful and truly new species in native soils in other countries, it can become truly illegal, involved, and potentially unlawful to bring in plants collected in other countries and illegally slipped through customs.

The Scent of Scandal is an actual, very carefully documented account of a rare and unusually beautiful orchid that got into the country, was recognized as an extremely new and beautiful specimen, caused all kinds of interest, all kinds of trouble, was illegally named, and becomes an absolutely true, carefully documented case history. Craig Pittman has done an incredible job of researching all strands of information, documentation, actions (good or bad), timing, and ultimately providing 242 pages of page-turning fascination, 43 pages of fine print, and a bibliography, tracing the path of one extremely beautiful, very rare, illegally named orchid but still bound to the name given it according to legal practice.

This is a page turner—with real people, real emotions, good intentions, devious actions, careless decisions, and a very beautiful plant—legally or illegally "officially named." It prompts numerous concerns all the way: legalities, illegal actions, some knowingly, others perhaps not so knowingly. And every bit is carefully researched and documented by the very capable author.—*Helen Jeude, Volunteer and Assistant Editor, Botanical Research Institute of Texas, 1700 University Dr., Fort Worth, Texas 76107-3400, U.S.A.*

CYTOTYPIC VARIATION IN *PHLOX PILOSA* SSP. *PILOSA* (POLEMONIACEAE) AT THE WESTERN EDGE OF ITS RANGE IN THE CENTRAL UNITED STATES

Lindsey Worcester, Mark H. Mayfield, and Carolyn J. Ferguson

Herbarium and Division of Biology
Kansas State University
Manhattan, Kansas 66506-4901, U.S.A.
ferg@ksu.edu

ABSTRACT

Polyploidy occurs frequently in plants, and some species exhibit intraspecific variation in ploidy level, or cytotypic variation. This study investigated cytotypic variation in *Phlox pilosa* L. ssp. *pilosa* (Polemoniaceae) along the western edge of its range from north central Texas to southeastern Kansas. Flow cytometry was used to assess genome size for individuals from 46 populations, and meiosis was observed for several populations using compound light microscopy to enable linkage of flow cytometry data with chromosome number. Results demonstrate that *P. pilosa* ssp. *pilosa* occurs as diploid and tetraploid populations in the region, with tetraploids generally occurring to the west of diploid populations. Three populations exhibited genome size values that were higher than expected for tetraploids, possibly due to presence of B chromosomes. This work contributes to an improved understanding of polyploidy in the genus *Phlox*.

RESUMEN

La poliploidía ocurre con frecuencia en las plantas, y algunas especies presentan variación intraespecífica en su nivel de ploidía, o variación citotípica. Este estudio investigó la variación citotípica en *Phlox pilosa* L. ssp. *pilosa* (Polemoniaceae) a lo largo del borde occidental de su área de distribución desde el centro norte de Texas hasta el sureste de Kansas. Se utilizó la citometría de flujo para evaluar el tamaño del genoma de individuos de 46 poblaciones, y se observaron meiosis en varias poblaciones utilizando microscopía óptica para permitir la vinculación de los datos de citometría de flujo con el número de cromosomas. Los resultados demuestran que *P. pilosa* ssp. *pilosa* ocurre como poblaciones diploides y tetraploides en la región, con las tetraploides generalmente al oeste de las poblaciones diploides. Tres poblaciones mostraron valores del tamaño del genoma que eran más altos de lo esperado para tetraploides, posiblemente debido a la presencia de cromosomas B. Este trabajo contribuye a una mejor comprensión de la poliploidía en el género *Phlox*.

KEY WORDS: autopolyploidy, chromosome count, cytotype, flow cytometry, *Phlox*, Polemoniaceae, polyploidy

INTRODUCTION

Polyploidy is frequent in plants and is considered an important factor in plant evolution (Otto & Whitton 2000; Adams & Wendel 2005; Soltis et al. 2009; Soltis et al. 2010). Autopolyploidy, or genome doubling within a species, can lead to intraspecific ploidy level (cytotypic) variation (although some autopolyploids alternatively meet criteria for species recognition; see Soltis et al. 2007). Such cytotypic variation within species may be underappreciated, as systematists have sometimes made assumptions about ploidy levels for entire taxa based on one or few chromosome counts. Advances in flow cytometry methods enable rapid assessment of genome size and inference of ploidy level (Doležel & Bartoš 2005), and recent studies have demonstrated intriguing cytotypic variation in some species (e.g., Balao et al. 2009; Cires et al. 2009; Whittemore & Olsen 2011). Documentation of cytotypic variation is a critical first step toward understanding ecological, genetic, and taxonomic consequences of autopolyploidy in particular groups.

Phlox pilosa L. (Polemoniaceae) is a showy, upright, perennial species ranging throughout most of the eastern United States, from the east coast to the edge of the Great Plains and Central Texas (Wherry 1955; Great Plains Flora Association 1986; Gleason & Cronquist 1991). *Phlox pilosa* exhibits noteworthy morphological variation across its range, and several subspecies are usually recognized (Wherry 1955; Levin & Smith 1965; Levin 1966; Locklear 2011; see also Ferguson 1998). *Phlox pilosa* ssp. *pilosa* occurs in prairies and woodland openings across most of the general range of *P. pilosa* as a whole, with westernmost populations occurring in north central Texas and south central Oklahoma. Most published chromosome counts for *P. pilosa* are diploid, and represent the wide-ranging *P. pilosa* ssp. *pilosa* (e.g., Kelly & Wahl 1928; Flory 1931 [*P. argillacea* Clute &

Ferris, a taxonomic synonym], 1934; Meyer 1944; Levin & Smith 1965; Levin 1966, 1968; Smith & Levin 1967; see also Levin & Schaal 1970; Levy & Levin 1974). However, there has long been a suggestion of polyploidy near the western edge of the range of *P. pilosa* ssp. *pilosa*. Smith and Levin (1967) reported a tetraploid chromosome count for material of *P. pilosa* ssp. *pilosa* from a mile south of Sachse, Texas (Dallas County, in north central Texas) and one tetraploid count for material of *P. pilosa* ssp. *pilosa* from the state of Arkansas (precise locality unknown). This has led to some question regarding ploidy level and possible cytotypic variation in *P. pilosa* ssp. *pilosa* in the region.

Phlox pilosa is one of the most thoroughly studied species of the genus *Phlox* (due particularly to the extensive systematic and ecological research conducted by D.A. Levin and colleagues in the 1960s and 1970s; e.g., citations listed above), and further work on *P. pilosa* advances the utility of *Phlox* as a study system. *Phlox* is a genus of ca. 60 species of perennial herbs occurring mostly in North America (Wherry 1955; Locklear 2011; Ferguson et al. in prep. [FNA vol. 15]). The base chromosome number for *Phlox* is x=7 (Flory 1934), and diploid, tetraploid and hexaploid chromosome counts have been reported (see Kelly & Wahl 1928; Flory 1931, 1934, 1937, 1948; Meyer 1944; Levin 1964, 1966, 1968; Levin & Smith 1965; Eater 1967; Smith & Levin 1967; Löve 1971; Strakosh 2004; Fehlberg & Ferguson 2012 and in press). Furthermore, polyploidy has been implicated as a factor contributing to complicated patterns of phylogeny, including incongruence between nrDNA and cpDNA phylogenies for samples of *P. pilosa* and close relatives (Ferguson & Jansen 2002; see also Ferguson et al. 1999). Study of cytotypic variation within *P. pilosa* ssp. *pilosa* can thus be placed within an extensive broader research context.

In this study, patterns of cytotypic variation in *P. pilosa* ssp. *pilosa* were explored at the western edge of its range, from north central Texas to eastern Oklahoma, western Arkansas, and southeastern Kansas. Flow cytometry was conducted chiefly on fresh field-collected leaf material, as well as previously preserved material for some populations (silica gel-dried, frozen, or herbarium material). Meiotic chromosome counts were performed on bud material from several populations to enable ploidy level inferences based on genome size (Doležel et al. 2007).

MATERIALS AND METHODS

Field collection.—Material was collected from over 50 populations of *P. pilosa* ssp. *pilosa* ranging from the general area of the earlier reported tetraploid count in Texas (Smith & Levin 1967) and north along the western edge of the taxon range as far as southeastern Kansas. Fresh leaf material from an individual plant from each population was reserved for flow cytometry. For some populations, leaves from multiple individuals were collected in silica gel to enable later testing for cytotypic variation within populations. For populations at an early stage of flowering, bud material for chromosome counts was collected (and preserved in a solution of 3 parts 95% ethanol: 1 part glacial acetic acid, with subsequent transfer to 70% ethanol). Voucher specimens from all populations were prepared and deposited in the Kansas State University Herbarium (KSC). This study was further augmented with material from several populations previously collected (material that had been collected in silica gel or fresh-frozen and stored at -70°C, and one recent herbarium specimen).

Flow cytometry.—DNA content per cell was assessed for individuals using flow cytometry. At least one individual was sampled per population, with additional within-population sampling for 11 populations. Leaf material (0.04–0.10 grams) was chopped with a fresh razor blade in 2 mL of chopping buffer specified by Davison et al. (2007; modified from Bino et al. 1993). The resulting slurry was filtered through 30 µm nylon mesh (Small Parts, Inc.), followed by vortexing and centrifugation (500 RCF for 7 minutes). The supernatant was decanted off of the pellet, or if a pellet did not form, approximately half of the liquid was decanted. Propidium iodide staining solution (BioSure; 700 µL) was added to each sample to fluorescently stain the DNA; and 2 µL of chicken erythrocyte nuclei (CEN) singlets (BioSure) were added to each sample as an internal standard. Samples were vortexed and stored on ice for 1–2 hours prior to processing on a Becton Dickinson FACS-Calibur flow cytometer at the Flow Cytometry Lab of the College of Veterinary Medicine, Kansas State University.

The flow cytometer quantifies the amount of DNA by measuring the fluorescence per nucleus. The resulting histogram for each sample was analyzed using CellQuest software (Becton Dickinson), and a coefficient of variation (CV) was obtained. To ensure highest quality data, we aimed to retain samples with measurements based on ca. 10,000 nuclei per sample and having CV values <5% (see Galbraith et al. 1997; Doležel & Bartoš 2005). Picogram (pg) amounts were then calculated using the equation from Doležel and Bartoš (2005).

Chromosome counts.—Chromosome counts were conducted using a modified version of B.L. Turner's squash technique for meiotic cells (Jones & Luchsinger 1986). These counts enabled linking of picogram DNA amounts to chromosome numbers for *P. pilosa* ssp. *pilosa*, and thus inference of ploidy levels based on flow cytometry data.

RESULTS

Flow cytometry data were retained for 46 populations: these samples had 10,005–11,205 nuclei scored and CV values from 1.91–4.98% (Table 1). Flow cytometry worked well for the *Phlox* material; most runs yielded high quality data, although some samples did not meet criteria for inclusion (see Materials and Methods; due to lower numbers of events, high CV values, or, occasionally, poorly defined peaks). Based on these data (Table 1), cytotypic variation in *P. pilosa* ssp. *pilosa* was inferred, with 13 diploid populations, 30 tetraploid populations, and three unusual populations with higher DNA content (discussed below). DNA content per nucleus for the diploid and tetraploid populations averaged 10.66 pg (range 9.22–13.36 pg) and 21.90 pg (range 18.27–24.81 pg), respectively (based on measurements of all individuals; Table 1). The three remaining populations had an average DNA content per nucleus of 26.55 pg (range 23.59–29.46 pg; Table 1).

For 11 populations, additional individuals (2–9) were analyzed. No cases of intrapopulational cytotypic variation were inferred (Table 1). However, measured within population variation in picogram values ranged from 0.26 pg (in diploid population 16) to 4.13 pg (in tetraploid population 17; Table 1).

Chromosome counts were obtained, including a diploid count (*n*=7) and a tetraploid count (*n*=14; Fig. 1a, 1b; Table 1). Cells undergoing meiosis were also observed for two of the three populations that exhibited high genome size values (populations 12 and 13). Cells from some buds of population 12 showed clear tetraploidy (*n*=14), while those from other buds suggested additional chromosomes or chromosomal fragments (although clear counts could not be obtained). Cells from buds of population 13 appeared to have more chromosomes than the tetraploid material (*n*=17+), although the chromosomes could not be sufficiently spread apart. While it is possible that higher level polyploids are present, these results may also be due to the presence of B chromosomes (supernumary chromosomes; see Smith & Levin 1967 for reports of B chromosomes in *P. pilosa*; see also Meyer 1944 for notation of "fragments" in meiotic figures of some *Phlox* taxa).

Mapping the cytotypic data for sampled populations revealed a generally east-west pattern (Fig. 2), with diploid populations occurring in the eastern part of the sampling range, tetraploid populations in the western part, and the three populations with unusually high DNA content in southeastern Oklahoma (Fig. 2).

DISCUSSION

This study demonstrates that *P. pilosa* ssp. *pilosa* occurs as diploid and tetraploid populations at the western edge of its range from the southeastern Great Plains (sensu Great Plains Flora Association 1986) and south into northern Texas. This variation does not correspond to any previously recognized infraspecific taxa in *P. pilosa*, and no morphological differences were noticed among cytotypes (future work will investigate micromorphology of these populations). Interestingly, two subspecies of *P. pilosa* occurring further west in Texas (onto the Edwards Plateau) are known to be tetraploid (*P. pilosa* ssp. *latisepala* Wherry and *P. pilosa* ssp. *riparia* Wherry; see Levin 1966, 1968; Smith & Levin 1967). Some workers have recognized these Central Texas taxa at the specific level, partly due to the polyploid condition: *P. aspera* E.E. Nelson and *P. villosissima* (A. Gray) Whitehouse (Levin 1968; Levin & Schaal 1970; Levy 1973); or, as a single species under *P. villosissima* (Turner 1998; Locklear 2011). Our documentation of tetraploid populations of *P. pilosa* ssp. *pilosa* in northern Texas (and northward) indicates that there are no ploidy level differences precluding intergradation with the Central Texas taxa. Investigation of population level morphological, genetic, and cytotypic variation are warranted

Table 1. Samples of *P. pilosa* ssp. *pilosa*: population number, locality, voucher information, sample material, average DNA content per nucleus based on flow cytometry (n; min.-max. values), and inferred ploidy level based on DNA content (and linked to chromosome count information in addition, as indicated by an asterisk).

Popn.	Locality	Voucher(s)[1]	Sample material	DNA content (pg)	Ploidy level[1,2]
1	Scott Co., AR	CJF 448	Frozen	12.34 (1)	2x, n=7
2	Sevier Co., AR	CJF 457	Frozen	10.11 (1)	2x, n=7
3	Bourbon Co., KS	LW 26	Fresh	9.56 (1)	2x, n=7
4	Montgomery Co., KS	LW 2	Fresh	22.62 (1)	4x, n=14
5	Neosho Co., KS	LW 24	Fresh	10.50 (1)	2x, n=7
6	Neosho Co., KS	LW 25	Fresh, Silica gel	9.96 (6; 9.22–10.95)	2x, n=7
7	Wilson Co., KS	LW 1	Fresh	22.33 (1)	4x, n=14
8	Carter Co., OK	MHM 3847	Fresh	23.80 (1)	4x, n=14
9	Cherokee Co., OK	LW 19	Fresh	11.27 (1)	2x, n=7
10	Cherokee Co., OK	LW 20	Fresh, Silica gel	20.00 (4; 19.29–21.27)	4x, n=14
11	Cherokee Co., OK	LW 103	Fresh	9.52 (1)	2x, n=7
12	Choctaw Co., OK	LW 107*	Silica gel	25.42 (3; 23.59–26.52)	4x+*, n=14+
13	Choctaw Co., OK	MHM 3854, LW 89*	Fresh, Herbarium	27.87 (2; 26.27–29.46)	4x+*, n=14+
14	Craig Co., OK	LW 22	Fresh	18.27 (1)	4x, n=14
15	Creek Co., OK	LW 5	Fresh	22.99 (1)	4x, n=14
16	Delaware Co., OK	LW 104	Fresh, Silica gel	10.04 (2; 9.91–10.17)	2x, n=7
17	Haskell Co., OK	LW 100	Fresh, Silica gel	21.30 (9; 19.79–23.92)	4x, n=14
18	Latimer Co., OK	LW 15	Fresh	12.04 (1)	2x, n=7
19	Latimer Co., OK	LW 99	Fresh, Silica gel	11.01 (1)	2x, n=7
20	Le Flore Co., OK	CJF 473	Silica gel	13.36 (1)	2x, n=7
21	Mayes Co., OK	LW 21	Fresh	23.01 (1)	4x, n=14
22	McCurtain Co., OK	CJF 470	Silica gel	27.28 (1)	4x+, n=14+
23	Muskogee Co., OK	LW 8	Fresh	22.13 (1)	4x, n=14
24	Muskogee Co., OK	LW 9	Fresh	24.75 (1)	4x, n=14
25	Muskogee Co., OK	LW 10	Fresh	21.00 (1)	4x, n=14
26	Muskogee Co., OK	LW 11, LW 97*	Fresh, Silica gel	20.40 (4; 19.65–20.75)	4x*, n=14
27	Nowata Co., OK	LW 3	Fresh	22.39 (1)	4x, n=14
28	Nowata Co., OK	LW 4	Fresh	22.46 (1)	4x, n=14
29	Okmulgee Co., OK	LW 7	Fresh	24.45 (1)	4x, n=14
30	Okmulgee Co., OK	LW 98	Fresh, Silica gel	22.15 (8; 20.60–23.49)	4x, n=14
31	Pontotoc Co., OK	MHM 3856	Fresh	23.59 (1)	4x, n=14
32	Pushmataha Co., OK	LW 13	Silica gel	23.03 (2; 21.27–24.29)	4x, n=14
33	Pushmataha Co., OK	LW 14	Silica gel	22.54 (1)	4x, n=14
34	Sequoyah Co., OK	LW 17, LW 93*	Fresh	11.75 (1)	2x*, n=7
35	Sequoyah Co., OK	LW 18	Fresh	11.17 (1)	2x, n=7
36	Tulsa Co., OK	LW 6	Fresh	23.97 (1)	4x, n=14
37	Wagoner Co., OK	LW 101	Fresh, Silica gel	24.15 (2; 23.48–24.81)	4x, n=14
38	Wagoner Co., OK	LW 102	Fresh, Silica gel	21.60 (1)	4x, n=14
39	Bowie Co., TX	CJF 418	Frozen	24.79 (1)	4x, n=14
40	Grayson Co., TX	MHM 3848	Fresh	20.06 (1)	4x, n=14
41	Grayson Co., TX	MHM 3849	Fresh	20.95 (1)	4x, n=14
42	Grayson Co., TX	MHM 3850	Fresh	22.53 (1)	4x, n=14
43	Lamar Co., TX	CJF 416, MHM 3851	Fresh, Frozen	20.86 (6; 19.15–22.90)	4x, n=14
44	Lamar Co., TX	MHM 3852	Fresh	22.81 (1)	4x, n=14
45	Lamar Co., TX	MHM 3853	Fresh	24.44 (1)	4x, n=14
46	Red River Co., TX	CJF 417	Frozen	22.89 (1)	4x, n=14

[1] Asterisks indicate chromosome count information: an asterisk in the voucher column signifies the voucher linked to bud material for a chromosome count, and an asterisk in the ploidy level column indicates confirmation of the ploidy level inference (2x or 4x; or 4x and/ or higher [4x+]; see text) by the chromosome count.

[2] Diploid, 2x, 9.22–13.36 pg; tetraploid, 4x, 18.27–24.81 pg; populations including individuals with higher than expected DNA content for tetraploids, 4x+, 23.59–29.46 pg (see text).

across the Central Texas taxa and *P. pilosa* ssp. *pilosa* to better understand diversity in the region. Intriguingly, the narrowly endemic *P. pilosa* ssp. *longipilosa* (Waterf.) J. Locklear, occurring in granite outcrops of southwestern Oklahoma, is diploid (MHM & CJF, unpubl. chromosome count data). To our knowledge, polyploidy

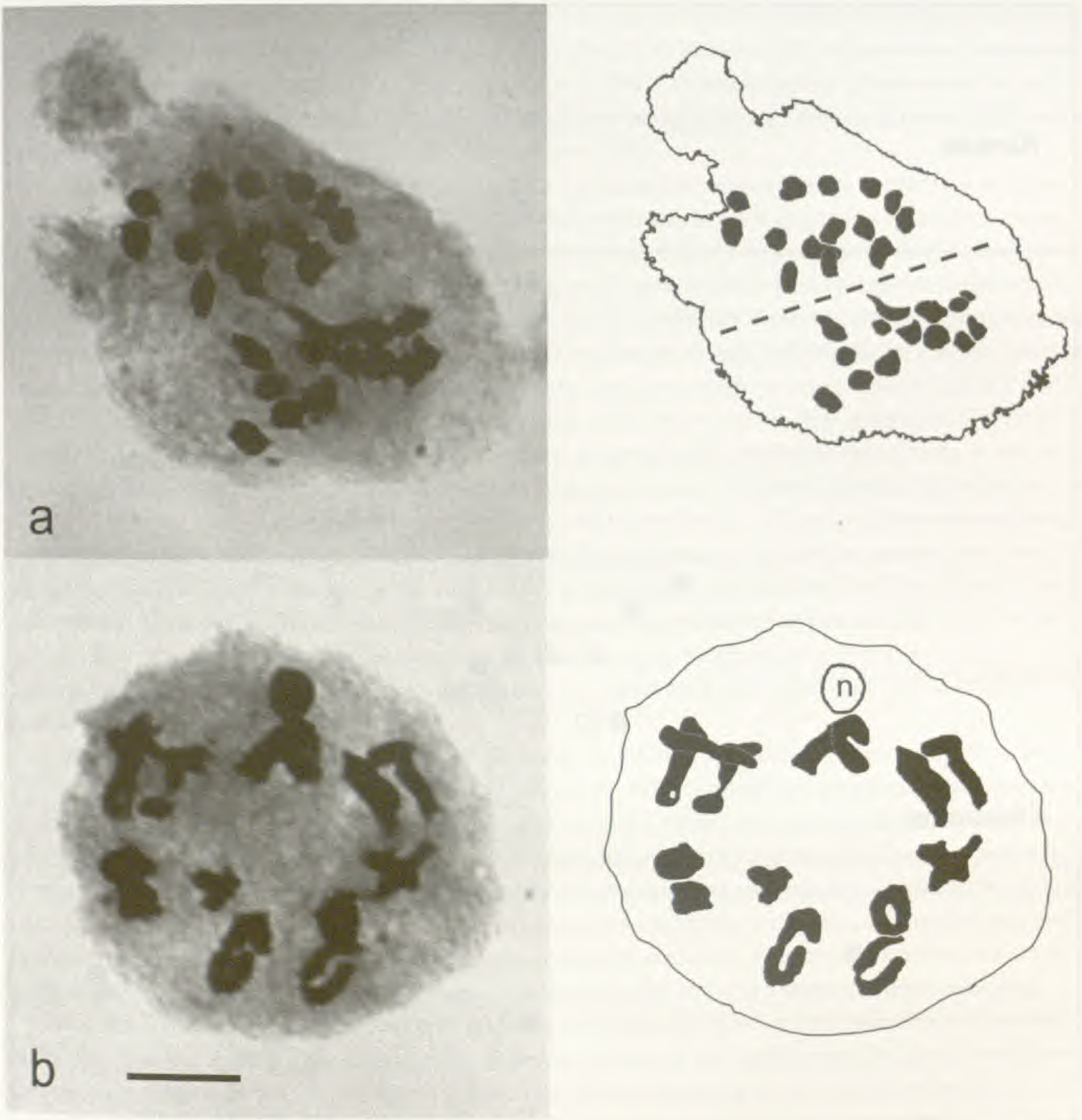

Fig. 1. Images of meiosis from compound light microscopy (with drawings showing interpretation) documenting tetraploidy (n=14) for population 26; **a)** Anaphase I (image, left; and drawing, right); **b)** Metaphase I (image, left; and drawing, right). The scale bar (lower left) indicates 10 µm, and the label "n" (1b, drawing) indicates the nucleolus.

within *P. pilosa* thus occurs in the region sampled in the present study (southeastern Kansas and south into northern Texas; in *P. pilosa* ssp. *pilosa*), west and south through Central Texas (in *P. pilosa* ssp. *latisepala* and *P. pilosa* ssp. *riparia*).

While most populations of *P. pilosa* ssp. *pilosa* examined in this study were inferred to be diploid or tetraploid, three populations in southeastern Oklahoma had unusually high DNA content per nucleus, and compound light microscopy of meiosing cells suggested presence of chromosomes (or chromosome fragments) beyond the tetraploid number. Further cytological study of these populations will be necessary to definitively document ploidy. Accessory, B chromosomes have been documented in *P. pilosa* ssp. *pilosa* (Smith & Levin 1967; in populations from central and northern Alabama, northeastern Arkansas, and northwestern Indiana), and may well explain the variation detected here. Although perhaps less likely, higher ploidy levels are also

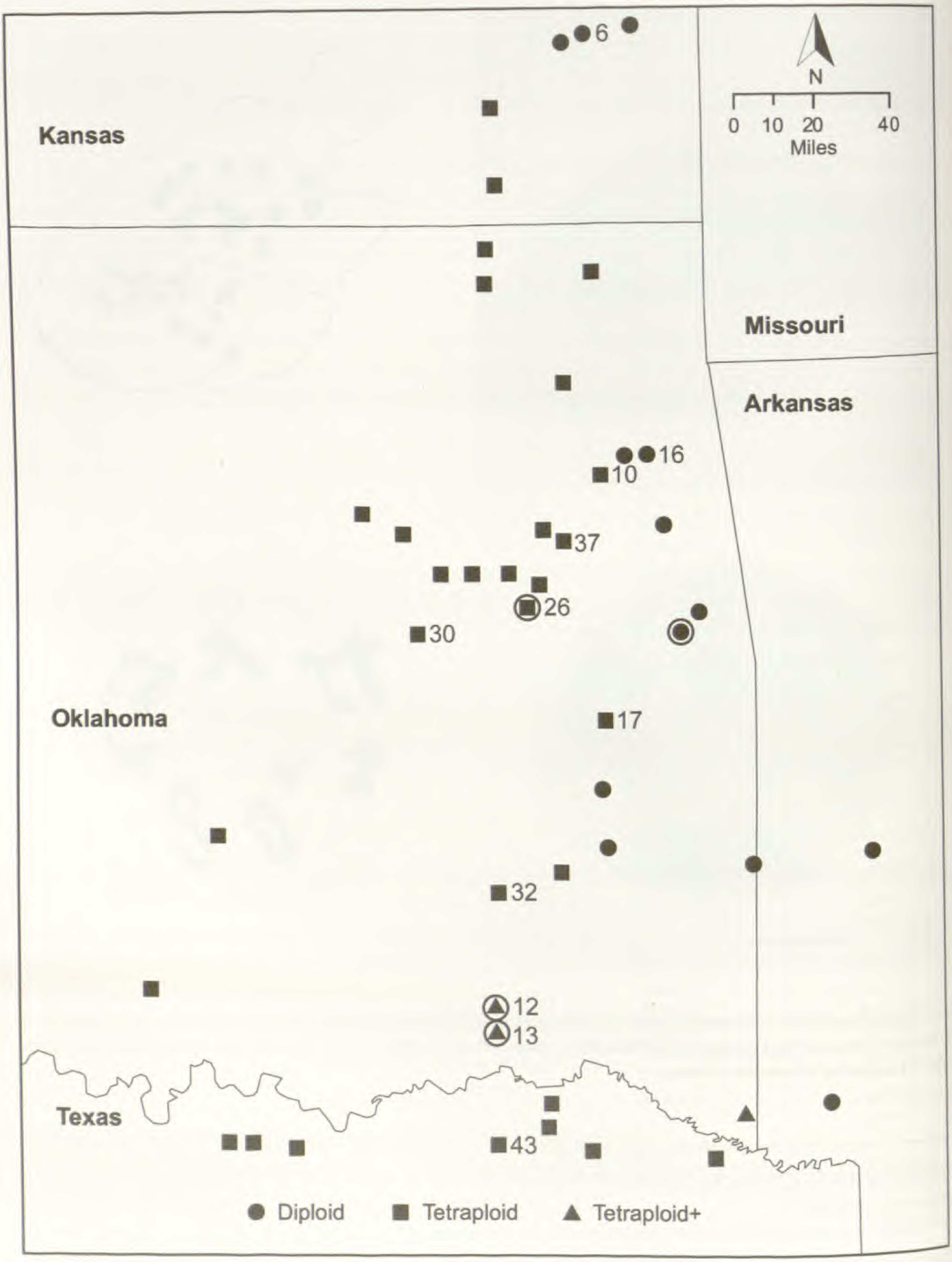

Fig. 2. Map showing localities of *P. pilosa* ssp. *pilosa* samples included, with state names labeled. Diploid populations are indicated with circles, tetraploid populations with squares, and populations with unusually high DNA content ("tetraploid+") with triangles. A circle surrounding a shape symbol indicates that meiosis was observed with compound light microscopy (Table 1). Populations for which more than one individual was analyzed using flow cytometry are indicated by population number (Table 1) to the direct right of the symbol.

known in *Phlox*. For example, Fehlberg & Ferguson (2012; in press) have found diploid, tetraploid and hexaploid cytotypes in *P. amabilis* Brand and *P. woodhousei* (A. Gray) E.E. Nelson (with evidence from chromosome counts, flow cytometry, and population genetic data); Eater (1967) obtained diploid, tetraploid and hexaploid chromosome counts for *P. nana* Nutt. (following current taxon recognition; e.g., Wilken & Porter 2005); and a hexaploid count is known for *P. andicola* E.E. Nelson (Löve 1971).

Tetraploid individuals of *P. pilosa* ssp. *pilosa* have a genome size approximately double that of diploids (averaging 21.90 pg [*n*=58] vs. 10.66 pg [*n*=19]; populations with unusually high genome size values averaged 26.55 pg [*n*=6]). Ranges in genome size within a ploidy level (e.g., 9.22–13.36 pg for individual diploids) were somewhat greater than expected. For example, Fehlberg and Ferguson (2012) found picogram ranges within a ploidy level of less than three picograms for *P. amabilis* and *P. woodhousei*. However, their sampling on a per cytotype basis within a taxon was more limited (with a maximum of eight individuals for a single cytotype [tetraploids] within *P. amabilis* and a maximum of 18 individuals for a single cytotype [also tetraploids] within *P. woodhousei*; Fehlberg & Ferguson 2012). In the present study, there were no clear geographical patterns to genome size variation within cytotypes: in some cases, geographically proximate populations of the same ploidy level differed greatly (e.g., DNA content for two Wagoner County, Oklahoma, tetraploid populations was 21.60 vs. 24.15 pg), and measurements from individuals within populations differed (with the extreme being a tetraploid population with a range in values slightly over four picograms). Variation in genome size observed within a ploidy level for *P. pilosa* ssp. *pilosa* may reflect, at least in part, an error level for flow cytometry measurements in this study; it may reflect true variation in genome size within cytotypes, and this could be due in part to differential presence of B chromosomes (discussed above; see Smith & Levin 1967); or, cytotypic variation may actually be more complex than inferred here (i.e., some additional cytotypes such as triploids and hexaploids may be present).

Spatial patterns of cytotypic variation in *P. pilosa* ssp. *pilosa* show that tetraploids generally occur west of diploid populations, potentially under more xeric conditions. While diploid and tetraploid populations were detected in close proximity (within eight miles), we did not detect mixed cytotype populations (though, within-population sampling was limited). Cytotypes are somewhat separated by geographic features, particularly river systems: for example, the Neosho River in southeastern Kansas separates sampled diploids to the east and tetraploids to the west. Into central Oklahoma (where most of our sampling was conducted), tetraploid populations tend to occur at slightly lower altitudes relative to diploids and west of major river systems, but detailed study of potential ecological correlates of cytotypic variation in the area will require additional sampling.

Documentation of intraspecfic cytotypic variation in *P. pilosa* ssp. *pilosa* at the western edge of its range is intriguing, and sets the stage for further study exploring ecological and cryptic morphological correlates of this variation. This work advances study of systematics of *Phlox* by adding to our understanding of cytotypic variation. Current work in our lab seeks to synthesize chromosome count and flow cytometry data for *Phlox* in a revised taxonomic context. In a broader context, cytotypic variation may in general be underappreciated in plants: for certain, systematists should not assume inference of ploidy level for an entire taxon based on one or few chromosome counts alone. Broader surveys (made easier through techniques such as flow cytometry) and detailed studies of cytotypic patterns promise to improve our general understanding of this aspect of biodiversity in plants.

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BOOK REVIEW

David Bramwell and Juli Caujapé-Castells (eds.). 2011. **The Biology of Island Floras.** (ISBN 978-0-531-11808-8, hbk.). Cambridge University Press, 100 Brook Hill Drive, West Nyack, New York 10994-2133, U.S.A. (**Orders:** www.cambridge.org; phone 1-800-872-7423, fax 845-353-4141), $120.00, 536 pp., weight 2.65 lbs., 72 b/w illus., 36 tables, 9¾" × 6⅞".

It is estimated that the biodiversity of 53 archipelagos includes between 50,000 and 52,000 plant endemic species worldwide that are highly threatened, and 20,000 of these species are in critical danger of extinction as part of fragile ecosystems. This suggests the urgency and importance of continued study of island biodiversity and conservation highlighted in this book. The 21 separate chapters and 48 authors discuss the evolution, diversity, and conservation of island vascular plants.

Some examples of chapters that emphasize specific island groups are: Origin and evolution of Hawaiian endemics: new patterns revealed by molecular phylogenetic studies; Origin and evolution of Galapagos endemic vascular plants; The plants of the Caribbean islands: a review of the biogeography, diversity and conservation of a storm-battered biodiversity hotspot; The biogeography of Madagascar palms; Evolution and biogeography of the flora of the Socotra archipelago (Yemen); Biogeography and conservation of the flora of New Caledonia; Phytogeography and relationships of the Pitcairn Islands flora; Chromosomes and evolution in New Zealand endemic angiosperms and gymnosperms; Jesters, red queens, boomerangs and surfers: a molecular outlook on the diversity of the Canarian endemic flora; and Dispersal, diversity and evolution of the Macaronesian cryptogamic floras.

The prestigious list of 48 contributors are represented by Juli Caujapé-Castells, David Bramwell, Daniel J. Crawford, Gregory J. Anderson, Gabriel Bernardello, Paula Posadas, Jorge V. Crisci, Liliana Katinas, Sterling C. Keeley, Vicky A. Funk, Alan Tye, Javier Francisco-Ortega, Michael Maunder, Melissa Abdo, Rosalina Berazain, Colin Clubbe, Francisco Jiménez, Ángela Leiva, Eugenio Santiago-Valentín, John Dransfield, Mijoro Racotoarinivo, Lisa M. Banfield, Kay Van Damme, Anthony G. Miller, Steve Waldren, Naomi Kingston, Brian G. Murray, Peter J. de Lange, M. Dolores Lledó, Per O. Karis, Manuel B. Crespo, Michael F. Fay, Mark W. Chase, Alain Vanderpoorten, Ben Laenen, Rosalina Gabriel, Juana M. González-Mancebo, Fred J. Rumsey, Mark A. Carine, Michael Kiehn, Ole Hamann, Stuart Cable, Jennifer L. Trusty, Herbert C. Kesler, Jorge Rodríguez, Sara Oldfield, and Vernon H. Heywood.

The Socotra archipelago in the Indian Ocean off the coast of Yemen currently counts 835 as endemic vascular plant species. Some of the tree species are unique plant growth forms found nowhere else in the world. The most outstanding example is the so-called bottle tree (*Adenium obesum* subsp. *sokotranum* (Apocynaceae)), a succulent that stores water in the swollen trunk. Also, *Dorstenia gigas* (Moraceae) has a similar appearance and is far larger than any other species of its genus, suggesting these may be examples of island gigantism. The island has been described as the most alien-looking place on the planet earth. Additionally, the dracoid growth forms (e.g., *Dracaena cinnabari* (Ruscaceae))—which have a single trunk with ramified branches coming off at one point on the trunk giving an umbrella-shaped crown—occur in 15 unrelated species, suggesting that this growth form has survival value in this landscape.

Exploration, collections, and research on island biology have been supported largely by botanic gardens as part of Botanic Gardens Conservation International, BDCI. These activities are highlighted in a chapter titled "Botanic gardens and the conservation of island floras." This network of people and organizations operates to support the multidisciplinary conservation objectives to protect and understand insular endemic floras. The features of this book update recent research advances including molecular biology, genetic diversity, population dynamics, invasiveness, and colonization events that include human intervention among others as they apply to island biology and conservation.

An abstract for each chapter that briefly summarizes the salient points represented in the topical headings would have been a valuable addition. Each chapter is a stand-alone thematic topic that has supporting references. This book should be on the bookshelf of every biologist who teaches plant evolution, plant systematics, ecology, and conservation as well as decision-makers and organizations who seek to preserve biodiversity.—*Harold W. Keller, Research Associate, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76102-4025, U.S.A.*

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A NEW COMBINATION AND A NEW SPECIES IN *COMBRETUM* (COMBRETACEAE) FROM INDIA

K.A. Sujana, M.K. Ratheesh Narayanan[1], and N. Anil Kumar[1]

Central Botanical Laboratory, Botanical Survey of India
AJCB Indian Botanic Garden, Botanical Garden
P. O., Howrah, West Bengal – 711103, INDIA
Author for correspondence: sujanacabc@yahoo.com

ABSTRACT

Quisqualis malabarica Bedd. is transferred to *Combretum* and a new combination, viz., **Combretum malabaricum** (Bedd.) Sujana, Ratheesh, & Anil, is proposed. **Combretum recurvatum** Sujana, Ratheesh, & Anil, a new species allied to *Combretum malabaricum* (Bedd.) Sujana, Ratheesh, & Anil, is described from South Western Ghats of Kerala with illustration and photographs.

RESUMEN

Quisqualis malabarica Bedd. se transfiere a *Combretum* y se propone una nueva combinación, **Combretum malabaricum** (Bedd.) Sujana, Ratheesh, & Anil. **Combretum recurvatum** Sujana, Ratheesh, & Anil, se describe una nueva especie emparentada con *Combretum malabaricum* (Bedd.) Sujana, Ratheesh, & Anil, del suroeste de Ghats de Kerala con una ilustración y fotografías.

INTRODUCTION

The genus *Quisqualis* L. (Combretaceae) comprises ca. 16 species of lianas from the Old World tropics (Exell & Stace 1966). Recent research, however, has shown that the supposed differences with *Combretum* Loefl. cannot be maintained on the basis of molecular evidence (Jongkind 1991; Stace 2007; Maurin et al. 2010). *Quisqualis* dates from 1762, *Combretum* from 1758, and the latter name therefore has priority. Gangopadhyay and Chakrabarty (1997) recognized two species of *Quisqualis* from India, viz., *Q. indica* L. and *Q. malabarica* Bedd. The latter is here transferred to *Combretum* and a new combination, viz., *Combretum malabaricum* (Bedd.) Sujana, Ratheesh, & Anil is proposed. Both species have been recorded for Kerala (Nayar et al. 2006; Sasidharan 2011).

During botanical exploration as part of a project on "Investigation of rare, endemic and threatened woody climbing plants of the Western Ghats," one of us (Sujana) collected specimens with recurved petals from the Aralam Wildlife Sanctuary in 2008 which did not match with any known species of *Combretum* or *Quisqualis* and is therefore described as a new species here. The species, although morphologically similar to the *Combretum malabaricum* (Bedd.) Sujana, Ratheesh, & Anil, comb. nov., differs from it in some characters; these data are given in Table 1.

TAXONOMY

Combretum malabaricum (Bedd.) Sujana, Ratheesh, & Anil, comb. nov. (**Fig. 1**). *Quisqualis malabarica* Bedd., Icon. Pl. Ind. Or. 1:33, t. 155. 1874. TYPE: INDIA. KERALA: Carcoor ghat Wayanad, elev. ca. 450 m, *Beddome s.n.* (LECTOTYPE: MH - Acc. No. 20405; ISOLECTOTYPE: BM).

Combretum recurvatum Sujana, Ratheesh, & Anil, sp. nov. (**Figs. 2, 3**). TYPE: INDIA. KERALA. Kannur district: Aralam Wildlife Sanctuary, ca. 800 m, 28 Feb 2008, *Sujana 0509* (HOLOTYPE: CAL; ISOTYPES: CALI).

A liana, 15–20 m tall. Stems 15–25 cm in diameter; bark light brown with vertical striations, spines 1.5–2.5 cm long, at the base of the branchlets; young branchlets puberulous, purplish, terete. Leaves opposite, ovate to oblong, symmetric, 4–15 × 4–7 cm, membranous, glabrous above, lead-coloured when dry, brown beneath, domatia as tufts of brown hairs in the axils of the secondary nerves, base rounded, margins entire to undulate

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[1] Community Agrobiodiversity Centre, M. S. Swaminathan Research Foundation, Puthoorvayal, P.O., Kalpetta, Wayanad, Kerala – 673121, INDIA

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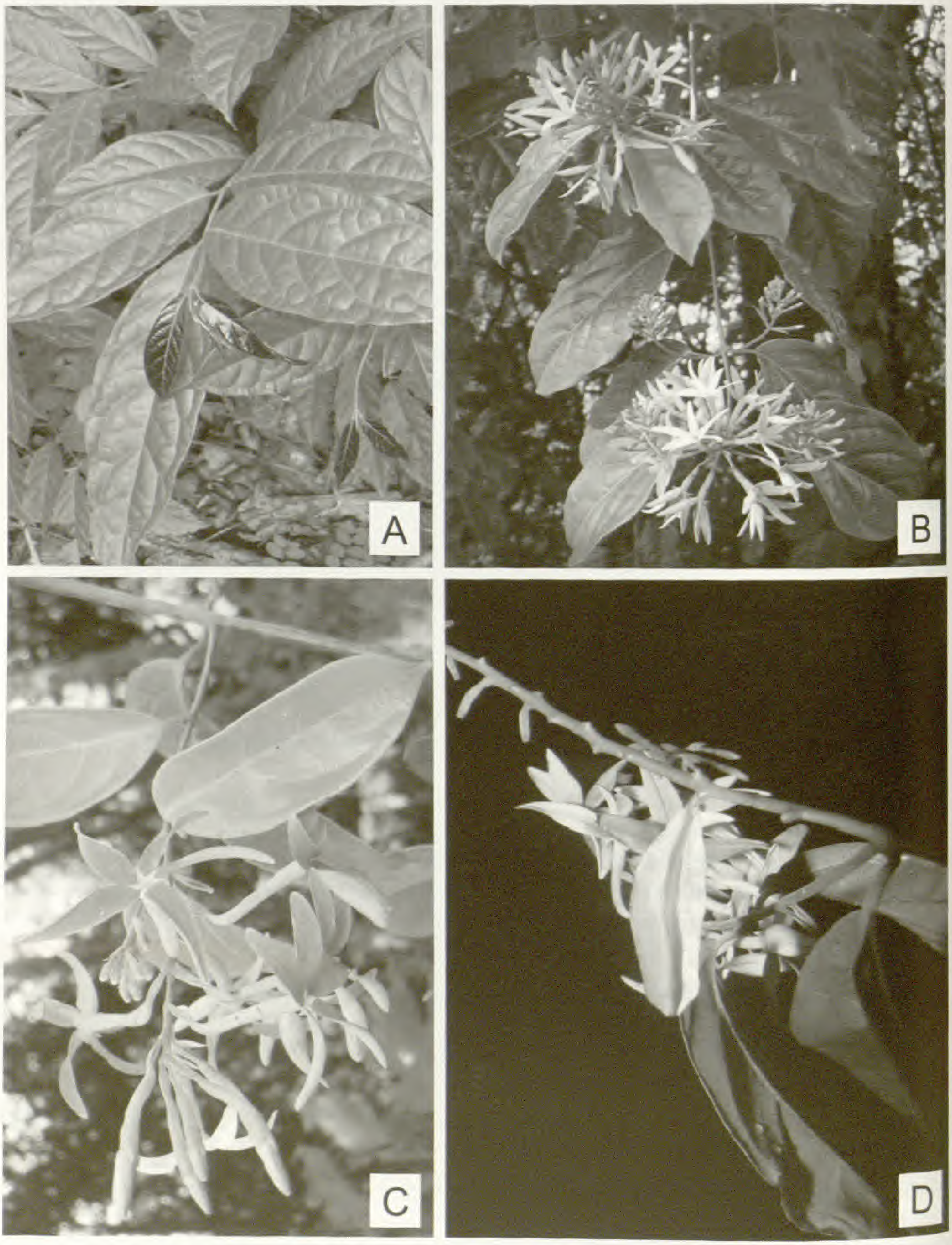

Fig. 1. *Combretum malabaricum* (Bedd.) Sujana, Ratheesh, & Anil. **A.** Habit, **B.** Inflorescence, **C.** Flowers–close up, **D.** Fruit.

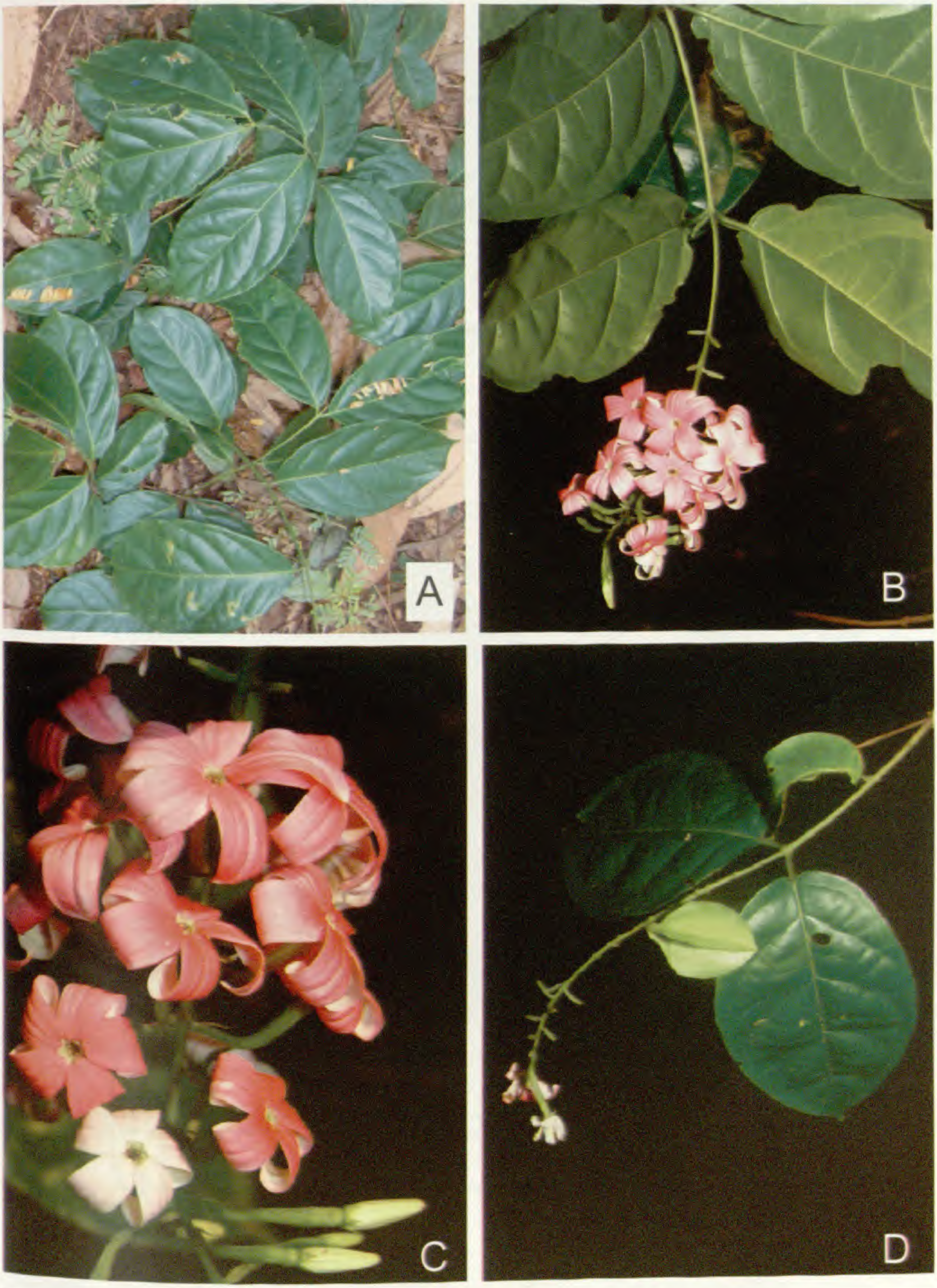

Fig. 2. *Combretum recurvatum* Sujana, Ratheesh, & Anil. **A.** Habit, **B.** Inflorescence, **C.** Flowers – close up, **D.** Fruit.

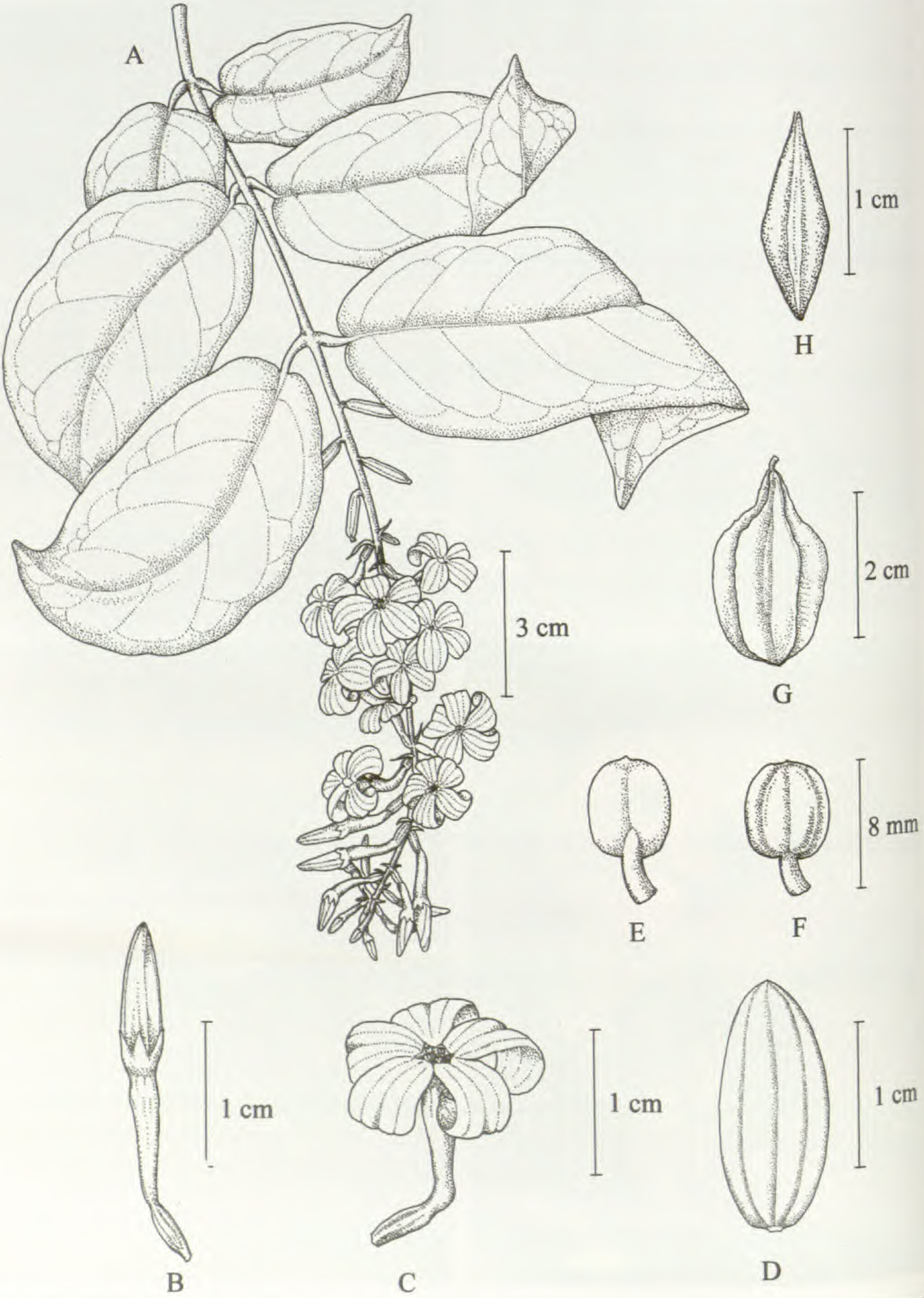

Fig. 3. *Combretum recurvatum* Sujana, Ratheesh, & Anil. **A.** Flowering twig, **B.** Mature bud, **C.** Flower, **D.** Petal, **E.** Stamen-ventral view, **F.** Stamen-dorsal view, **G.** Fruit, **H.** Seed.

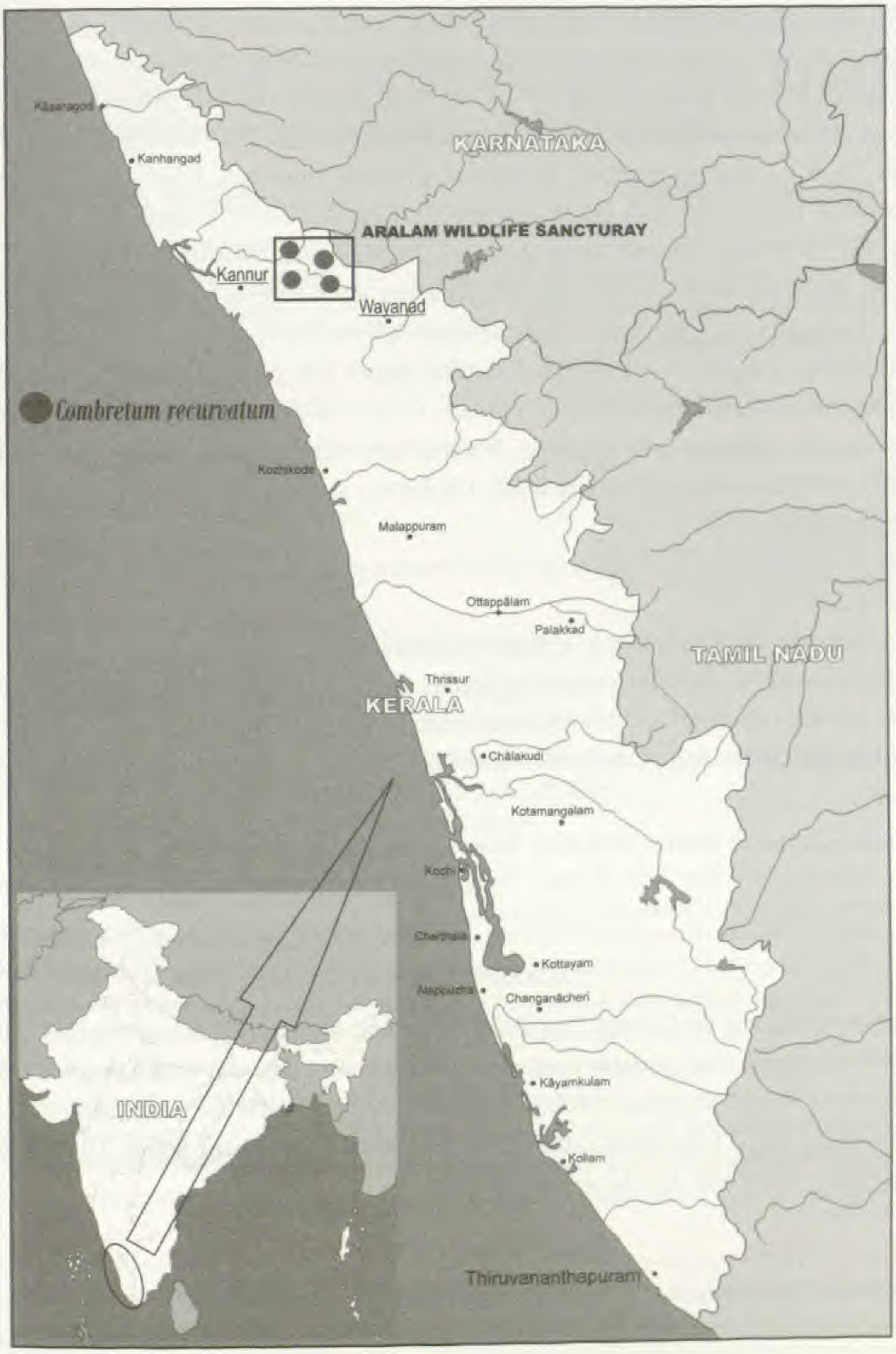

Fig. 4. Distribution of *Combretum recurvatum* in Aralam Wildlife Sanctuary.

Table 1. The distinguishing features between *Combretum recurvatum* and *C. malabaricum*.

Characters	*C. recurvatum*	*C. malabaricum*
Inflorescence	18–26 flowered	8–16 flowered
Peduncle	7–11 cm long, purple	3.6 – 4.4 cm long, green
Flower size	1.5–1.7 × 1.5–1.6 cm	2.4–2.5 × 2–2.2 cm
Pedicels	0–1 mm	6.3 mm
Calyx teeth	3 mm long, apex recurved	1.7 mm long, apex straight
Petals	13–14 × 6.8 -7 mm, recurved, ovate or oblong, apex obtuse, veins 3, distinct	8–12 × 2–3 mm, straight, linear lanceolate, apex acute, veins indistinct
Stamens	Apex protruded	Apex notched
Fruits	Widely ellipsoid or ovoid, 2–2.3 × 1.8–2.2 cm	Ellipsoid, 2.4–2.5 × 1.3–1.5 cm

with tawny hairs, apex shortly acuminate or acute, lateral veins 5–8 pairs, slender, adaxially faint, abaxially prominent, arcuate, tertiary nerves adaxially faint, sometimes abaxially prominent, scalariform, marginal ultimate veins recurved to form loops; petioles 1–1.2 cm long, sulcate, densely pubescent. Inflorescence terminal, spicate, 18–26-flowered; peduncles slender, purplish, puberulous, 7–11 cm long; bracteoles linear-lanceolate or triangular, ca. 5 × 1 mm, tomentose, deciduous. Flowers 5-merous, 1.5–1.7 × 1.5–1.6 cm; pedicels 0–1 mm long, puberulous. Calyx tube pale green, narrowly infundibuliform, ridged, 0.9–1 cm long, puberulous; teeth triangular, ca. 3 × 2 mm, ciliolate, apex recurved. Petals white, turning pink with age, ovate or oblong, 13–14 × 6.8–7 mm, recurved with 3 distinct nerves, glabrous, apex obtuse. Stamens 5 + 5, inserted in the throat of the calyx tube; filaments ca. 1 mm long, white; anthers yellow, basifixed, ca. 1 × 0.7 mm. Ovary 4–5 × 1–1.2 mm, tawny puberulous, ridged, 1-celled with 3 ovules; upper free portion of style 1–2 mm long, yellowish white, slender, flattened; stigma capitate, creamy white. Fruits chocolate brown, chartaceous, 2–2.3 × 1.8–2.2 cm, villous when young, glabrous when mature, horizontally faintly striate, widely ellipsoid; stalk ca. 1 mm long, wings 5, thin, 10–12 mm broad. Seed solitary, fusiform, ca. 1.3 × 0.5 cm. Funicle ca. 6 mm long, curved; testa brown, membranous.

Distribution.—*Combretum recurvatum* is so far known only from Aralam Wildlife Sanctuary, Kannur district of Kerala, India (Fig. 4).

Flowering.—January–March; *Fruiting:* February–May.

Habitat.—Rarely seen in the semi-evergreen forests of the Aralam Wildlife Sanctuary, Kerala (Fig. 3), at an altitude of 800 m above sea level and is found associated with *Anamirta cocculus* (L.) Wight & Arn., *Baccaurea courtallensis* (Wight) Müll.-Arg., *Combretum latifolium* Blume, *C. razianum* K.G. Bhat, *Sterculia foetida* L., and *Vateria indica* L.

Additional specimens examined: **INDIA. KERALA. Kannur district:** Aralam Wildlife Sanctuary, alt. 800 m above sea level, 26 Mar 2009, *Sujana* 0714; 6 May 2009, *Sujana* 0786; 2 April 2010, *Sujana* 0833 and 6 Apr 2011, *Sujana* 0913 (Herbarium of M.S. Swaminathan Research Foundation, Wayanad).

ACKNOWLEDGMENTS

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CONVOLVULACEAE OF SONORA, MEXICO. I. *CONVOLVULUS, CRESSA, DICHONDRA, EVOLVULUS, IPOMOEA, JACQUEMONTIA, MERREMIA,* AND *OPERCULINA*

Richard S. Felger

Herbarium, University of Arizona
P.O. Box 210036, Tucson, Arizona 85721
and Sky Island Alliance, Tucson
rfelger@ag.arizona.edu

Daniel F. Austin

Arizona-Sonora Desert Museum
2021 N. Kinney Road, Tucson, Arizona 85743, U.S.A.
and Herbarium, University of Arizona, Tucson
dr_ipomoea@yahoo.com

Thomas R. Van Devender

Sky Island Alliance, P.O. Box 41165
Tucson, Arizona 85717
and Herbarium, University of Arizona, Tucson
VanDevender@skyislandalliance.org

J. Jesús Sánchez-Escalante

Universidad de Sonora
Dept. de Investigaciones Científicas y Tecnológicas
Rosales y Niños Héroes, Centro
Hermosillo, Son, 83000, MÉXICO
jsanchez@guayacan.uson.mx

Mihai Costea

Dept. of Biology
Wilfrid Laurier University
75 University Avenue W
Waterloo, ON, N2L 3C5, CANADA
mcostea@wlu.ca

ABSTRACT

Based on decades of field work and herbarium research we document 84 species of Convolvulaceae (convolvs) in nine genera for the state of Sonora, Mexico: *Ipomoea* (41 species), *Cuscuta* (21), *Evolvulus* (6), *Jacquemontia* (4), *Merremia* (4), *Dichondra* (3), *Convolvulus* (2), *Operculina* (2), *Cressa* (1). This species richness compares with the more tropical regions of southern Mexico (e.g., Bajío region, Veracruz) and Central America (Costa Rica, Nicaragua). Convolv species occur in a diverse range of plant communities from intertidal zones to mountain conifer forest, with highest diversity in tropical deciduous forest and oak woodlands in ten major vegetation types: tropical deciduous forest (44), oak woodland (34), Sonoran desert (33), foothills thornscrub (31), coastal thornscrub (30), pine-oak forest (27), grassland (13), Chihuahuan desert (11), coastal salt scrub and mangroves (1), and mixed conifer forest (1). Nearly 10 percent of the Sonoran convolvs are not native to the region. The majority of worldwide and Sonoran convolvs are scandent annuals or herbaceous perennials with twining stems. Three native Sonoran *Ipomoea* are trees or large shrubs: *I. arborescens*, *I. chilopsidis*, and *I. seaania*. The *Cuscuta* of Sonora are discussed in a separate article in this volume (Costea et al. 2012a).

We revise the nomenclature and typification of all the taxa. We give the correct names and synonyms for all taxa and provide special attention to details regarding the place of publication and type specimens. Lectotypes are chosen for nine species. Special attention has been paid to providing correct authorities and publication information in view of incorrect data that circulated in major floristic and biodiversity databases. Dichotomous identification keys, detailed descriptions, phenology, local and global geographic distribution data are provided. Known indigenous names and uses are given for Sonoran convolvs when known.

Key Words: floristic diversity, ecology, geographic distribution, Mexico, Sonora, vegetation, typification

RESUMEN

Décadas de trabajo de campo e investigación de herbario permitieron documentar 84 especies en 9 géneros de la familia Convolvulaceae en el estado de Sonora, México: *Ipomoea* (41 especies), *Cuscuta* (21), *Evolvulus* (6), *Jacquemontia* (4), *Merremia* (4), *Dichondra* (3), *Convolvulus* (2), *Operculina* (2) y *Cressa* (1). Esta riqueza es comparable con la de regiones más tropicales del sur de México (ej. región del Bajío, Veracruz) y América Central (Costa Rica, Nicaragua). Las especies se distribuyen en un rango diverso de comunidades vegetales desde áreas entre mareas hasta montañas con bosques de coníferas. La más alta diversidad se encuentra en la selva baja caducifolia (44), seguida por el encinal (34), matorral del desierto sonorense (33), matorral espinoso de piedemonte (31), matorral espinoso costero (30), bosque de pino-encino (27), pastizal (13), matorral del desierto chihuahuense (11), matorral salado costero y manglares (1) y bosques de coníferas mixtas (1). Cerca del 10% de las Convolvulaceae de Sonora son introducidas.

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La mayoría de las Convolvulaceae del mundo, incluyendo Sonora, son anuales escandentes o herbáceas perennes trepadoras. Tres *Ipomoea* nativas de Sonora son árboles o arbustos: *I. arborescens*, *I. chilopsidis* y *I. seaania*. El género *Cuscuta* se discute en un artículo separado en este mismo volumen (Costea et al. 2012a).

Se revisó la nomenclatura y la tipificación de todos los taxones. Se proporciona el nombre aceptado, nombres de autoridades y los sinónimos, así como la publicación y los ejemplares tipo. Se escogieron lectotipos para 9 especies. Se incluyen claves dicotómicas de identificación, descripciones detalladas, fenología, así como datos de distribución geográfica mundial y local. Se citan nombres comunes y usos de las especies en Sonora.

INTRODUCTION

The Convolvulaceae constitute a large and diverse assemblage of 58 genera and about 1800 species worldwide (Staples 2011). This monophyletic family has greatest diversity in tropical and subtropical regions worldwide and does not generally occur in higher latitudes. The sweet potato (*Ipomoea batatas*) and water spinach (*I. aquatica*) are the only major crop plant in the family. In addition to species with horticultural value (e.g., various morning glories), there are significant crop weeds (e.g., certain species of *Convolvulus*, *Cuscuta*, and *Ipomoea*) and many medicinal uses among Sonoran people and worldwide. This publication is the first taxonomic account of all the known Convolvulaceae (convolvs) native or naturalized in the state of Sonora, Mexico (Fig. 1). We include approximately 84 species and 2 infraspecific taxa in 9 genera for the state. Due to the large size of the article, we divided it into two parts: the first part includes all the Convolvulaceae genera minus *Cuscuta*, while the second part provides a floristic/taxonomic treatment for the latter genus (Costea et al. 2012a). This introduction includes the 9 genera.

Although a political border is not necessarily an ecological or biological boundary, the borders of Sonora are to varying degrees biologically and logistically significant. The western boundary (except the extreme northwestern corner) is the Gulf of California. The east boundary mostly coincides with the continental divide. The north boundary marks a division between the better-known continental flora of Arizona and the relatively less-known flora of northern Sonora. The southern border with the state of Sinaloa border separates a continuous flora but is far enough south to include the northern climatological limits of the New World tropics (in east-central Sonora at 28–29°N).

Sonora encompasses 185,934 km^2 (Molina-Freaner & Van Devender 2010) and is the second largest state in Mexico after Chihuahua. The region is topographically and biologically diverse (Molina-Freaner & Van Devender 2010). Three major river systems, the Río Colorado, Río Yaqui, and Río Mayo, and several minor rivers systems course through the state and empty into the Gulf of California. The eastern margin of the state is comprised of the Sierra Madre Occidental and numerous north-south trending Sky Island ranges forming the Madrean Archipelago. The highest elevation is 2625 m in the Sierra de los Ajos in northeastern Sonora. The Sierra San Luis in the extreme northeastern corner is nearly as high, and another high peak, further south on the Chihuahua border, near Mesa Tres Ríos may be equally high. Numerous other ranges, generally decreasing in peak elevations westward, spread across the rest of the state, interspersed with broad valleys and expansive plains.

Sonora includes the northern limits of tropical and subtropical biota as well as some of the most arid desert regions of North America. Tropical species follows the lowland tributaries in the Río Yaqui drainage system northward in northeastern Sonora.

Total annual precipitation decreases from south to north and east to west, and increases with elevation. Rainfall is largely bi-seasonal with summer and winter-spring rainy seasons. Precipitation increases from west to east: for example from the Río Colorado River to northeastern Sonora/New Mexico, and with elevation and from north to south. Total annual precipitation varies from less than 40 mm in the extreme northwest of the state near the delta of the Río Colorado to about 1000 mm in southeast and east-central Sonora (e.g., Yécora at 1500 m) and probably considerably more farther north, such as the Tres Ríos–Sierra Huachinera region (Brito-Castillo et al. 2010; Felger et al. 2001; Martínez-Yrízar et al. 2010).

Human populations in Sonora remained sparse and major roads were relatively few until the mid-twentieth century (e.g., Stoleson et al. 2005). Much diversity and richness of natural habitat remain, but like elsewhere, assaults on the environment are escalating (e.g., Castellanos-Villegas et al. 2010). Since the latter part of the twentieth century large areas of the state have been established for conservation purposes (e.g., Búrquez and Martínez –Yrízar 2007, Felger and Broyles 2007).

Major works including ethnobotanical information on convolvs in Sonora include Felger and Moser (1985), Gentry (1942, 1963), Yetman and Felger (2002), and Yetman and Van Devender (2002). For summary information see species accounts for *Ipomoea ancisa*, *I. arborescens*, *I. bracteata*, and *I. pedicellaris*.

While soil moisture is the principal limiting factor in this generally arid region, freezing temperatures limit the northern distributions of the more tropical or subtropical species (e.g., Brito-Castillo et al. 2010; Shreve 1951; Turner et al. 1995; also see the species accounts for *Ipomoea arborescens*). Freezing weather is infrequent across most of Sonora, especially in the southern part of the state and at low to moderate elevations, and many habitats are essentially frost-free, but freezing temperatures become more frequent and severe northward and at higher elevations (Brito et al. 2010).

The total flora of the state includes about 3700 taxa (Van Devender et al. 2010 and new records). Within this rich flora, the Convolvulaceae is the seventh largest family, following the Asteraceae, Poaceae, Fabaceae, Euphorbiaceae (Steinman & Felger 1997), Malvaceae (s.l.), Cactaceae (Paredes et al. 2000), and Cyperaceae (Van Devender et al. 2010). With 42 taxa, *Ipomoea* is the fourth largest vascular plant genus in the state and the largest genus in the family worldwide. Among the documented convolv species in Sonora, we include species that occur in Arizona and New Mexico close to the northern boundary and are expected to occur in Sonora.

Growth forms.—Most convolvs throughout the world are scandent annuals or herbaceous and woody perennials. Three native Sonoran *Ipomoea* are trees or large shrubs: *I. arborescens*, *I. chilopsidis*, and *I. seaania*. The non-native *I. carnea* subsp. *fistulosa* is a shrub while *I. bracteata* and some *Jacquemontia* may become somewhat shrubby. *Ipomoea bracteata* and *I. longiflora* form large tuberous roots, as do *I. capillacea* and *I. plummerae*, while *Merremia palmeri*, *Operculina pinnatifida*, and *O. pteripes* probably have large tuberous roots because their closest relatives have them.

The majority of Sonoran convolvs are vining or have twining stems. The liana growth form, characteristic of tropical regions, occurs among *Ipomoea bracteata*, *I. pedicellaris*, several *Jacquemontia*, *Merremia quinquefolia*, and *Operculina pteripes*. All occur in tropical deciduous forest in Sonora and some also range into thornscrub and oak woodland. *Cuscuta* spp. are always annual when parasitic on annual hosts; however, when parasitizing on perennial woody hosts, some species such as *C. americana*, *C. corymbosa* var. *grandiflora*, and *C. tinctoria* are often perennial, regenerating every year from haustorial tissues left inside the stems of the host (Costea & Tardif 2006).

Endemism and Rare/Endangered Taxa.—Although many species may be locally rare and known from few collections in Sonora, most of these are common elsewhere. Only a small number of Sonoran convolvs are rare and/or endangered throughout their range.

Ipomoea seaania, the only convolv endemic to the state of Sonora, is known only from the vicinity of the type locality and seems to be globally restricted to a relatively small area. Among *Cuscuta*, *C. dentatasquamata* is known in Sonora only from the type collection; *C. salina* is known from one locality in Sonora but is common elsewhere, and the only known Sonoran *C. tinctoria* specimen is a parasite on a cultivated tree and is not native. There are two records for *Dichondra brachypoda* in Sonora, both in mountains in the northeastern part of the state. *Evolvulus prostratus* is known from two collections in Sonora but is widespread elsewhere in Mexico. *Ipomoea alba*, with two records, is common elsewhere and may or may not be native in Sonora. *Ipomoea ancisa* is a relatively narrow endemic in mountains in eastern Sonora and western Chihuahua but is locally common. *Jacquemontia abutiloides* is widespread in Baja California (norte) and Gulf of California islands and approaches Sonora on Isla Tiburón, although a thorough taxonomic investigation may render it a synonym of a mainland species. *Merremia cissoides*, with a single Sonora collection, is a cosmopolitan species.

Non-natives.—About eight convolvs found in Sonora are not native to the state. *Convolvulus arvensis* and *I.* ×*leucantha* are widespread weeds. *Ipomoea carnea* subsp. *fistulosa*, *I. triloba*, and *Merremia dissecta* are prob-

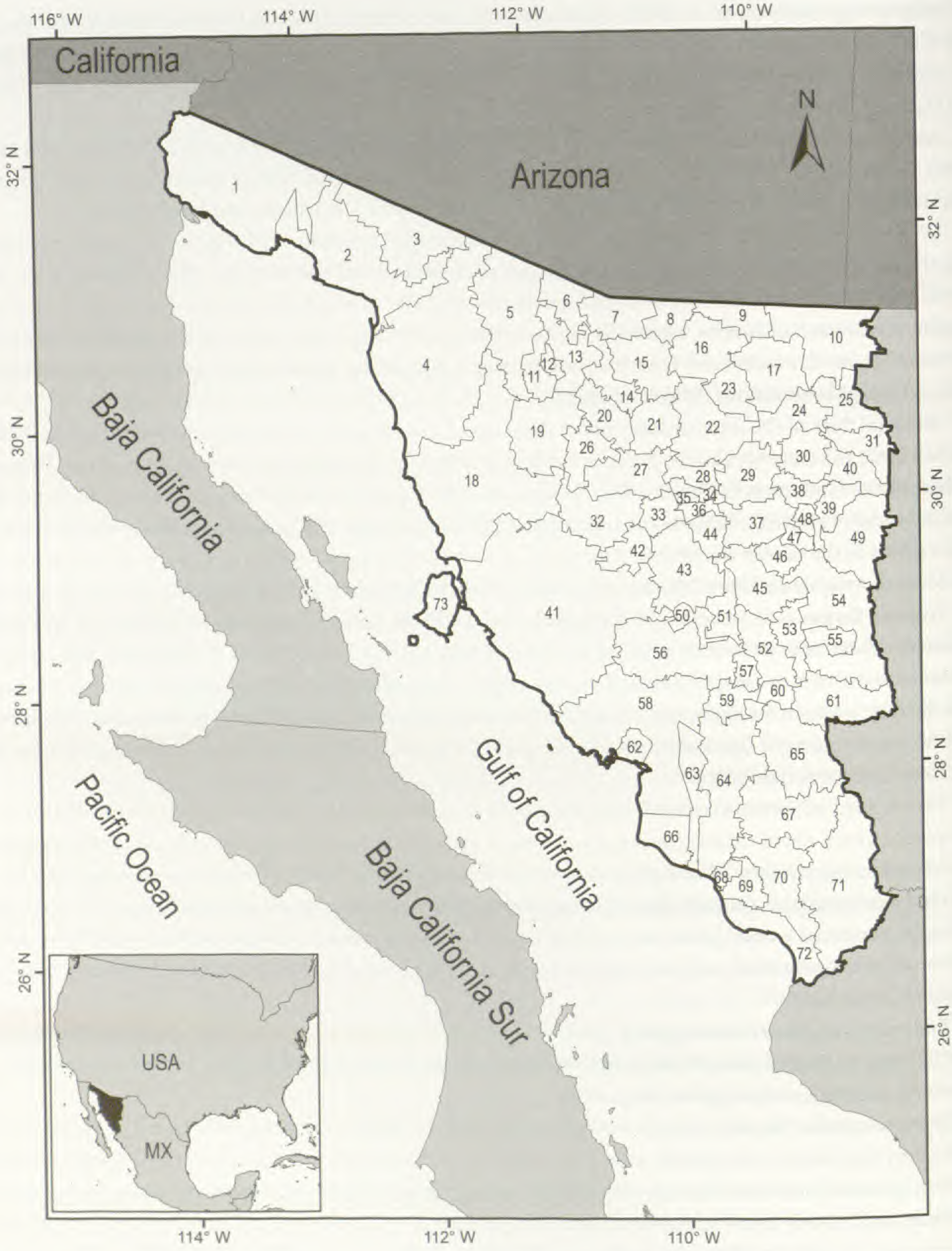

Fig. 1. Sonora showing the 72 municipios and Isla Tiburón (73). Drafted by Pedro P. Garcillán, based on the digital map of states and municipios of Mexico by Instituto Nacional de Estadística y Geografía (INEGI), www.inegi.org.mx (2012).

NUMERICAL LIST: 1 San Luis Río Colorado. **2** Puerto Peñasco. **3** General Plutarco Elías Calles. **4** Caborca. **5** Altar. **6** Sáric. **7** Nogales. **8** Santa Cruz. **9** Naco. **10** Agua Prieta. **11** Oquitoa. **12** Átil. **13** Tubutama. **14** Magdalena. **15** Ímuris. **16** Cananea. **17** Fronteras. **18** Pitiquito. **19** Trincheras. **20** Santa Ana **21** Cucurpe. **22** Arizpe. **23** Bacoachi. **24** Nacozari de García. **25** Bavispe. **26** Benjamín Hill. **27** Opodepe. **28** Banámichi. **29** Cumpas. **30** Villa Hidalgo. **31** Bacerac. **32** Carbó. **33** Rayón. **34** Huépac. **35** San Felipe de Jesús. **36** Aconchi. **37** Moctezuma. **38** Huásabas. **39** Bacadéhuachi. **40** Huachinera. **41** Hermosillo. **42** San Miguel de Horcasitas. **43** Ures. **44** Baviácora. **45** San Pedro de la Cueva. **46** Tepache. **47** Divisaderos. **48** Granados. **49** Nácori Chico. **50** Mazatán. **51** Villa Pesqueira. **52** Soyopa. **53** Bacanora. **54** Sahuaripa. **55** Arivechi. **56** La Colorada. **57** San Javier. **58** Guaymas. **59** Suaqui Grande. **60** Ónavas. **61** Yécora. **62** Empalme. **63** Bácum. **64** Cajeme. **65** Rosario. **66** San Ignacio Río Muerto. **67** Quiriego. **68** Benito Juárez. **69** Etchojoa. **70** Navojoa. **71** Álamos. **72** Huatabampo. (*Continued on next page.*)

ably of Caribbean origin and *I. batatas*, the sweet pototo, is of tropical American origin. The origin of *I. heptaphylla* is not known although it is probably native to the Old World. *Ipomoea batatas* and *I. carnea* subsp. *fistulosa* are cultivated and are sometimes encountered outside of cultivation. *Cuscuta campestris* and *C. indecora* are weedy and probably have been introduced, and *C. tinctoria* probably is also not native to the flora.

Diversity.—In comparison with neighboring areas to the north and west (Arizona, the two Baja California states, California, and New Mexico), the convolvs are quite diverse in Sonora. This is due to the more tropical affinities of much of the Sonoran flora as well as habitat diversity. As one moves further south in Mexico and Central America, the convolv diversity continues to increase. A comparison of the convolv diversity in Sonora with adjacent and comparable areas in Mexico and the southwestern United States is shown in Table 1.

Vegetation of Sonora and the Convolvs

The major habitats or vegetation types in Sonora include mangroves and coastal vegetation, tropical deciduous forest, thornscrub, desertscrub (both Sonoran and Chihuahuan), grassland, oak woodland, pine-oak forest, and mixed conifer forest (Fig. 2, Table 2). The Sonoran convolvs are distributed as follows: Chihuahuan desert (11), Sonoran desert (33), coastal thornscrub (30), foothills thornscrub (31), tropical deciduous forest (41), grassland (13), oak woodland (34), pine-oak forest, 27), mixed conifer forest (1), salt scrub (1), mangroves (1). These vegetation regions are briefly mentioned below, with some examples of characteristic convolvs. For discussions of the vegetation of Sonora the reader is referred to Brown (1982), Felger et al. (2001), Gentry (1942), Martin et al. (1998), Martínez-Yrízar et al. (2010), Rzedowski (1978), and Shreve (1951).

Coastal vegetation.—Mangroves occur sporadically along the coastal fringe of the southern two-thirds of the state, bordering salt scrub. *Cressa truxillensis* occurs along beaches and extends into tidal marshes (locally called *esteros*) of salt scrub and sometimes at the inland border of mangroves, as well as inland in some agricultural areas. *Ipomoea imperati* and *I. pes-caprae* are found along beaches.

Chihuahuan desert.—The northwestern corner of the Chihuahuan desert extends into limited areas of northeastern Sonora and adjacent southeastern Arizona at elevations below about 1430 m. This landlocked desert covers much of north-central Mexico between the Sierra Madre Occidental and Sierra Madre Oriental and extends into adjacent inland areas of the southwestern United States. Hard freezes may occur in the Chihuahuan desert, which accounts for the absence of columnar cacti and reduced convolv diversity. Rainfall mostly occurs during the summer. The Sonoran portion of the Chihuahuan desert is bordered by grassland and oak woodland. As with the Sonoran desert, there is open ground, and shrubs predominate. The substrate often consists of limestone and alkaline soils. A total of 12 convolv species are recorded for the relatively small area of the Chihuahuan desert in Sonora (one occurs adjacent in Arizona) and all except *Ipomoea cardiophylla* also occur in adjacent vegetation.

Sonoran desert.—The Sonoran desert, defined and described elegantly by Forrest Shreve (1951), covers roughly the northwestern two-thirds of Sonora. Shreve divided the Sonoran desert into seven geographic vegetation zones, five of which occur in Sonora, although Shreve's Foothills of Sonora is reclassified as thornscrub (Felger & Lowe 1976), leaving the Plains of Sonora, portions of the Arizona Upland, the Sonora portions of the Central Gulf Coast, and the Lower Colorado Valley. Within the span of environments in the Sonora portion of the Sonoran desert there is great variation in vegetation cover and structure and regional plant diversity. Thirty-two convolv species are documented for the Sonora portion of the Sonoran desert.

ALPHABETICAL LIST: Aconchi 36, Agua Prieta 10, Álamos 71, Altar 5, Arivechi 55, Arizpe 22, Átil 12, Bacadéhuachi 39, Bacanora 53, Bacerac 31, Bacoachi 23, Bácum 63, Banámichi 28, Baviácora 44, Bavispe 25, Benito Juárez 68, Benjamín Hill 26, Caborca 4, Cajeme 64, Cananea 16, Carbó 32, Cucurpe 21, Cumpas 29, Divisaderos 47, Empalme 62, Etchojoa 69, Fronteras 17, General Plutarco Elías Calles 3, Granados 48, Guaymas 58, Hermosillo 41, Huachinera 40, Huásabas 38, Huatabampo 72, Huépac 34, Ímuris 15, La Colorada 56, Magdalena 14, Mazatán 50, Moctezuma 37, Naco 9, Nácori Chico 49, Nacozari de García 24, Navojoa 70, Nogales 7, Ónavas 60, Opodepe 27, Oquitoa 11, Pitiquito 18, Puerto Peñasco 2, Quiriego 67, Rayón 33, Rosario 65, Sahuaripa 54, San Felipe de Jesús 35, San Ignacio Río Muerto 66, San Javier 57, San Luis Río Colorado 1, San Miguel de Horcasitas 42, San Pedro de la Cueva 45, Santa Ana 20, Santa Cruz 8, Sáric 6, Soyopa 52, Suaqui Grande 59, Tepache 46, Trincheras 19, Tubutama 13, Ures 43, Villa Hidalgo 30, Villa Pesqueira 51, Yécora 61.

TABLE 1. Comparitive diversity of Convolvulaceae species in Sonora and other region in Mexico and southwestern United States.

	Sonora	Arizona	New Mexico	California	Baja California (norte)	Baja California Sur[1]	Bajío, Mexico[2]	Veracruz, Mexico	Nicaragua	Costa Rica	USA	Mexico
Total sp.	84	48	47	40	25	48	89	85 (w/o *Cuscuta*)	81–85	90	108	ca. 220
Ipomoea	41	16	14	0	3	24	50	55	43–47	52	46	ca. 151
Cuscuta	21	18	22	19	12	12	15	11	3–5	6	55	ca. 60
Sources		Austin 1991, Costea & Nesom in prep.	Austin 1990a, Allred 2011, Costea & Nesom in prep.	Austin 2012, Costea & Stefanović 2012	Costea unpubl., Rebman unpubl.	Costea unpubl. Rebman unpubl.	Carranza 2008	McDonald 1993b, 1994, Costea unpubl.	Austin 2001, Beliz 2001	Hammel 2010	Austin et al. in prep.	McDonald 1991, pers. comm. June 2012; Carranza 2008, Costea unpubl.

[1] Total species = 64 for the peninsula (both states); 20 species for Cuscuta; 24 for Ipomoea (Jon Rebman, personal communication 2011).

[2] Including Guanajuanto, Querétaro, and northern Michoacán.

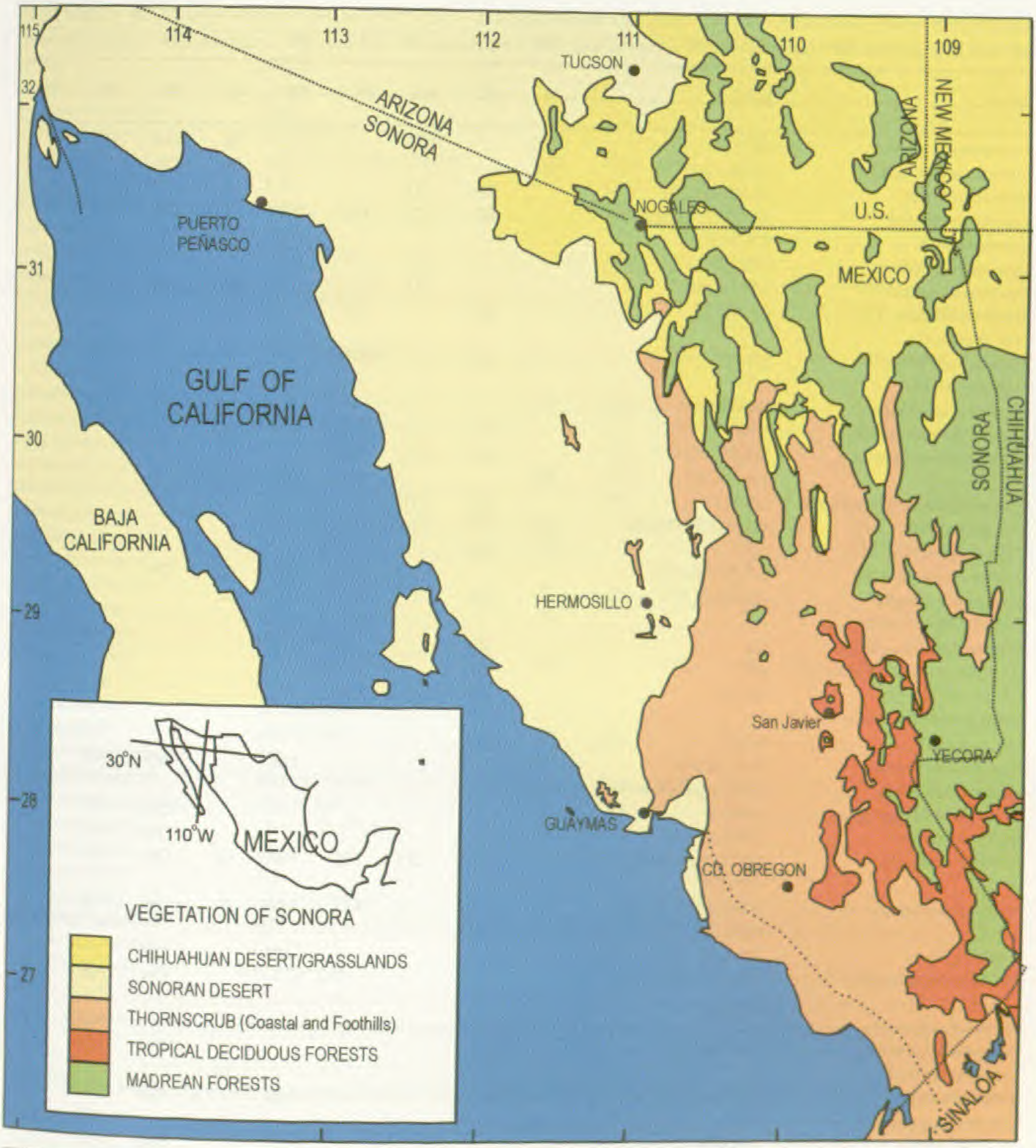

FIG. 2. Potential vegetation of Sonora. The dotted line in thornscrub indicates an approximation of coastal thornscrub to the west and foothills thornscrub to the east, Madrean forests include oak woodlands at lower elevations and pine-oak forest at higher elevations, and small areas of mixed conifer forests at highest elevations. Substantial areas of of the original vegetation has been urbanized or converted to agriculture or modified for cattle grazing, especially in the coastal thornscrub and portions of Sonoran Desert. Map drafted by Alberto Búrquez (modified from Felger et al. 2001 and Martínez-Yrízar et al. 2010).

Unlike thornscrub there is much open ground. Most of the perennial Sonoran desert plants have evolved from tropical or subtropical relatives that are found today in thornscrub and tropical deciduous forest. Many of the perennials are sensitive to winter freezing, their northern limits fixed by an invisible line of freezing temperatures and drought. The desert is essentially frost-free at its southern limits, such as near Guaymas, and the severity and duration of freezing increases northward. Similarly, drought is more severe northward and westward (Felger 2000; Turner et al. 1995).

Table 2. Sonoran convolvs, habitats. **CD** = Chihuahuan desert, **SD** = Sonoran desert, **CTS** = coastal thornscrub, **FTS** = foothills thornscrub, **TDF** = tropical deciduous forest. **GL** = grassland, **OW** = oak woodland, **POF** = pine-oak forest, **MSL** = miscelaneous: **SS** = salt scrub, **MG** = mangroves, **MCF** = mixed conifer forest.

Species	Habitat	CD	SD	CTS	FTS	TDF	GL	OW	POF	MSL
**Convolvulus arvensis*	SD	CD		CTS			GL	OW	POF	
Convolvulus equitans	CD GL OW	CD					GL	OW		
Cressa truxillensis	SS MG SD CTS		SD	CTS						SS MG
Cuscuta americana	SD CTS FTS TDF OW		SD	CTS	FTS	TDF		OW		
Cuscuta azteca	TDF POF					TDF			POF	
Cuscuta boldinghii	CTS TDF			CTS		TDF				
Cuscuta campestris	CTS GL OW			CTS			GL	OW		
Cuscuta chinensis var. *applanata*	SD TDF GL		SD		TDF		GL			
Cuscuta corymbosa var. *grandiflora*	SD FTS		SD		FTS					
Cuscuta costaricensis	OW POF							OW	POF	
Cuscuta dentatasquama	POF								POF	
Cuscuta desmouliniana	SD CTS FTS		SD	CTS	FTS					
Cuscuta erosa	CD FTS TDF	CD			FTS	TDF				
Cuscuta indecora var. *indecora*	SD CTS		SD	CTS						
Cuscuta legitima	CD SD CTS FTS TDF	CD	SD	CTS	FTS	TDF				
Cuscuta leptantha	SD		SD							
Cuscuta macrocephala	FTS TDF GL OW				FTS	TDF	GL	OW		
Cuscuta odontolepis	SD FTS GL		SD		FTS		GL			
Cuscuta polyanthemos	FTS				FTS					
Cuscuta salina var. *salina*	SD		SD							
**Cuscuta tinctoria* var. *tinctoria*	SD		SD							
Cuscuta tuberculata	SD FTS		SD		FTS					
Cuscuta umbellata var. *umbellata*	SD		SD							
Cuscuta vandevenderi	TDF OW POF					TDF		OW	POF	
Dichondra argentea	CD in adjacent Arizona	CD								
Dichondra brachypoda	OW POF							OW	POF	
Dichondra sericea	OW POF							OW	POF	
Evolvulus alsinoides	SD CTS FTS TDF GL OW POF		SD	CTS	FTS	TDF	GL	OW	POF	
Evolvulus arizonicus	SD GL FTS TDF OW POF		SD		FTS	TDF	GL	OW	POF	
Evolvulus filipes	TDF OW					TDF		OW		
Evolvulus nuttallianus	OW POF in adjacent Arizona							OW	POF	
Evolvulus prostratus	POF								POF	
Evolvulus rotundifolius	OW POF MCF							OW	POF	MCF
Evolvulus sericeus	GL						GL			
Ipomoea alba	TDF OW					TDF		OW		
Ipomoea ampullacea	POF								POF	
Ipomoea ancisa	OW POF							OW	POF	
Ipomoea arborescens var. *arborescens*	SD CTS FTS TDF OW		SD	CTS	FTS	TDF		OW		
Ipomoea arborescens var. *pachylutea*	TDF OW POF					TDF		OW	POF	
Ipomoea aristolochiifolia	CD TDF OW	CD				TDF		OW		
Ipomoea barbatisepala	FTS TDF GL OW				FTS	TDF	GL	OW		
Ipomoea batatas	SD CTS FTS TDF		SD	CTS	FTS	TDF				
Ipomoea bracteata	CTS FTS TDF OW			CTS	FTS	TDF		OW		
**Ipomoea cairica*	TDF					TDF				
Ipomoea capillacea	OW POF							OW	POF	
Ipomoea cardiophylla	CD in adjacent Arizona	CD								
**Ipomoea carnea* ssp. *fistulosa*	CTS TDF			CTS		TDF				
Ipomoea chilopsidis	OW							OW		
Ipomoea costellata	CD SD GL CTS FTS TDF OW POF	CD	SD	CTS	FTS	TDF	GL	OW	POF	
Ipomoea cristulata		CD	SD	CTS	FTS	TDF	GL	OW	POF	

Table 2. continued

Species	Habitat	CD	SD	CTS	FTS	TDF	GL	OW	POF	MSL
Ipomoea decasperma	POF								POF	
Ipomoea hederacea	SD TDF GL		SD			TDF	GL			
Ipomoea hederifolia	(SD) CTS FTS TDF OW POF		SD	CTS	FTS	TDF		OW	POF	
Ipomoea heptaphylla	CTS			CTS						
Ipomoea imperati	CTS			CTS						
Ipomoea laeta	POF								POF	
**Ipomoea ×leucantha*	CTS FTS TDF			CTS	FTS	TDF				
Ipomoea longifolia	FTS TDF GL OW				FTS	TDF	GL	OW		
Ipomoea madrensis	OW POF							OW	POF	
Ipomoea meyeri	TDF					TDF				
Ipomoea minutiflora	FTS TDF OW POF				FTS	TDF		OW	POF	
Ipomoea muricata	TDF					TDF				
Ipomoea nil	SD CTS TDF		SD	CTS		TDF				
Ipomoea parasitica	CD FTS TDF OW	CD			FTS	TDF		OW		
Ipomoea pedicellaris	CTS FTS TDF			CTS	FTS	TDF				
Ipomoea pes-caprae	CTS		SD	CTS						
Ipomoea plummerae	CTS POF			CTS					POF	
Ipomoea pubescens	OW POF							OW	POF	
Ipomoea purpurea	SD TDF OW		SD			TDF		OW		
Ipomoea quamoclit	TDF					TDF				
Ipomoea scopulorum	SD CTS FTS TDF		SD	CTS	FTS	TDF				
Ipomoea seaania	SD		SD							
Ipomoea tenuiloba	OW POF							OW	POF	
Ipomoea ternifolia var. *leptotoma*	SD CD FTS TDF GL OW	CD	SD		FTS	TDF	GL	OW		
Ipomoea thurberi	GL OW POF						GL	OW	POF	
Ipomoea triloba	SD CTS TDF		SD	CTS		TDF				
Jacquemontia abutiloides	SD		SD							
Jacquemontia agrestis	SD CTS FTS TDF		SD	CTS	FTS	TDF				
Jacquemontia polyantha	SD CTS TDF		SD	CTS		TDF				
Jacquemontia pringlei	CD SD CTS FTS TDF	CD	SD	CTS	FTS	TDF				
Merremia cissoides	TDF					TDF				
**Merremia dissecta*	TDF					TDF				
Merremia palmeri	SD CTS FTS TDF		SD	CTS	FTS	TDF				
Merremia quinquefolia	TDF					TDF				
Operculina pinnatifida	CTS FTS			CTS	FTS					
Operculina pteripes	FTS TDF OW				FTS	TDF		OW		
Totals		11	33	30	31	44	13	34	27	2

The tree morning glory, *Ipomoea arborescens*, extends into the limited areas of the southern portion of the Sonoran desert (north of Hermosillo) and the narrow endemic *I. seaania* occurs at the desert edge north of Guaymas. Several *Jacquemontia* species are semi-woody vines and are common in much of the semi-arid portions of the Sonoran desert. The remaining Sonoran desert convolvs are herbaceous perennials and annuals, and are mostly found in active growth and reproduction with hot weather or summer rains.

Although convolvs are well represented in the Sonoran desert, only 8 species occur in the flora of the extremely arid Gran Desierto of northwestern Sonora (Felger 2000). Five of these, *Cuscuta legitima*, *C. tuberculata*, *C. umbellata*, *Evolvulus alsinoides*, and *Ipomoea hederacea*, range into the actual desert, the others generally occurring as weeds in irrigated fields or in coastal wetlands (*Cressa*). In contrast, the Central Gulf Coast of Sonora subdivision (sensu Shreve 1951) of the Sonoran desert, the southernmost region of the desert in Sonora, supports at least 26 convolv species in seven genera. Included among these are the unusual narrow endemic *Ipomoea seaania* and at least eight species of *Cuscuta*.

Thornscrub.—Thornscrub in Mexico is essentially a drier version of tropical deciduous forest (TDF) and in Sonora intermediate between the Sonoran desert and TDF. The boundaries are fuzzy. Like TDF, the plants show a strong seasonality linked with monsoonal rains and for the most part are highly frost-sensitive. Unlike TDF, natural thornscrub generally does not form 100% perennial coverage. The stature of the vegetation is generally lower and the dominant species tend to have smaller leaves than those of the TDF. Thornscrub in Sonora was described as Sinaloan Thornscrub by Brown (1982) and Thorn Forest by Gentry (1942).

Two thornscrub formations can be discerned in Sonora: the coastal thornscrub (CTS) of southwestern Sonora (Felger and Lowe 1976; Friedman 1996; Martin et al. 1998) and the interior, foothills thornscrub (FTS) along the east side of the Sonoran desert and at higher elevations within the Sonoran desert. We document 30 convolv species in CTS in Sonora and 31 in FTS.

Coastal thornscrub is on the coastal plain from Empalme-Guaymas southward. Foothills thornscrub is on inland, often rocky slopes. In southern Sonora, FTS is below tropical deciduous forest in elevation. In central Sonora, it is the transitional vegetation between the Plains of Sonora subdivision of the Sonoran desert on the west and oak woodland in Sky Island mountain ranges and the Sierra Madre Occidental to the east. In the north FTS is replaced by desert grassland as winters become colder and periodic fires become ecological processes. The northern limits of FTS in Sonora are at about 30°11'N in the Río Sonora Valley and 30°26'N on the Río Bavispe at the southern end of the Sierra El Tigre. FTS does not reach Arizona, but the distributions of a number of FTS species extend into southern Arizona in desert grassland or oak woodland.

Coastal thornscrub extends southward on the coastal plain from the southern margin of the Sonoran desert in the vicinity of Guaymas into coastal northwestern Sinaloa. Southward and eastward this vegetation type merges with TDF. Much of the coastal thornscrub has been converted to large-scale modern agriculture.

Foothills thornscrub.—This vegetation type is essentially synonymous with Shreve's (1951) Foothills of Sonora subdivision of the Sonoran desert (Felger and Lowe 1976; Felger et al. 2001). FTS is shrubby or semi-arborescent vegetation with a nearly closed canopy of small trees and large shrubs. FTS extends northward along the eastern side of the Sonoran desert, becoming narrower in geographic and elevational range towards its northern limits. Northward it gives out at about the vicinity of Arizpe, where rise in elevations and winter freezing as well as drier conditions become pronounced.

Tropical deciduous forest.—The northern arm of TDF, sweeping northward from the tropics, ends in the mountains of eastern Sonora and southwestern Chihuahua. Sonoran TDF is sandwiched between thornscrub to the west at lower elevations and oak woodland eastward at higher elevations. Northward, along the east side of the Sonoran desert, TDF merges into foothills thornscrub (Felger et al. 2001; Martínez-Yrízar et al. 2010).

There is a long dry season interrupted by a short but intense rainy season generally from mid-June to October. Summers are long and hot and winters short and mild. Freezing weather is rare and most Sonoran TDF species are highly frost-sensitive. Awesome and seemingly sudden transformation to luxuriant tropical green occurs with the onset of the summer monsoon. TDF, with 44 documented species, supports a greater convolv species richness than any other vegetation in the state. The tree morning glory, *Ipomoea arborescens* is a common and conspicuous component, as are others such as *Ipomoea bracteata* with its spectacular pink inflorescences. *Ipomoea muricata*, *I. quamoclit*, *Merremia cissoides* (with one record), *M. dissecta*, and *M. quinquefolia* are more or less restricted to TDF.

Grasslands.—The southwestern extension of the Great Plains grassland biome in the mid-continent is in the southwestern United States and northwestern Mexico. The best developed regional grasslands with more rainfall and colder winter temperatures termed Plains Grassland are restricted to the Animas and San Rafael Valleys along the Arizona-Sonora border. Most other areas are termed desert grassland (McClaran & Van Devender 1995), with warmer, drier climates. Dominant or common species in the regional desert grassland have fluctuated four times during the last 4,000 years—between bunch grasses during wetter periods and shrubs such as mesquites (*Prosopis glandulosa*, *P. velutina*) and others during drier periods (Van Devender 1995). Today desert grassland controlled by human disturbance related to cattle grazing is widespread in valley lowlands below oak woodland from northeastern Sonora west to the Sásabe area southeast of the Baboquivari Mountains and south to the Cananea-Fronteras area within 100 km of the Arizona border.

In southeastern Arizona and northeastern Sonora, valley bottom desert grassland forms a mosaic with Chihuahuan Desert on rocky limestone slopes. To the west, Sonoran desert borders desert grassland at its lower elevations. To the south, desert grassland is replaced by foothills thornscrub below oak woodland, although there are local areas of grassland still present. In addition, there are open grassy areas within oak woodland and pine-oak forest in the higher Sky Island mountain ranges and the Sierra Madre Occidental. As freezes decrease southward, foothills thornscrub replaces desert grassland. Only 13 convolvs are documented from grasslands in Sonora. Characteristic species include *Ipomoea longifolia*, a large herbaceous perennial often conspicuous sprawling across expanses of short grasses, and *Evolvulus sericeus*, a small, silvery-leaved herbaceous perennial.

Oak woodland.—Oak woodland is widely distributed at elevations above desert, grassland, thornscrub, and tropical deciduous forest, but below pine-oak woodland. In Sonora, 34 convolv species occur in OW. Across Sonora, and northern Mexico, the species composition and density of oak woodland changes both with elevation and from south to north. Although these oak zones have been called Madrean Evergreen Woodland (Brown 1982), many Sonoran oaks and associated species are deciduous during the late spring drought, and their biggest flush of new foliage occurs with the renewal of summer rains. In these regions "autumn color" occurs in late spring as the air and ground desiccate and temperatures soar.

Extensive areas in northeast and north-central Sonora are dominated by open woodland of *Quercus emoryi*. This species, with *Q. oblongifolia* and *Q. arizonica*, are among the most common low-elevation oaks in the northern part of the state. At lower elevations the oaks border desert grassland, foothills thornscrub, and desertscrub. There is sometimes a broad ecotone between oak woodland and grassland where the oak trees become widely spaced and grasses predominate. Oak woodland sometimes occurs on acidic, hydrothermally altered soils within tropical deciduous forest where the ecotone between the two plant communities is often only a few meters wide.

Oak woodland in southeastern Sonora, called Oak Forest by Gentry (1942), shows considerable tropical affinity. The lower limits border tropical deciduous forest, and the boundaries are often remarkably well defined, apparently maintained by fire. Fire, however, is not an ecological process in desertscrub, thornscrub, or tropical deciduous forest. Across mountains in the Río Mayo and Río Fuerte drainages, low fires creeping almost harmlessly through dry grasses and forbs among the leafless oaks used to be a common sight in May and June. These fires destroy small TDF trees and shrubs but not the perennial grasses, forbs, and oaks. Many of the oaks in east-central and southeastern Sonora and nearby southwestern Chihuahua are tropical montane oaks. *Ipomoea chilopsidis* is the most spectacular and unique convolv among the diverse 34 convolv species in oak woodland.

Pine-oak forest.—There are numerous montane islands of pine-oak forest in the mountains of eastern Sonora. However, pine-oak forest is more extensive east of Sonora in Chihuahua along the east side of the continental divide. In comparison, on the western slope of the Sierra Madre Occidental the climate is generally somewhat wetter, with presumably milder winter temperatures, resulting in a more diverse flora with more tropical-derived pines such as *Pinus engelmannii*, *P. herrerae*, *P. oocarpa*, and a number of tropical-montane oaks such as *Q. tarahumara*. The pine-oak forest has been included within the concept of Madrean Evergreen Woodland and Madrean Montane Conifer Forest (Brown 1982; Martin et al. 1998). Towards southeastern Sonora the pine-oak woodland is floristically and structurally more like Mexican pine-oak woodland than the temperate pine-oak woodland to the north. Pine-oak forest, where the pines form the overstory while the oaks generally form an understory, is continuous with oak woodland at lower elevations. Among the 27 convolv species in POF, *Cuscuta dentatasquama* (the type collection is the only Sonora record), *Ipomoea ampullacea* (one record, see the species accounts), and *Ipomoea decasperma* (one record) appear to be restricted to this habitat.

Mixed conifer forest.—This zone is restricted to limited areas on the several highest mountain tops in northeastern Sonora and very limited areas near Yécora, in the upper Río Mayo drainage. Three conifers, *Abies*, *Pinus*, especially *P. strobiformis*, and *Pseudotsuga*, define this vegetation. *Evolvulus rotundifolius* is the only convolv recorded in mixed conifer forest in Sonora.

CONVOLVULACEAE JUSSIEU – MORNING GLORY FAMILY

Twining herbs, lianas, subshrubs, shrubs, or trees, some species with milky sap. Rootstocks sometimes tuberous, otherwise fibrous. **Leaves** alternate, usually simple, entire to pinnately lobed or pectinate, some species palmately compound; stipules absent. **Inflorescences** solitary in leaf axils or in racemose or paniculate cymes, some dichasial basally and monochasial above. **Flowers** small and inconspicuous to large and showy, but usually wilting quickly after opening (mostly within 4–5 hours) except *Cuscuta* and often excepting plants flowering during cooler weather, bisexual (or unisexual in some African species), actinomorphic or slightly irregular. Sepals 5, distinct, imbricate, equal or unequal, persistent, occasionally accrescent. Corollas sympetalous, tubular, funnelform, campanulate, urceolate, or salverform, 5-lobed, 5-toothed, or ± entire, with plicae (areas folded in bud) and interplicae (unfolded in bud), usually induplicate and often also convolute in bud. Nectary disc annular or cup-shaped, sometimes 5-lobed, occasionally absent. Stamens 5, distinct; filaments inserted on the corolla tube base alternate with corolla lobes; anthers dithecal, usually linear or oblong, extrorse or introrse. Ovary superior, 2–4(–6)-carpellate, usually with as many cells, placentation basal or basal-axile, ovules 2 (4–6) per cell, or ovary 1-celled and ovules 4, these erect, anatropous; style 1, filiform, simple or bifid, or sometimes with 2 distinct styles; stigmas capitate or bilobed, or, when stigmas 2, then linear, ellipsoid, or globose. **Fruits** capsular, dehiscent by valves, transversely or irregularly, or indehiscent and baccate or nutlike. Seeds 1–4(–6; to 10 in *Ipomoea decaspema*), often fewer than ovules, glabrous or pubescent, endosperm absent or scanty, cartilaginous; cotyledons usually foliaceous.

Genera 58, species estimated 1880 (Staples 2011), cosmopolitan; genera 9, species about 84 in Sonora.

SPECIES ACCOUNTS

Brief descriptions of the habit and distinguishing or noteworthy characteristics are provided for species and infraspecific taxa. The months or seasons noted refer to the recorded times of reproduction. Flowering and fruiting usually overlap broadly, and therefore we generally do not distinguish separate flowering and fruiting times. Many species that are reproductive at various seasons do so facultatively, mostly depending on soil moisture and temperature. There is, however, a marked tendency for members of the family to have flowering initiated by short day length and thus they usually flower in the autumn.

Representative specimens are cited in the last paragraph of each species or infraspecific taxon account. We include the Sonora *municipios* (mpio.), as of 2011, to help place the collection localities (Fig. 1). We also include records from Gulf of California islands nearest the Sonora coast (Islas Tiburón, Alcatraz in Bahía Kino, Dátil, San Esteban, and San Pedro Nolasco; see Felger and Wilder 2012, Felger et al. 2011). We have seen all specimens (except those specified as "not seen") and use "!" for all specimens or images that we have seen, except in *Cuscuta* where "!" is used for the types seen. All *Cuscuta* specimens cited have been seen by Costea. All other convolvs have been seen by Austin and/or Felger.

Unless otherwise indicated, specimens cited are deposited at the University of Arizona Herbarium (ARIZ); specimens in other herbaria are indicated by the abbreviations given in Thiers (2011). Most of our collections are duplicated in the herbaria of USON, MEXU, and SD and other regional and international collections. If a specimen is at ARIZ, we generally do not cite duplicates at other herbaria. When a specimen lacks a collection number, it is identified by the date if available to us, for example: *Ezcurra 9 Nov 1982*. We generally abridge label information, but provide enough that one can find the specimen at a herbarium or search additional information in a data base, especially SEINet (Southwest Environmental Information Network 2012) and MABA (Madrean Archipelago Biodiversity Assessment 2012). Usually only the first collector's name is listed. Elevations and reproductive times (flowers and fruiting) are mostly from herbarium label data and are specific only for Sonora. Coordinates for specimens cited are often available in SEINet (Southwest Environmental Information Network 2012), however these might not have come from the collectors' labels. Many coordinates were added/determined by students entering information by looking on Google Earth, or other maps and some may be inaccurate (especially for specimens from Mexico). Coordinates for many specimens cited are not repeated here to save space. North America is defined here as Mexico northward, excluding Central

America. Hundreds of photographs that illustrate diagnostic details of morphology for the majority of species, are provided on a companion website—Convolvulaceae (morning glories) of Sonora, Mexico, which is hosted at ARIZ and WLU (Costea et al. 2012b). Plants not native to flora area are marked with an asterisk (*).

TYPIFICATIONS

Special attention has been given to study of type specimens for the taxa included, not only to assure the correct names but also for proper identification. These data are included because there have been errors in citing types in the literature. Types have been checked by consultation of protologues and corrected where necessary. Type sheets have been studied at various herbaria or as loans, and also from online databases at various herbaria, some through JSTOR Plants (2011). Moreover, because of the information now available, it is possible to note many more duplicates of type collections than previously known. The information provided here gives a more complete picture of the available resources for each taxon than formerly obtainable.

Problems and errors in typification are discussed in several cases. Some taxa have never had lectotypes selected. In several cases, we designate lectotypes to establish proper use of names and concepts. In other cases, various problems with former selections of types have been located and these are discussed and resolved except in the case of *E. alsinoides* var. *angustifolia*. Lectotypes are selected for nine species and new information and clarifications are provided for others: *Convolvulus palmatus* (in *Merremia dissecta*), *Convolvulus pennatus* (in *Ipomoea quamoclit*), *Cuscuta corymbosa* var. *grandiflora*, *Ipomoea ancisa*, *Ipomoea alata* (in *Operculina pteripes*), *I. alatipes* (in *Operculina pteripes*), *I. decasperma*, *I. pedicellaris*, *Merremia dissecta*, *Operculina pinnatifida*, *O. pteripes*, and *O. roseana* (in *Operculina pinnatifida*).

KEY TO THE GENERA

1\. Plants parasitic, lacking chlorophyll and without roots (except seedlings). Stems yellow or orange and notably slender and glabrous. Leaves absent or reduced to small scale-leaves ____ **Cuscuta**

1\. Plants not parasitic; with roots, leaves, and chlorophyll. Stems not orange or yellow.

  2\. Trees or shrubs at least 1 m tall with notably thick trunks and/or lower branches and stems. Corollas white, 4–9 cm wide. ____ **Ipomoea** (in part: the tree morning glories)

  2\. Herbaceous annuals or perennials, or at least not substantial shrubs or trees.

    3\. Stems, small, prostrate, sometimes mat-forming. Leaves reniform to cordate. Flowers usually <1 cm wide, corollas deeply lobed, greenish, yellowish to purple. Fruits utricles or capsules ____ **Dichondra**

    3\. Stems mostly ascending to erect, rarely prostrate, not mat-forming. Flowers mostly ≥1 cm wide, corollas deeply to shallowly lobed, white, pink, lavender, purple or variously colored. Fruits capsules or indehiscent.

      4\. Styles 2, free or united near the base.

        5\. Plants often of saline regions. Herbs, much-branched, perennial, stems not vining. Leaves usually <1 cm long, sessile. Styles 2-lobed, the stigmas globose ____ **Cressa**

        5\. Plants of hydric or xeric regions, rarely saline. Perennial or annual herbs or vines, lianas, or shrubs. Leaves mostly >1 cm long, petiolate or sessile. Styles divided into 4 lobes, the stigmas elongate to clavate ____ **Evolvulus**

      4\. Styles 1, entire or with 2 inconspicuous branches hidden by the stigmas.

        6\. Stems and leaves with stellate trichomes.

          7\. Corollas 0.6–2.7 cm long. Stigmas ellipsoid to oblong. Fruits usually 8 or more valved ____ **Jacquemontia**

          7\. Corollas 6–8 cm long. Stigmas globose. Fruits 4-valved ____ **Ipomoea scopulorum**

        6\. Stems and leaves with or without trichomes, but not stellate. Stigmas linear to linear-subulate or globose. Fruits with 4–6 valves, or irregularly or transversely dehiscent, or indehiscent.

          8\. Flowers campanulate, white or white limb with purple-red throat.

            9\. Corolla white ____ **Operculina pinnatifida**

            9\. Corolla white with red-purple throat ____ **Merremia dissecta**

          8\. Flowers funnelform, salverform to funnelform-salverform, white or colored.

            10\. Flowers white to pink. Stigmas subulate and cylindrical, apices acute ____ **Convolvulus**

            10\. Flowers variously colored, from white through pink to purple, yellow or other colors. Stigmas globose.

              11\. Stamens straight upon dehiscing. Pollen pantoporate, spinulose, the spinules visible with 10× magnification ____ **Ipomoea**

              11\. Stamens spirally twisted upon dehiscing. Pollen colpate, not spinulose.

                12\. Corollas white or white with purple throat ____ **Merremia dissecta**

                12\. Corollas reddish, red-orange, or salmon ____ **Operculina pteripes**

Convolvulus L., Sp. Pl. 153. 1753. [Latin *convolvere*, to entwine, in reference to the twining habit of these plants.]

BINDWEED

Woody or herbaceous **vines** or **shrubs**. **Leaves** petiolate rarely sessile; blades herbaceous to coriaceous, linear to ovate or elliptic with subtruncate cordate, sagittate or hastate bases, glabrous or hairy, the margins usually undulate to crenate or irregularly lobed or laciniate. **Inflorescences** of solitary flowers or in cymose groups, on pedicels mostly 1–3 cm long, bracts and bracteoles linear, elliptic or ovate. **Flowers** small to medium (0.4–4 cm long in North America). Sepals subequal, the inner three often somewhat longer, suborbicular, elliptic to ovate, hairy or glabrous, obtuse to acute, usually mucronate. Corollas white or rose to purple or blue on the limb and white or purplish within the tube, funnelform, the limb 5-angulate to 5-lobed, the midpetaline (exposed areas between the corolla folds in the bud) bands glabrous or hairy. Stamens included, unequal, with glandular trichomes on the filament base, the anthers oblong, basally auriculate, introrse. Pollen 3-colpate. Disc usually lobed. Ovary 2-locular, 4-ovulate, ovoid to subglobose, glabrous or hairy. Style one; with 2 filiform, papillose stigmas. **Fruits** capsular, 4-valved, mostly brown, chartaceous, ovoid to conical-ovoid, glabrous or hairy. Seeds 1–4, trigonous or rounded, smooth or verrucose, black to dark brown, glabrous.

Species ca. 200 (many are found only in Europe and Asia). Three species are native to North America.

Selected reference.—Sa'ad (1967).

1. Perennials from deep creeping roots. Stems forming large dense patches. Leaf blades almost as broad as long. Calyx 3–5 mm long ________ **C. arvensis**
1. Perennials from a taproot. Stems not forming large dense patches. Leaf blades usually much longer than broad. Calyx 6–12 mm long ________ **C. equitans**

*__Convolvulus arvensis__ L., Sp. Pl. 153. 1753. TYPE: SWEDEN: Linnaeus (218.1 LINN!).

Convolvulus ambigens House, Bull. Torrey Bot. Club 32:139. 1905. TYPE: U.S.A. COLORADO: near Fort Collins, 22 Jun 1896, *Crandall 4218* (HOLOTYPE: NY!, ISOTYPE: US!; 23 Aug 1898, *Crandall 4218* (PARATYPES (2) NY!).

CORREHUELA; BINDWEED

Widely spreading rhizomatous perennial **herbs** with branched, decumbent or twining stems. **Leaves** variable, often ovate, ovate-lanceolate to elliptic, 1–10 cm long, 0.3–6 cm wide, entire or with the margin somewhat undulate, basally cordate to subtruncate, hastate or sagittate, the lobes obtuse or acute, entire or with 2 or 3 teeth, glabrous or inconspicuously puberulent; petioles 3–40 mm long. **Inflorescences** cymose, on peduncles 3–3.5 mm long; bracts elliptic, linear or obovate, 2–3(–9) mm long, the bracteoles linear, 2–4 mm. long, usually glabrous. **Flowers** 2 or 3, or solitary, the pedicels 5–18(–35) mm long, reflexed in fruit. Sepals slightly unequal, obtuse or less often truncate or emarginate, mucronate, ciliate; outer sepals elliptic, 3–4.5 mm long, 2–3 mm wide, glabrous or tomentose, the inner ones suborbicular to obovate, 3.5–5 mm long, 3–5 mm wide. Corollas 1.2–2.5 cm long, glabrous, campanulate, typically white or tinged with pink, sometimes becoming pink with age, or with white interplicae and pink plicae. **Capusules** subglobose to ovoid, 5–7 mm wide, glabrous. Seeds 1–4, 3–4 mm long, black to dark brown, glabrous, tuberculate. $2n = 48, 50$.

Sonora.—Widespread and weedy, especially in cultivated fields: Chihuahuan and Sonoran deserts, desert grassland, coastal thornscrub, oak woodland, and pine-oak forest; near sea level–2100 m. Flowering throughout the year, but specifically recorded in March–August.

General distribution.—A worldwide weed including cultivated fields, disturbed ground, roadsides; throughout most of southern Canada and USA; Baja California (norte) and Sur, Chihuahua, Distrito Federal, Guanajuato, Hidalgo, Edo. México, Michoacán, Querétaro, Sinaloa, Tamaulipas; naturalized from Europe.

This Old World weed is considered by some to be the worst in the world (Austin 2000a). Due to its deep rhizomatous growth, it persists and reappears even when above ground parts have been eliminated with herbicide. Together with *Cressa*, this is one of the few members of the family that develops rhizomes (Austin 2000a).

Mpio. Agua Prieta: 8.4 km S of Agua Prieta (at MEX 2) on SON 17 (to Fronteras), flowers white, open in afternoon, 16 Apr 2007, *Reina-G. 2007-395*! **Mpio Cananea:** Cananea, 1545 m, flowers white, turning pink, 15 May 2002, *Van Devender 2002-306* (USON!). **Mpio. Hermosillo:** 2 km W of Hermosillo, 29°05'N, 111°01'W, common scandent vine in disturbed field, flowers pink, 9 Aug 1995, *Friedman 259-95*! **Mpio. Guaymas:** 30 km NW of Pótam, coastal thornscrub, irrigated field, flowers white, 4 Mar 2006, *Van Devender 2006-250*! **Mpio. Huatabampo:** 5 km E of La Unión on Huatabampo road, common, flowers white, 14 Apr 1995, *Van Devender 95-284*! **Mpio. Yécora:** El Llano on Mesa del Campanero (W of Yécora), 28°20'30"N, 109°01'55"W, 2100 m, *Trauba 23 Sep 1997* (FTG-FAU!).

Convolvulus equitans Benth., Pl. Hartweg. 16. 1839. TYPE: MEXICO. NUEVO LEÓN: 1837, *Hartweg 98* (HOLOTYPE: K!; ISOTYPES: G!, LD!, NY!).

Convolvulus hermannioides A. Gray, Syn. Fl. N. Amer. 2(1):216. 1878. TYPE: U.S.A. TEXAS: [without locality], *Lindheimer 469* (HOLOTYPE: GH!).

Convolvulus incanus sensu Kearney & Peebles, not Vahl (see also Staples et al. 2006).

Perennial **herbs** with branched, prostrate or decumbent stems arising from a taproot; densely hairy. **Leaves** variable, ovate-elliptic to triangular-lanceolate or narrowly oblong with projecting basal lobes, blades most often deeply indented basally, 1–7 cm long, 0.2–4 cm wide, densely hairy on both surfaces with loosely appressed indumentum, margins toothed or lobed or both, rarely entire; petioles 0.25–5 cm long. **Inflorescences** usually 1-flowered, less often 2 or 3 and cymose, on peduncles 0.5–10.5 cm long; bracts and bracteoles lanceolate, 1.5–3 mm long or sometimes scale-like, hairy like the leaves. **Flowers** often solitary, on short pedicels 5–24 mm long. Sepals oblong to ovate, 6–12 mm long, 3–6 mm wide, obtuse to weakly retuse apically, appressed sericeous, the margins membranaceous, subcordate with age. Corollas (1.5–) 2.5–3 cm long, campanulate, white or pink to pale lavender, at times with a reddish center, sericeous on the petal lobes. **Capsules** ± globose, 7–8 mm wide, glabrous. Seeds 1–4, 4–4.5 mm long, black, granulate, glabrous. $n = 12$.

Sonora.—Northeastern part of the state in Chihuahuan Desert, grassland, and oak-mesquite scrub; often in disturbed sites; 1200–1600 m. Flowering April–December.

General distribution.—California, Arizona, New Mexico, Texas; Chihuahua, Coahuila, Guanajuato, Hidalgo, Edo. México, Michoacán, Nuevo León, Oaxaca, Puebla, Querétaro, San Luis Potosí.

Mpio Agua Prieta: Rancho El Nogalito, Cuenca Los Ojos Foundation Conservation Area, 49.6 km (by air) E of Agua Prieta, 1476 m, 30 Sep 2009, *Reina 2009-1747*! **Mpio Cananea:** 4 km NE of Cananea on MEX 2, 21 May 2008, 1496 m, *Van Devender 2008-234-A*! **Mpio Santa Cruz:** Rancho Los Fresnos, upper San Pedro River drainage, along US–Mexico border, just SW of Huachuca Mountains, 15 Oct 2005, 1555 m, *Boyle 7751*!

CRESSA L., Sp. Pl. 223. 1753. [Greek, based on *kris* or *kriti*, "from Crete," a Cretan woman; apparently not etymologically related to *cress* or *cressa* (Cruciferae) of Germanic derivation].

ALKALI WEED

Perennial **herbs** or **subshrubs**, gray appressed pilose to sericeous, usually much-branched, the stems erect to decumbent. **Leaves** sessile or short-petiolate, entire, small or scale-like. **Inflorescences** axillary, 1-flowered. **Flowers** appearing sessile or on short peduncles (at least some, e.g., *C. truxillensis*), bracteate, in spicate to head-like clusters at tips of branchlets, bracteoles unequal in length. Sepals ovate to obovate, imbricate. Corollas salverform, the limb 5-lobed, the lobes mostly ovate, imbricate, spreading to reflexed. Stamens and styles exserted; filaments filiform; pollen 3-colpate. Ovary 2-locular, 4-ovulate; styles 2, distinct to the base; stigmas capitate. **Fruit** capsular, ovoid, unilocular, 2–4-valved, usually 1-seeded. Seeds glabrous, smooth and shining to reticulate, dark brown.

Species 4, two in the Americas, one in Asia, and one in Australia.

Selected reference.—Austin (2000b).

Cressa truxillensis Kunth, Nov. Gen. Sp. (quarto ed.) 3:119. 1818 [1819]; also folio ed. 3:93. 1819. TYPE: PERU: Trujillo, *Humboldt & Bonpland 3727* (microfiche seen; photo F!, ISOTYPE: F!). *Cressa cretica* var. *truxillensis* (Kunth) Choisy in DC., Prodr. 9:440. 1845.

Cressa australis var. *petiolata* Meisn. in Mart., Fl. Bras. 7:329. 1869. TYPE: ARGENTINA: Buenos Aires, [date not given in protologue or in O'Donell (1957)], *Tweedie* (HOLOTYPE: M, not seen).

Cressa depressa Goodd., Bot. Gaz. 37:58. 1904. TYPE: U.S.A. NEVADA: saline swampy ground, Virginia River, 6 May 1902, *Goodding 726* (HOLOTYPE: RM!; ISOTYPES: MO!, NY!, UC!, US!).

Cressa insularis House, Bull. Torrey Bot. Club 33:315. 1906. TYPE: MEXICO. REVILLAGIGEDO ISLANDS: Soccoro Island, May 27–July 3, 1903, *Barkelew 252* (HOLOTYPE: US!; ISOTYPES: NY!, UC!).

Cressa erecta Rydb., Bull. Torrey Bot. Club 40:466. 1913. TYPE: U.S.A. Utah. Salt Lake City County, near Beck's Hot Springs, Jul 1905, *Garrett 870f* (HOLOTYPE: NY!).

Cressa minima A. Heller, Muhlenbergia 8:140, tab. 17, 1913. TYPE: U.S.A. NEVADA. Washoe Co.: N side Peavine Mt, 1 Jul 1907, *Heller & Kennedy 8663a* (HOLOTYPE: NY!; ISOTYPES: CAS!, L!, photo FTG-FAU!, NY!, US!), sphalma as *C. pumila* on tab. 17. *C. truxillensis* var. *minima* (A. Heller) Munz, Aliso 4:96. 1958.

Cressa vallicola A. Heller, Muhlenbergia 8:140, pl. 17, 1912 [1913]. TYPE: U.S.A. CALIFORNIA: 4 Jun 1908, *Heller 8936a* (HOLOTYPE: UC! ISOTYPES: CAS!, L!, photo FAU!, NY!, US!). *Cressa truxillensis* var. *vallicola* (A. Heller) Munz, Aliso 4:96. 1958.

C. arenaria Willd. ex Roem. & Schult., Syst. Veg. 6:207. 1820. TYPE: "In Americ. merid. Humboldt et Bonpland." There are two sheets: Sheet 1, with XIII on the label, has "in Guanchaco [Huanchaco] areniosis" in Bonpland's hand. Sheet 2 simply has in the upper right corner the numeral 2 along with *Cr. arenaria* written D. F. L. von Schlechtendal. The label has "Habitat in America meridionali," in Willdenow's hand. *Humboldt 3227* (sheet 1 lectotype, barcode B-W-05422-01-0!)

Cressa multiflora Willd. ex Roem. & Schult., Syst. Veg. 6:207. 1820. TYPE: Willdenow has written IX on a small label with the name *Cressa* and a drawing of the flower, along with the name "Truxillo" written by Humboldt. The label has "Habitat in America meridionali," a short description in Latin, and *Cressa multiflora* in Willdenow's hand. *Humboldt s.n.* (HOLOTYPE: barcode B-W 05420-01-0!, photo FTG-FAU! This is probably an isotype of *C. truxillensis*).

ALKALI WEED; *ZIIX CASA INSII* (SERI)

Perennial herbs. Stems gray, appressed pilose to silvery-sericeous, not twining, usually much-branched, at first erect, becoming decumbent to spreading, often 8–25 cm long in open, sunny habitats, or often with weak slender stems to 75 cm long when growing through and branching over the tops of other salt-marsh halophytes; stems dying back during adverse times to thickened rhizomes and/or rootstocks often 8–15+ cm below the surface; lower stems often semiwoody. **Leaves** on main branches often larger than those on branchlets, with pubescence like the stems, subsessile or with petioles 0.5–2 mm long; blades mostly 3–10 mm long, 1–4 mm wide, elliptic to lanceolate or ovate-lanceolate, basally cuneate, sometimes obtuse, the apex usually acute; older leaves sometimes thick and succulent in hypersaline habitats. **Inflorescences** of solitary flowers, axillary, usually concentrated in the upper leaf axils and appearing almost spicate. **Flowers** on stalks (peduncles and pedicels) 2–6 mm long, the pedicel much reduced and more slender than the peduncle, the bracteoles ovate to ovate-lanceolate, acute, unequal, 2–3 mm long, mostly 1 mm wide. Sepals ± equal or the inner slightly longer; outer sepals obovate, elliptic, 3–4 mm long, 2.5–3 mm wide, obtuse or acute, pubescent; inner sepals obovate, 3–4.5 mm long, 2–3 mm wide, acute, with scarious margins, appressed sericeous only at the apex. Corollas white, becoming scarious when dry and somewhat persistent, salverform, 5–6.5 mm long, the tube 3–3.5 mm long, the limb 5-lobed. Corolla lobes obtuse to ± acute, about as long as the tube, somewhat pubescent on the outer surface, becoming reflexed with age. Stamens exserted, 4–6 mm long, usually equal, the filaments basally pubescent with glandular indumentum; anthers red and becoming purple with age, 1–1.5 mm long, oblong with the base cordate to ± bilobed. Ovary ovoid, unilocular to ± bilocular, apically somewhat hirsute; styles pure white, unequal, 3–5 mm long; stigmas pure white, capitate, smooth. **Capsules** 5–6 mm long, ovoid, shiny brown, surrounded at least basally by the calyx, apically hirsute, unilocular. Seeds usually 1, ovoid, 3–4 mm long, brown, glabrous. $2n = 28$.

Sonora.—Often common in tidally wet saline mud and sandy soils among saltscrub and margins of mangroves, *esteros*, bays, and low-lying coastal soils from the Río Colorado delta to the Sinaloa border. In northwestern Sonora sometimes in small inland playas but near the coast, and as an agricultural weed south of San Luis, especially in fine-textured silty-clay alkaline soils. Sonoran desert and coastal thornscrub: 0–20 m. Flowering March–December.

In contrast to populations in northwestern Sonora, this species has apparently become relatively rare, at least in recent years, in nearby southwestern Arizona (Austin 1992). In the early 1990s *Cressa* was a common weed in sandy soil of seawater-irrigated experimental plots at the Environmental Research Laboratory adjacent to Estero Morúa at Puerto Peñasco. *Cressa* had been evaluated earlier as a potential halophytic seed crop in these plots. Substantial seed crops were obtained, but no economic value was found and further evaluation was terminated. This is probably the first report of a weed in seawater-irrigated agriculture (Felger 2000).

General distribution.—California, Arizona, Nevada, New Mexico, Texas, Utah; Baja California (norte) and Sur, Chiapas, Chihuahua, Coahuila, Colima, Jalisco, Nuevo León, Oaxaca, San Luis Potosí, Sinaloa, Revillagigedo Islands; Ecuador, Peru, Chile, Argentina.

Mpio Guaymas: Guaymas, 15 Dec 1939, *Drouet & Richards 4015* (CAS!). **Mpio Empalme:** Playa Cochorit, 13 Aug 1985, *Felger 85-902B*! **Mpio Etchojoa:** Paredoncito on Bahía Tobari, about 28 mi W of Navojoa, 17 Dec 1988, *Sanders 8970* (UCR!). **Mpio Guaymas:** Yasícuri, opposite Las Guásimas, sandy-gravel on upper beach, 16 Mar 1989, *Felger 89-190*! **Mpio Hermosillo:** Santa Rosa Peninsula, Infiernillo Channel, 4 Mar 1971, *Felger 20100*!; Kino Bay, 25 Nov 1979, flowers white, *Van Devender 93-281* (UCR). **Mpio Hutatabampo:** Playa Las Bocas, near beach, 6 May 1966, *Friedman 003-96*! **Mpio Puerto Peñasco:** Estero Moruá, 29 Apr 1990, some older leaves succulent, *Felger 91-40*. **Mpio San Luis R.C.:** Colorado River, opposite mouth of Hardy River, 29 May 1894, *Mearns 2842* (CAS!); Ciénega de Santa Clara, 5 km S of Rillito, 6 Oct 1985, *Felger 92-989*. **SONORAN ISLANDS:** Alcatraz, Bahía Kino, 4 Dec 2007, *Felger 07-167*!; Tiburón, base and N side of Punta San Miguel, E side of island, 23 Nov 2006, *Wilder 06-366*! (See Felger and Wilder 2012 for additional records.)

DICHONDRA J.R. & G. Forster, Char. Gen. Pl. 40, t. 20. 1776. [Greek διχονδρα, *di* "double" and *chondra* "a grain," an allusion to the structure of the fruit.]

OREJA DE RATÓN; PONYFOOT, PENNYWORT, FALSE PENNYWORT

Herbs with slender glabrous or pubescent and mostly repent stems, from perennial taproots; stems sometimes rooting at nodes. **Leaves** petiolate; blades cordate-orbicular to reniform, small, the margins entire. **Inflorescences** of inconspicuous, axillary, solitary (rarely paired) flowers on short to long peduncles. **Flowers** usually less than 1 cm wide, greenish-yellow or white (purple in *D. occidentalis*, but that one not in the flora area). Sepals ± equal, barely united basally, often spathulate. Corollas broadly campanulate to subrotate when living, appearing funnelform at times when dried, usually deeply 5-lobed, the lobes induplicate. Stamens typically included, more or less equal. Pollen 3-colpate. Ovary 2-lobate to emarginate, the lobes distinct or usually basally united, 2-locular. Styles 2, attached between the lobes and appearing almost gynobasic, filiform, the stigmas capitate. **Fruits** capsular or utriculate, 2-lobed to almost entire, membranaceous, usually 2-seeded, irregularly bivalvate or indehiscent. Seeds obovoid, smooth, the cotyledons linear, 2-plicate.

Species ca. 15; tropics and temperate regions: 8 species in North America, ±7 in South America, the others in Australia and New Zealand.

Selected references.—Austin (1998a), Johnston (1963), Tharp and Johnston (1961).

1. Leaves and stems appressed, whitish or canescent-pubescent. Pedicels recurved near the point of attachment of the stolon. Fruits entire or emarginate, carpels often 2-seeded ____ **D. argentea**
1. Leaves and stems sparsely appressed pubescent above, leaves more densely below but green or greenish on both surfaces. Fruits deeply bilobed, carpels usually 1-seeded.
    2. Lower leaf surfaces glabrous or pubescent, similar in color to the upper surfaces; fruiting peduncles recurved just below calyces ____ **D. brachypoda**
    2. Lower leaf surfaces densely appressed hairy below, at least on young leaves, usually contrasting with green upper surfaces; peduncles often nodding but not sharply recurved ____ **D. sericea**

Dichondra argentea Humb. & Bonpl. ex Willd., Enum. Pl. 297. 1809. TYPE: COLOMBIA: "Habitat in America meridionali prope Hundam" (from protologue), no date, *Humboldt & Bonpland s.n.* (B-W, presumably barcode B -W 05468-01-0 and the reverse, 05468-02-0, having "*Dichondra argentea* (W)" in what seems to be Willdenow's handwriting).

Perennial herbs, whole plant except roots, stamens, corolla and styles silvery-canescent with a dense pubescence of long, silky, usually appressed, flattened hairs; taproots perennial, dark brown, 1.8–4 mm thick; stolons annual, 10–35 from the crown, ca. 0.7–1.1 mm thick, rarely branched; internodes 1–2.5(–3) cm long; nodes often bearing adventitious roots and occasionally short-shoots with crowded nodes. **Leaves** reniform, 5–13 mm long, 12–20 mm broad, apically often shallowly emarginate, basally truncate or broadly and shallowly cordate, with a narrow cuneate base where the blade joins the petiole; petioles (1–)2–3(–5) cm long, 0.5–1 mm thick, erect, straight. **Inflorescences** on pedicels 4–6 mm long, 0.5–1 mm thick, basally sharply recurved. **Flowers** 3.4–4 mm wide. Calyx broadly campanulate, 2–2.6 mm long, accrescent to 2.4–3 mm in fruit, 5-lobed two-thirds to three-fourths the length, the lobes linear-oblong, apically blunt and often somewhat recurved. Corollas nearly cylindrical, cream-colored, 5-lobed about half the length or more, the lobes subulate. Ovary only slightly bilobed. **Fruits** capsules 2.2–2.8 mm long, and 2–2.1 mm wide. Seeds 1.9–2.4 mm long, ovoid to pyriform, dark brown to black when fully mature.

This species is known from southeastern Arizona close to Sonora as well as southwestern New Mexico and Chihuahua and is likely to be in the Chihuahuan desert region of northeastern Sonora (Austin 1998a). Also in Chiapas, Coahuila, Durango, Edo México, Nuevo León, San Luis Potosí,Tamaulipas, Zacatecas.

U.S.A. **ARIZONA: Cochise Co.:** Bisbee, 26 Sep 1931, *Harrison 8256*! **NEW MEXICO. Luna Co.:** S end of Florida Mountains, Copper Kettle Canyon, 4997 ft, 1 Sep 2006, *Jercinovic 617* (UNM!). **MEXICO. CHIHUAHUA: Mpio Ojinaga:** Chihuahua, 13 (rd) miles N of La Perla (81 miles S of Ojinaga) along Hwy 18 (Ojinaga-Camargo), on small lava knoll along Hwy, 4900 ft. 17 Sep 1972, *Henrickson 7724*! **Mpio. Aquiles**

Serdán: 7 mi SE of Tomás García, SE end of Sierra de Mapula, 1.5 mi off road toward mts, Rancho El Ojito, vicinity of Pico Ojito, vicinity 28°28'N, 105°45'W, ca. 4300 ft, chaparral grassland with many cacti, 19 Jul 1977, *Lehto L-21558* (ASU!).

Dichondra brachypoda Wooton & Standl., Contr. U.S. Natl. Herb. 16:160. 1913. Type: U.S.A. New Mexico. Doña Ana Co.: Organ Mountains, Filmore Canyon, 23 Sep 1906, *Wooton & Standley s.n.* (holotype: US!; isotype: NMC 21191!).

Herbs with a perennial taproot, and annual stolons, stems closely hairy with soft, silky appressed hairs, giving the plant a pale tawny-green cast. **Leaves** herbaceous; blades suborbicular to reniform, 8–40 mm long, 10–55 mm wide, the apex often shallowly emarginate, the base truncate to broadly cordate, usually with a deep sinus, the lower surface glabrous or pubescent, the upper surface sparsely pubescent; petioles 1.5–15 cm long, arcuate or curved. **Inflorescences** on peduncles 5–26 mm long, sharply recurved, usually in the upper portion. **Flowers** 3.5–5 mm in diameter. Calyx broadly campanulate, the sepals lanceolate, 2.5–4 mm long at anthesis, accrescent to 3.8–5.2 mm long in fruit, the outer surfaces villous. Corollas cream colored, campanulate, 3.5–5 mm long, 5-lobed about ⅔–¾ of the length, the lobes lanceolate, acute, and villous on outer surfaces. **Fruits** capsular, 6–7 mm long, 3–5 mm wide. Seeds 1 or 2, pyriform, 1.5–2.3(–4) mm long, brown.

Sonora.—Canyon slopes and riparian habitats, often in shaded niches, among oak woodland and pine-oak forests in the northeastern part of the state, and higher mountains along the Chihuahua border in the southeastern part of the state; 1300–2000 m. Flowering mostly August–October.

General distribution.—Southeastern Arizona, New Mexico, Texas; Chihuahua, Coahuila, Durango, Hidalgo, Edo. México, Oaxaca, San Luis Potosí, Zacatecas.

Mpio Agua Prieta: Sierra San Luis, Rancho Pan Duro, 2000 m, flowers white, localized beneath *Pinus chihuahuana*, pine-oak woodland with *Juniperus deppeana, Quercus emoryi, Pinus engelmannii*, 25 Jul 1993, *Felger 93-518A*! **Mpio Cananea:** Rancho Las Gallinas, 1260 m, E of Cerro Bola, eastern Sierra Azul, sycarmore-willow-juniper riparian forest, locally common in sandy soil under shrubs in canyon bottom, 26 May 2005, *Van Devender 2005-907*! **CHIHUAHUA: Mpio Chínipas:** Along the Sonora border, Sierra Saguaribo (Sierra Tecorahui), 2 mi SW of Tecorahui, [vicinity] 27°07'N, 108°39'W, ca. 1300 m, common in shade beneath trees, leaves greeen on both sufaces, 23 Oct 1961, *Felger 5543*!

Dichondra sericea Sw., Prodr. 54. 1788. Type: JAMAICA: *Swartz* (holotype: S!, isotype: BM, not seen). *Dichondra repens* var. *sericea* (Sw.) Choisy in DC., Prodr. 9:451. 1845.

Dichondra repens of authors, not J.R. Forst. & G. Forst.

Herbs with a perennial taproot, and annual stolons sometimes rooting at nodes, the stems sparsely to densely appressed hairy. **Leaves** chartaceous to subherbaceous; blades suborrbicular, 8–20 mm long, 7–19 mm wide, the apex rounded or usually shallowly emarginate, the base cordate with shallow to deep sinuses, the lower surface densely hairy when young, less so when older and giving a silvery sheen, the green upper surface green in contrast, the differences most notable on younger leaves and sometimes becoming difficult or impossible to detect on older leaves; petioles 0.5–7 cm long, weak, arcuate, curved. **Inflorescences** on peduncles 5–35 mm long, arching, erect, to slightly nodding or curved but not recurved in the upper part. **Flowers** 3–4 mm wide. Calyx campanulate; sepals obovate to obovate-spathulate, 1.5(–2.5) mm long, reaching 3.3 mm in fruit, 1 mm wide at widest point, the outer surfaces sericeous, the inner surfaces sparsely sericeous. Corollas yellow-green, campanulate, slightly shorter than the calyx, 1.5(–2) mm long, 0.5 mm wide, the sinuses nearly reaching the base, the lobes lanceolate, acute, and glabrous. **Fruits** utricle-like, 2–3.5 mm long, 1.8–2.5 mm wide, falling in two parts or one, each half dehiscing loculicidally. Seeds 1 or 2, pyriform, 1.5(–2.1) mm long, brown.

Sonora.—Mountains near the Chihuahua border in east-central and southeastern parts of the state, mostly in moist, shaded or riparian habitats in canyons among oak woodland and pine-oak forest; ca. 1200–1500 m. Flowering mostly August–December.

General distribution.—Southern Arizona; Baja California Sur, Chihuahua, Nuevo León, Tamaulipas, Veracruz, Durango, San Luis Potosí, Guanajuato, Hidalgo, Edo. México, Distrito Federal, Puebla, and Chiapas; Central and South America; West Indies.

Mpio Álamos: Santa Bárbara, 27°07.2'N, 108°43.3' W, 1300 m, 23 Oct 1992, *Jenkins 92-88*!; Rancho El Rayo, on road to Chínipas, 27°15.4'N, 108°37.9'W, 1500 m, *Martin & Yetman 18 Aug 1991*! **Mpio Yécora:** Río Maycoba, ca. 1 km upstream from Hwy 16 crossing, 28°22.5'N, 108°45'W, 1210 m, 7 Sep 1995, *Fishbein 2526*!; La Pila, 0.6 km E of El Trigo Moreno, riparian forest in pine-oak forest, 28°17'48"N, 108°47'11"W, 1450 m, 30 Aug 2008, *Reina-G. 2009-429*!

EVOLVULUS L., Sp. Pl., ed. 2, 1:391. 1762. [Latin, *evolvulare*, to enroll, an allusion to their non-twining habit.]

Dwarf morning glory

Herbs or small suffrutescent shrubs, annual or perennial, not twining but sometimes creeping. **Leaves** usually small; blades ovate to almost linear, entire. **Inflorescences** of 1–several-flowered axillary cymes, pedicellate, pedunculate, or sessile. **Flowers** on pedicels about as long as calyx or pedicels apparently absent. Sepals equal or subequal. Corolla conspicuous, blue, or inconspicuous, faded pale bluish-white, rotate, funnelform or salverform, the limb plicate, mostly subentire, the lobes pilose externally. Stamens with filiform filaments, the anthers ovate to oblong or linear; pollen 3-colpate, 12-rugate. Ovary 2-locular, each locule 2-ovulate, sometimes 1-locular and 4-ovulate. Styles 2, free or partially united at the base, each style deeply bifid for at least half its length into long, terete, filiform to subclavate stigmas. **Fruits** of capsules, globose to ovoid, 4-valved. Seeds 1–4, small, smooth or minutely verrucose.

Species ca. 100; all native to the New World. Two species have become widespread in the Old World. There are 7 or 8 species in Sonora and 17 in North America.

Selected references.—Austin (1990b), van Ooststroom (1934), Ward (1968).

1. Stems creeping, prostrate. Leaves about wide as long. Flowers with pedicels but lacking peduncles.
  2. Leaves distichous and imbricate, broadly ovate to orbicular or wider than long; petioles 0.5–1 mm long. Corollas white **E. prostratus**
  2. Leaves distichous but not imbricate, broadly ovate to ovate or elliptic; petioles 1–2 mm long. Corollas blue **E. rotundifolius**
1. Stems straight, erect to spreading. Leaves at least twice as long as wide. Flowers with pedicels and/or peduncles.
  3. Pedicels absent; flowers solitary (usually) in leaf axils.
    4. Leaves markedly distichous. Sepals lanceolate to narrowly lanceolate, spreading pilose **E. sericeus**
    4. Leaves usually not distichous. Sepals oblong-lanceolate, appressed-pilose **E. nuttallianus**
  3. Pedicels present, flowers clustered into cymose groups.
    5. Stems appressed pilose to tomentose, rarely with spreading trichomes. Leaves lanceolate to linear-lanceolate. Corollas (10–)12–22 mm wide. Sepals pilose to tomentose, 3–3.5 mm long **E. arizonicus**
    5. Stems essentially glabrous or pubescent. Leaves elliptic, ovate or oblong to lanceolate or narrowly lanceolate to linear. Corollas mostly less than 10 mm wide. Sepals glabrous or sparsely to densely pilose, 2–2.5 mm long,
      6. Stems with long spreading trichomes. Leaves elliptic, ovate or oblong to lanceolate. Corollas (5–) 7–10 mm wide. Sepals densely pilose **E. alsinoides**
      6. Stems usually sparsely pubescent. Leaves linear to narrowly lanceolate. Corollas 3.5–4 mm wide. Sepals glabrous or sparsely pilose **E. filipes**

Evolvulus alsinoides (L.) L., Sp. Pl., ed. 2, 1:392. 1762. Type: SRI LANKA: Hermann Herb. 3:55 (lectotype: BM!; isolectotypes: S! UPA!). *Convolvulus alsinoides* L., Sp. Pl. 1:157. 1753.

Evolvulus alsinoides var. *angustifolius* Torr., Rep. U.S. Mex. Bound., Bot 2(1):150. 1859. Type: U.S.A. Texas. Presidio Co.: near the Great Cañon of the Rio Grande, Aug, *Parry s.n.* (holotype: not located).

Evolvulus alsinoides var. *acapulcensis* (Willd.) Ooststr., Meded. Bot. Mus. Herb. Rijks Univ. Utrecht 14:54. 1934. *Evolvulus acapulcensis* Willd., Syst. Veg. 6:199. 1820. Type: MEXICO. Guerrero: ca. Acapulco, *Willdenow 6128* (holotype: barcode B-W 06128-01-0!).

Oreja de ratón, babocillo (fide *Rea 1208*); mouse ears; *la'a hühodam sah'i* (Pima Bajo, "laughing bush/herb," fide *Rea 1208*)

Herbs, perennial; stems prostrate or ascending, 6–50 cm long, loosely appressed pilose and with some hairs spreading. **Leaves** ovate, oblong or elliptic to lanceolate, 8–25 mm (exceptionally to 44 mm in extreme SE Sonora mountains) long, 3.5–11 mm wide, the apex obtuse and mucronulate, the base acute to rounded, sparsely to densely pilose on both surfaces, with strongly and loosely appressed, soft, short, grayish trichomes. **Inflorescences** 1 or 2 flowers on filiform peduncles, shorter or longer than the leaves. **Flowers** on pedicels 2–4 mm long, short pilose; bracteoles linear-subulate. Sepals lanceolate, 2–2.5 mm long, acuminate, short pilose. Corollas pale blue or white, rotate, (5–) 7–10 mm wide, filaments 2–3 times as long as the anthers. Ovary globose to ovoid, glabrous. **Capsules** 3–4 mm wide, globose, 4-valved, reflexed, glabrous. Seeds 1–4, ovoid, tan to brown, glabrous.

Sonora.—Sonoran desert, desert grassland, coastal and foothills thornscrub, tropical deciduous forest, oak woodland, and pine-oak forest. Natural and disturbed sites, often somewhat xeric and rocky habitats. Nearly statewide and one of the most widely distributed members of the family in Sonora. Near sea level–1650 m. Flowering much of the year, depending on soil moisture and temperature.

General distribution.—Arizona, New Mexico, Texas, Florida; Aguascalientes, Baja California Sur, Chiapas, Chihuahua, Coahuila, Nuevo León, Tamaulipas; Mesoamerica and South America.

Van Ooststroom (1934) recognized fifteen varieties around the world. Sonora, Arizona, New Mexico, and Texas plants belong to var. *angustifolia* Torrey. This variety typically has shorter sepals, narrower leaves, less densely pubescent stems, and tends to have shorter stems than other varieties.

Mpio Agua Prieta: Colonia Morelos, 2600 ft, 15 Sep–4 Oct, *White 4499*!; Ca. 10 km SW of Agua Prieta, 1287 m, 2 Oct 2004, *Van Devender 2004-1110*! **Mpio Álamos:** San Bernardo, *Gentry winter 1934-35*!; Güirocoba, 14 Nov 1933, *Gentry 826M*! **Mpio Arizpe:** 19 km N of Sinoquipe on SON 89, foothills thornscrub, 30°19'23"N 110°12'25"W, flowers blue, open 12:00 a.m., 16 Sep 2000, *Reina-G. 2000-728*! **Mpio Bacoachi:** Sierra de los Ajos, 30°44'N, 109°59'W, 1150 m, 22 Apr 1995, *Fishbein 2280*! **Mpio Bavispe:** Santa Rosa Canyon, near Bavispe, 3850 ft, 20 Jul 1938, *White 611*!; Río Bavispe, Cañón de la Petaquilla, 15 Aug 1940, *White 3332*! **Mpio Carbó:** 14.6 mi by MEX 15 N of Pesqueira Junction, 1800 ft, 19 Aug 1960, *Felger 3845*!; El Tecolote road (1.2 mi N of El Oasis) W of Mex 15, 27 Aug 1983, *Reichenbacher 1471*! **Mpio Cucurpe:** Palm Canyon, 17 mi SE of Magdalena, *Van Devender 16 Jul 1977*! **Mpio Gen. Plutarco Elías:** 16 mi S[E] of Sonoyta on MEX 2, 14 Apr 1963, *Felger 7537*! **Mpio Guaymas:** Nacapule, 25 Feb 1985, *Felger 85-248*! **Mpio Hermosillo:** Rocky lower slopes of Sierra de Calena S of Villa de Seris, 13 Nov 1939, *Drouet & Richards 3566* (MO!); Rocky hillside, Hermosillo, 220 m, 29°05'N, 110°54'W, 25 Nov 1939, *Drouet & Richards 3754* (MO!); Sierra Seri, 550 m, 2 Feb 1969, *Felger 18130*! **Mpio Hutabampo:** Camahuiroa, 23 Nov 1993, *Friedman 330-93*! **Mpio La Colorada:** 1 mi W of Colorado, *Wiggins & Rollins 310*! **Mpio Moctezuma:** 8 mi E of Moctezuma, rd to Huásabas, 800 m, 17 Mar 1979, *Reichenbacher 189*! **Mpio Ónavas:** Ónavas, 11 Oct 1986, *Rea 1208*! **Mpio San Javier:** Cerro Verde to San Javier, *Martin & Ferguson 10 Mar 1990*! **Mpio Sahuaripa:** Mesa Cureda, 33.8 km (by air) NNE of Sahuaripa, Northern Jaguar Reserve, 29.32194°N, 109.07111°W, 945 m, buffelgrass pasture in foothills thornscrub, 1 Sep 2009, *Van Devender 2009-649* (USON!). **Mpio Soyopa:** 1.5 km E of Tónichi, 28°34'10"N 109°33'00"W, 180 m, 4 Sep 1996, *Van Devender 96-357*! **Mpio Ures:** 6 mi N of Ures, 20 Sep 1934, *Shreve 6708*! **Mpio Yécora:** 4 km SW of Santa Ana de Yécora, 745 m, 23 Sep 1977, *Goldberg 77-170*!; Agua Amarilla, 1000 m, *Martin 14 Mar 1989*! **SONORAN ISLANDS. Tiburón:** E side of island, E base of Sierra Kunkaak, 1 Jan 2006, *Wilder 06-4*!; NE base of Sierra Kunkaak, 25 Oct 2007, *Felger 07-108*!

Evolvulus arizonicus A. Gray, Syn. Fl. N. Amer. 2(1):218. 1878. Type: MEXICO. Sonora: sandy prairies, Sep 1856, *Thurber 1023* (lectotype: GH!). Van Ooststroom (1934: 74) designated a *Pringle* specimen as lectotype but there is no indication it was part of the original material used by Gray, and Austin (1990b) considered that action a neotypification.

Evolvulus laetus A. Gray, Proc. Amer. Acad. Arts 17:228. 1882. Type: U.S.A. Arizona: 1881, *Pringle s.n.* (holotype: GH!; isotypes: BR!, F!, K!, NY!, P!, PH!, U!, US!). *Evolvulus arizonicus* var. *laetus* (A. Gray) Ooststr., Meded. Bot. Mus. Herb. Rijks Univ. Utrecht 14:76. 1934.

Suffrutescent **herbs**, densely appressed pilose to almost woolly tomentose throughout. Stems few to many, arising from a woody base, erect to ascending or decumbent, 10–30(–45) cm long. **Leaves** lanceolate to linear-lanceolate, 10–25(–35) mm long, 2.5–6(–14) mm wide, gradually decreasing in size toward apex, the upper leaves linear, acute or obtuse apically, attenuate basally; petioles absent or short, sparsely to densely pilose on both surfaces, with strongly and loosely appressed, soft, short, grayish trichomes. **Inflorescences** cymose, 1–3 flowered on slender peduncles usually as long as or longer than the leaves. **Flowers** on pedicels 3–4(–8) mm long, reflexed in fruit; bracteoles linear-subulate, 1.5–3 mm long. Sepals equal, lanceolate, acuminate, 3–3.5 mm long. Corollas rotate to broadly campanulate, blue or blue with white stripes, (10–)12–22 mm wide. Filaments inserted near the corolla base, 1.5–2 times as long as the linear anthers. Ovary globular, glabrous. **Capsules** globular, 3.5–4 mm long, reflexed, glabrous. Seeds 2–4, 1–1.25 mm long, tan to brown, glabrous.

Sonora.—Widespread in eastern and central Sonora; Sonoran desert (Plains of Sonora), grassland including mesquite grassland, foothills thornscrub, tropical deciduous forest, oak woodland, and pine-oak forest; natural and disturbed sites, often in rocky habitats; 150–ca. 1200 m. Flowering mostly August–December.

General distribution.—Arizona, New Mexico; Chihuahua; disjunct in Argentina.

This species is easier to recognize in living material than on some herbarium specimens. Some have recognized two varieties that are not distinct.

Selected reference.—Austin (1990b).

Mpio Agua Prieta: Rancho Nuevo, Cajón Bonito, 2 May 1976, *Mason 3213b*! **Mpio Álamos:** Mocúzari, La Cruz, 17°13'N, 109°05.5'W, 150 m, *Martin 17 Mar 1989* (FTG-FAU!); Between Las Chinacas and La Lobera on road to Chínipas, 1500 m, *Martin & Yetman 18 Aug 1991*!; El Guayabo (upper) crossing of the Rio Cuchujaqui 3 km NE of Sabinito Sur and 15 km (airline) ESE of Álamos, near 27°00'N, 108°47'W, 350 m, tropical deciduous forest, 12 Oct 1992, *Sanders 12893* (UCR!); Sierra de Álamos, ridge between Cañon Algoroba and Cañon Los Tomates, above Parque Chalaton in the Sierra, off Chalaton Trail, near 26°59'N, 108°58'W, tropical deciduous forest, 19 Mar 1993, *Sanders 13458* (UCR!); Sierra de Álamos, upper SW fork of Cañón El Huirotal, near 26°57'N, 108°58'30"W, 950–1300 m, steep rocky canyon in transition from tropical deciduous forest to oak woodland, uncommon perennial moist grassy area, 7 Apr 1994, *Sanders 14410* (UCR!). **Mpio Arizpe:** Arizpe, 18 Aug 1958, *Turner 196*! **Mpio Benjamín Hill:** Rancho el Carrizo, 2400 ft, *Tomelson 7 Aug 1968*! **Mpio Carbó:** 1.2 mi N of El Oasis, 730 m, 6 Aug 1982, *Reichenbacher 982*! **Mpio Cumpas:** 8 mi SE of Cumpas on rd to Moctezuma, 24 Sep 1934, *Wiggins 7427*! **Mpio Fronteras:** 13 mi SW of Esqueda, oak zone, 28 Aug 1953, *Ownbey 1770* (MIN!). **Mpio Moctezuma:** 8 mi E of Moctezuma, 17 Mar 1979, *Reichenbacher 195*! **Mpio Opodepe:** 10 km S of Benjamín Hill, 750 m, 10 Sep 1994, *Van Devender 94-457*! **Mpio Santa Cruz:** Rancho Los Fresnos, Nature Conservancy reserve in upper San Pedro River drainage, US-Mexico border, 31.3205°N, 110.3667°W, 1555 m, grassland with isolated patches of oak-mesquite woodland, 22 Sep 2006, *Boyle 7871*! **Mpio Soyopa:** MEX 16, just S of Tónichi, 28°34'15"N, 109°33'09"W, 200 m, 21 Sep 1997, *Reina-G. 97-972* (FTG-FAU!). **Mpio Yécora:** Yécora, 1550 m, open pine-oak forest, common, 7 Sep 1995, *Fishbein 2472*!

Evolvulus filipes Mart., Flora 24 (2, Beibl.):100. 1841. Type: BRAZIL. Bahia: Rio Sao Francisco near Joazerio, *Martius s.n.* [Schedulae Nro. 2313] (B, not seen, BR!, M, not seen).

Evolvulus linifolius of authors, not L.

Annual **herbs,** the stems erect to ascending, delicate, generally sparsely pubescent. **Leaves** linear or narrowly lanceolate, 1–2.5(–3) cm long, usually 2–5 mm wide, sessile or ± sessile or sometimes short-petioled on larger leaves, cuneate basally, acute apically, sparsely pilose on the upper surface, slightly more pubescent on the lower surface. **Inflorescences** cymose to solitary, on peduncles usually 1–2.5 cm long or slightly longer. **Flowers** 1(–3) on pedicels to 2.5 mm long, short-pilose; bracteoles lanceolate to subulate, 1–2 mm long. Sepals lanceolate 2–2.5 mm long, glabrous or pubescent and ciliate. Corollas pale blue or white, 3–5 mm long, rotate, with 5 sericeous bands outside, filaments ca. 2 mm long. Ovary globose, glabrous. **Capsules** globose to ovoid, 3–4 mm long, reflexed, glabrous, brown. Seeds 1–4, smooth, dark brown to black.

Sonora.—Several specimens identified to this species are from the eastern part of the state in tropical deciduous forest and oak woodland.

General distribution.—Coahuila, Durango, Michoacán, Sinaloa, Veracruz; Mesoamerica; South America.

This species is weakly differentiated from *E. alsinoides*. In South America they appear to be distinctive, while in Mexico they are not always separable. The Sonora specimens have the appearance of first season plants of *E. alsinoides*. Perhaps those called *E. filipes* in part (or all) of the range are nothing more than depauperate or first season *E. alsinoides*, but there are insufficient data to confirm or deny that suspicion and we reluctantly retain them as separate until more detailed studies are made.

Mpio Álamos: El Guayabo, on road 18 km E of Álamos, 27°0'20"N, 108°4710"W, 250 m, *Martin 16 Mar 1989* (FTG-FAU!). **Mpio Cucurpe:** Palm Canyon, 15 SE of Magdalena, Cerro Cinto de la Plata, along stream, 1 Sep 1979, *Toolin 453-C* (2 sheets, ARIZ 220685!, ARIZ 221490)! **Mpio Ures:** Upper Cañada El Yugo, Sierra Mazatán, open oak woodland and on Catalina gneiss, 29°06'07"N, 110°11'48"W, 1300 m, common annual on open rocky areas, 10 Oct 2004, *Van Devender 2004-1306*!

Evolvulus nuttallianus Roem. & Schult., Syst. Veg. 6:198. 1820, New name for *E. argenteus* Pursh (1814 [1813]), not Brown (1810). Type: U.S.A. Missouri: Rapid River, "On the banks of the Missouri," (protologue), (from PH sheet), *Nuttall s.n.* (holotype: B was apparently destroyed during the Second World War, although van Ooststroom 1934: 122 saw it before the war; isotype: PH!).

Evolvulus pilosus Nutt., Gen. N. Amer. Pl. 1:174. 1818, nom. pro syn. Type: based on the same collection as *E. nuttallianus* (holotype: PH!).

Evolvulus argenteus Pursh, Fl. Amer. Sept. 1:187. 1814 [1813], not R. Br. (1810). Type: based on the same collection as *E. nuttallianus* (holotype: PH!).

Evolvulus oreophilus Greene, Leafl. Bot. Observ. Crit. 1(11):151. 1905. Type: U.S.A. New Mexico: Sierra [Co.]: S end of the Black Range, 1 mi W of Hillsboro, dry hills, 5500 ft, 16 Aug 1904, *Metcalfe 1228* (lectotype designated here: US!; isotypes: MO! NMC! NY!)

Suffrutescent **herbs,** the stems several, erect to ascending, 10–15 cm long, densely spreading-pilose with an indumentum of ferrugineous, brown, fulvous or gray color. **Leaves** linear-oblong, narrow-lanceolate to narrow-oblanceolate or rarely oblong, 8–20 mm long, 1.5–5 mm wide, attenuate basally, acute to obtuse apically, densely pilose on both surfaces; petioles short or absent. **Inflorescences** solitary, in axils over most of the length of stem; peduncles short or absent. **Flowers** on pedicels 3–4 mm long, becoming reflexed in fruit; bracteoles subulate, 1–4 mm long. Sepals lanceolate to narrowly lanceolate, long-acuminate, 4–5 mm long, spreading villose. Corollas rotate to broadly campanulate, 8–12 mm wide, subentire, purple or blue. Anthers 1–2 mm long, oblong, basally auriculate; filaments twice as long as the anthers. Ovary subglobose, glabrous. **Capsules** ovoid, about as long as sepals, reflexed, glabrous. Seeds (1) 2, brown, smooth.

This species grows in the mountains of southeastern Arizona near the Mexican border (Austin 1991, 1998b) and probably will be found in northeastern Sonora in oak woodland and pine-oak forest; 820–2450 m. Flowering April–September.

General distribution.—Arizona, New Mexico, and Texas to Montana, North Dakota, Illinois, Arkansas, disjunct in Tennessee; Chihuahua, Coahuila.

Evolvulus prostratus B.L. Rob., Proc. Amer. Arts 29:320. 1894. TYPE: MEXICO. JALISCO: near Guadalajara, 26 Jul 1893, *Pringle 4445* (LECTOTYPE designated here: NY!; ISOLECTOTYPES: GOET!, K!, PH!). MEXICO. HIDALGO: Real del Monte. *Coulter 1011* (SYNTYPE: K, not seen). MEXICO: Valley of Mexico at Santa Fé, 5 Jul 1865–66, *Bourgeau 323* (SYNTYPE: P, not seen).

Perennial **herbs;** stems few or several from a woody perpendicular root, prostrate, 10–20 cm long, sericeo-villose, with fulvous, grayish or whitish trichomes, glabrescent. **Leaves** distichous, more or less imbricate, at right angles to the stems or somewhat reflexed, broadly-ovate to orbicular or sometimes broader than long, 9–16 mm long, 7–16 mm wide, apically rounded to somewhat emarginate, basally truncate to cordate or rounded, covered with appressed silky-villous, light-brown to grayish trichomes below, green and glabrous above, the petioles 0.5–1 mm long. **Inflorescences** mostly solitary, axillary, sessile or on peduncles to 2 mm long. **Flowers** 1(2) on pedicels 2–3 mm long, appressed-villose; bracteoles oblong to linear-oblong, to 3.5 mm long. Sepals ovate-oblong to ovate, 3–4.5 mm long, acute, appressed-villose. Corollas white, outer surfaces of corollas in bud and midpetaline conspicuously tawny sericeous-hirsute, rotate to broadly funnelform, tube short, the limb 10–12 mm wide. Anthers 1–2 mm long, filaments 3–4 times as long as the anthers. **Capsules** globose, 4-valved, 3–5 mm long, glabrous. Seeds 1-4, brown, glabrous.

Sonora.—Pine-oak forest in east-central Sonora; 1550 m. Flowering at least in September.

General distribution.—Chihuahua, Distrito Federal, Durango, Hidalgo, Jalisco, Michoacán, Nayarit, Nuevo León, Oaxaca, Pubela, San Luis Potosí, Veracruz.

Mpio Yécora: Yécora, 28°23½'N, 108°54½'W, 1550 m, open pine forest, occasional, 7 Sep 1995, *Fishbein 2481*!; Yécora, near baseball field and cemetery, 28°22'25"N, 108°56'W, 1540 m, common on clay flats, 5 Sep 1996, *Reina-G. 96-377* (FTG-FAU!).

Evolvulus rotundifolius (S. Watson) Hallier f., Bot. Jahrb. Syst. 16:530. 1893. TYPE: MEXICO. CHIHUAHUA: damp places, pine plains, base of the Sierra Madre, 30 Sep 1887, *Pringle 1341* (HOLOTYPE: GH!; ISOTYPES: B, not seen, BM, not seen, F!, K!, MO!, NY!, PH!, RSA!, US!). *Breweria rotundifolia* S. Watson, Proc. Amer. Acad. Arts 23:281. 1888.

Perennial **herbs;** stems several from a woody root, prostrate, 10–15 cm long, sericeo-villose, glabrescent toward the base. **Leaves** distichous but not imbricate, at right angles to the stem, ovate to elliptic, sometimes broad-ovate, 13–22 mm long, 8–12 mm wide, apically obtuse to somewhat emarginate, basally rounded to cordate, appressed sericeo-villose below, glabrous above, the petioles 1–2 mm long. **Inflorescences** axillary, sessile, and 1-flowered. **Flowers** sessile; bracteoles linear-oblong, to 6 mm long. Sepals ovate-oblong to oblong, 4–5 mm long, acute, appressed-villose. Corollas blue with a white throat and midpetaline stripes, rotate to broadly funnelform, the tube short, the limb 10–13 mm wide. Filaments 2–4 mm long; anthers 1–2 mm long. **Capsules** globose, 4–5 mm long, 4-valved, glabrous. Seeds 1–4, brown, glabrous.

Sonora.—East-central and southeastern Sonora near the Chihuahua border; arroyos and open areas in oak woodland, pine-oak forest, and mixed conifer forest (with *Abies durangensis*, etc.); 1600–2100 m. Flowering August–September;

General distribution.—Chihuahua, and Durango; reported but not verified for Aguascalientes and Querétaro.

Mpio Álamos: Rd to Chiribo from Huicoche, 1 km W of Los Llaitos (El Sahuaribo), 27°19'N, 108°40'W, 1600 m, 21 Aug 1991, *Martin & Yetman 21 Aug 1991*! **Mpio Yécora:** Mesa El Campanero at head of Barranca el Salto, 2040 m, arroyo margin in pine-oak forest with *Abies durangensis, Arbutus xalapensis, Quercus rugosa*, etc, 9 Sep 1995, *Fishbein 2585*!; N end of Mesa Campanero at head of Barranca el Salto, 28°21.5'N, 109°01.5'W, 2040 m, shallow arroyo margin in pine-oak forest, prostrate perennial, flowers blue, uncommon, 2 Jul 1994, *McMahon 160* (FAU-FTG!); El Kípor (Quipur), Arroyo El Kípor, pine-oak forest, 28°24'25"N, 108°35'40"W, 1640 m, common herbaceous perennial in clay on edge of field, flowers light blue, 11 Sep 1996, *Van Devender 96-526* (FTG-FAU!); N end of Mesa del Campanero (El Remedio), flat pine-oak forest, 28°21'54"N, 109°01'48"W, 2100 m, common herbaceous perennial ground cover, flowers lavender with white centers, 14 Jul 1997, *Van Devender 97-633* (FTG-FAU!).

Evolvulus sericeus Sw., Prodr. 55. 1788. TYPE: JAMAICA: *Swartz s.n.* (HOLOTYPE: S!; ISOTYPES: BM!, M, not seen).

> *Evolvulus wilcoxianus* House, Bull. Torrey Bot. Club 33:315. 1906. TYPE: U.S.A. ARIZONA: near Ft. Huachuca Arizona, 1894. *Wilcox 96* (HOLOTYPE: US!). *E. sericeus* var. *discolor* (Benth.) A. Gray f. *wilcoxianus* (House) Ooststr., Med. Bot. Mus. Herb. Rijks Univ. Utrecht 14:132. 1934.

Perennial **herbs;** stems woody at the base, 10–30 cm long, prostrate or ascending, silky, with appressed to more or less spreading trichomes, often gray, white or fulvous. **Leaves** distichous, lanceolate, oblong-lanceolate, oblong or ovate to elliptic, 4–25 mm long, 2–10 mm wide, densely hairy below, glabrous or hairy above, the apex acute, mucronate, the base rounded to acute, the petioles very short or leaves sessile. **Inflorescences** solitary, axillary, sessile or on peduncles to 4 mm long; bracteoles subulate, to 2–4.5 mm long. **Flowers** lacking pedicels. Sepals oblong-lanceolate, 3–5 mm long, acuminate, silky. Corollas pale blue, pale violet or white, rotate to broadly funnelform, 7–12 mm across, subentire. Filaments 2–3 times as long as the oblong anthers. Ovary globose, glabrous. **Capsules** globose, 4-valved, glabrous. Seeds 1–4, ca. 1.5 mm long, brown or black.

Sonora.—Known for certain from disturbed habitats in desert grassland in the northeast part of the state, but it is probably more widespread; 1400–1800 m. Flowering May–September.

General distribution.—Arizona, New Mexico, Texas; Chihuahua, Coahuila, Nuevo León, Tamaulipas, and Durango southward to Chiapas; Mesoamerica; South America, and the West Indies.

Two varieties have been recognized: var. *sericeus* (leaves sericeous above and below) and var. *discolor* (Benth.) A. Gray (leaves glabrous above). These minor variants are not recognized since they can be found in the same stand.

Mpio Cananea: 15 km NE of Cananea on Mex 2, 1505 m, desert grassland, very common, roadside, 23 Apr 2004, *Reina-G. 2004-309*! **Mpio Santa Cruz:** Santa Cruz, 31°13'57"N 110°35'54"W, uncommon, in grassy school yard, flowers white, 17 Jul 2001, *Reina-G. 2001-551* (ARIZ!, USON!).

IPOMOEA L., Sp. Pl. 159. 1753. [Greek *ipos*, a worm, *homoios*, like, a reference to the twining habit]. *Batatas* Choisy, *Calonyction* Choisy, *Exogonium* Choisy, *Quamoclit* Moench, *Pharbitis* Choisy

MORNING GLORY

Vines, lianas, shrubs, or **trees,** the stems herbaceous to woody, usually twining, sometimes prostrate or floating, glabrous or hairy. **Leaves** variable in shape and size; blades simple, lobed, divided or less often compound, petiolate. **Inflorescences** mostly axillary, 1 to many flowers, in cymes, rarely paniculate. **Flowers** on long or short pedicels, the bracts scale-like to foliose. Sepals herbaceous to ± coriaceous, ovate to oblong or lanceolate, often somewhat enlarged in fruit but usually not markedly accrescent. Corollas purple, red, pink, white, or less often yellow (flowers with white corollas sometimes occur among normally non-white flowers), regular or rarely slightly zygomorphic, mostly funnelform, less often campanulate, tubular or salverform, the limb shallowly or rarely deeply lobed, the midpetaline bands well defined by 2 distinct veins; stamens included or less often exserted, the filaments filiform, often triangular-dilate at the base, mostly unequal in length. Ovary usually 2–4 locular, 4-ovulate, less often 3-locular, 6-ovulate. Style simple, filiform, included or less often exserted; stigmas capitate, entire or 2(3)-lobed, globose. Fruits globose to ovoid capsules, mostly 4(–6)-valved or splitting irregularly. Seeds 1–4 (6; to 10 in *I. decasperma*).

Perhaps 600 species worldwide, most diverse in tropical and subtropical regions; 41 species known in Sonora.

1. Erect herbs or woody shrubs or trees.
  2. Herbs, some with stems woody below.
    3. Leaves pinnatifid, the segments filiform.
      4. Stems woody below. Leaves pinnatifid with 3–9 filiform segments 3–60 mm long >1 mm wide. Corollas 5–12 cm long, white, blue, or purplish, not red.
        5. Plants 1–1.5 m tall, leaf segments 10–60 mm long; peduncles 3–12 cm long during anthesis; corolla limb white or pale lavender ____ **I. ancisa**

5. Plants to 1 m tall, leaf segments 3–25 mm long; peduncles 0.8–3.5(–8) cm long; corolla limb dark-blue or purplish **I. sescossiana**

4. Stems herbaceous throughout. Leaf segments usually 5, filiform, 5–15 mm long, <1 mm wide. Corollas 3–4 cm long, lavender to red-purple **I. capillacea**

3. Leaves rhombic, ovate or elliptic, or pedatisect at least on tips of mature branches.

6. Leaf blades 2–10 cm long, usually elliptic, rhombic or narrowly lanceolate, or rarely pedatisect on tips of mature branches. Sepals 6–8 mm long. Corollas 3–4 cm long. Capsules 5–6 mm in diameter, 3-locular **I. madrensis**

6. Leaf blades to 2 cm long, rhombic, ovate or broadly elliptic. Sepals 4–6 mm long. Corollas <3 cm long. Capsules 7–8 mm in diameter, 2-locular **I. plummerae**

2. Woody shrubs or trees, stems erect to spreading.

7. Corollas pink to lavender **I. carnea**

7. Corollas white, often with a purplish center.

8. Leaves narrowly linear-lanceolate with long-attenuate tips. Youngest stems glabrous. High mountains in SE Sonora on the Chihuahua border **I. chilopsidis**

8. Leaves more or less ovate or lanceolate, or if linear then the tips blunt. Youngest stems pubescent. Widespread in the state or west-central Sonora.

9. Trees often more than 4 m tall, with a well-developed trunk. Leaves 10–27 cm long, ovate. Widespread **I. arborescens**

9. Shrubs to 2 (4) m with many stems from the base, lacking a well-developed trunk. Leaves to 8 cm long, lanceolate. Mountains in west-central Sonora **I. seaania**

1. Twining or prostrate vines, herbaceous, annuals or perennials, sometimes lianas, but not woody shrubs or trees.

10. Leaves compound, pinnate, palmate, or pedate.

11. Leaves pinnately compound (pectinate), the segments filiform. Flowers red-orange **I. quamoclit**

11. Leaves palmately or pedately compound.

12. Leaves palmate. Peduncles spiralled, very slender, and springy, often about 10 cm long. Corollas pink to lavender, 1.8–3 cm long, funnelform, rosy with the interior of the tube red-violate, glabrous **I. heptaphylla**

12. Leaves pedatisect. Peduncles not spiraled. Corollas purple or lavender, if white then salverform.

13. Leaflets or the basal lobes profoundly incised, narrowly elliptic, more than 5 mm wide **I. cairica**

13. Leaf segments linear to lanceolate or filiforme, often less than 3 mm wide.

14. Corollas <1 cm long **I. costellata**

14. Corollas >1 cm long.

15. Leaves sessile, the segments usually 5, filiform, <1 mm wide **I. capillacea**

15. Leaves mostly petiolate, less often sessile, the segments usually 5–11, linear to lanceolate, 0.5–6.5 mm wide.

16. Corollas 4.5–10 cm long, funnelform or salverform, completely white or white with pale rose to purple limb, the basal, narrow portion of tube >3 cm long, 2–6 mm in diameter **I. tenuiloba**

16. Corollas 1.5–3.2 cm long, funnelform, purple, rarely white, throughout, the basal, narrow portion of tube 2–3 cm long, 2–3 mm in diameter.

17. Apex of leaf segments usually rounded. Outer sepals muricate, the tips obtuse to acute **I. plummerae**

17. Apex of leaf segments usually acute. Outer sepals smooth or rarely muricate, the tips acute or attenuate **I. ternifolia**

10. Leaves simple, entire, dentate, or deeply lobed, or occasionally basally pedatisect, usually cordate, obtuse to acute basally, entire, toothed, or palmately lobed sometimes linear to oblong.

18. Leaf blades acute to obtuse basally.

19. Leaf blades linear to oblong-lanceolate, 10–12(–20) cm long. Plants of inland regions **I. longifolia**

19. Leaf blades sometimes linear to ovate or oblong, lobed or unlobed, the size and shape variable, 1.5–8 cm long. Plants of beaches **I. imperati**

18. Leaf blade truncate to cordate basally.

20. Outer 2 sepals with a caudate or long-aristate apex. Corollas salverform.

21. Corollas red, rarely white, diurnal, 1.8–3 cm long.

22. Leaves pinnately compound (pectinate), the segments filiform **I. quamoclit**

22. Leaves simple, entire, toothed, or lobed.

23. Sepals unequal; outer sepals oblong, 3–3.5 mm long, 2–2.5 mm wide, muricate or smooth, with a ± terminal arista 3–5 mm long; inner sepals oblong, 4–5.5 mm long, 3–3.5 mm wide. Capsules reflexed **I. cristulata**

23. Sepals ± equal; outer two sepals oblong to elliptic, 1.3–5 mm long, 1.2–1.5 mm wide, smooth, with a ± terminal arista 1.6–6 mm long; inner sepals 2.5–3(–4) mm long, 1.5–2.5 mm wide. Capsuless erect **I. hederifolia**

21. Corollas white to lavender or purple, nocturnal, the tube 3–17 cm long.

24. Corollas 9–15 cm long, white **I. alba**

24. Corollas 3–7.5 cm long, white when first open, lavender to purple by morning **I. muricata**

20. Outer 2 sepals acute, acuminate to obtuse, but lacking a caudate or long-acuminate apex. Corollas campanulate, funnelform, or salverform.

25. Sepals 3–6 mm long, ovate to ovate-lanceolate, surface texture rugose to muricate on only the raised midrib. Corollas either campanulate or funnelform, blue with white or yellow throat.

26. Inflorescence often enclosed by the basal lobes of a leaf. Sepals ovate, more or less equal, rugose on outer surfaces. Corollas, with throat pale purple, the tube cream on the outside surface, interior yellow **I. aristolochiifolia**

26. Inflorescence separate from the basal lobes of a leaf. Sepals ovate-lanceolate, equal, with a thick, muricate, raised midrib. Corollas, with throat white, the tube greenish on the outside surface, interior yellow **I. cardiophylla**

25. Sepals usually much longer than 5 mm, shape and length variable, surface texture variable. Corollas funnelform or salverform, color mostly not different on the inner and outer surfaces.

27. Flower subtended by enlarged foliose bracts 1.8–4.3 cm long, 1.8–4.8 cm wide, persistent and pink **I. bracteata**

27. Flower subtended by scale-like or foliose bracts less than 1.8 cm long, cauducous or peristent, not enlarged and colored.

28. Corollas 4.5–13 cm long, salverform to funnelform-salverform.

29. Sepals unequal, the outer ones oblong-lanceolate, 5–11.5 mm long, 2–3 mm wide, the inner sepals 8–9 mm long. Corollas 4.5–10 cm long **I. tenuiloba**

29. Sepals ± equal, lanceolate, 12–15 mm long, 3–4 mm wide. Corollas 5–8 cm long **I. thurberi**

28. Corollas 0.6–9 cm long, funnelform or campanulate-funnelform.

30. Perennials. Stems prostrate-trailing. Mostly on beaches.

31. Sepals 1–1.5 cm long, unequal, oblong, the outer two shorter. Corollas white with a yellow throat, sometimes purplish within the base **I. imperati**

31. Sepals 0.5–1.1 cm long, equal or unequal, elliptic, ovate-elongate to orbicular. Corollas pinkish or lavender, the throat darker within **I. pes-caprae**

30. Annuals or perennials. Stems mostly twining (often prostrate in *I. batatas*). Inland plants.

32. Sepals more or less equal. Corollas 0.6–2 cm long.

33. Sepals (8–)10–14 mm long, the outer sepals lanceolate-acuminate, mucronate, typically glabrous. Corollas 0.6–1.5(–2) cm long, white to lavender, the throat often darker **I. x leucantha**

33. Sepals 6–7 mm long, the outer sepals oblong to narrowly elliptic-oblong, obtuse to acute, mucronulate-caudate, sparsely pubescent without, always conspicuously ciliate. Corollas 1–2 cm long, lavender **I. triloba**

32. Sepals mostly unequal, the outer ones shorter. Corollas 3–9 cm long.

34. Outer 2 sepals oblong, abruptly acuminate. Corollas white or lavender, the inner surface pubescent near the base **I. batatas**

34. Outer 2 sepals ovate to ovate-lanceolate, broadly elliptic to oblong, acute to obtuse. Corollas lavender to purple, the inner surface glabrous.

35. Sepals herbaceous, setaceous to hispid, trichomes with swollen bases.

36. Outer sepals basally ovate-lanceolate or narrowly ovate-lanceolate to elliptic, acute to abruptly acuminate apically **I. purpurea**

36. Outer sepals basally ovate with long attenuate tips.

37. Bracts foliaceous, resembling the sepals.

38. Bracts 5–6 mm long. Sepals 10–12 mm long, 1–2 mm wide, the bases slightly dilated, hispid-pilose throughout, the apex elongate narrowly linear, typically erect to spreading **I. barbatisepala**

38. Bracts 10–20 mm long (about as long as sepals). Sepals 10–20 mm long, 3–4 mm wide, the base not dialated, hirsute, the apex acuminate, glabrous and attenuate, reflexed to spreading **I. meyeri**

37. Bracts scale-like or caducous.

39. Sepals abruptly narrowed from the ovate base into a narrow linear-lanceolate apex, usually curved, at least in fruit, apex sometimes strongly curved, sepals densely long-hirsute at least on the basal ⅓. Corollas 2–3.7(–4.5) cm long, light blue, with the inside of the tube white or pale yellow **I. hederacea**

39. Sepals basally narrowly ovate, gradually tapering toward the apex, the tips straight, not curved, the base densely hispid to strigose on the upper parts, or distally glabrous. Corollas (2–) 3–6 cm long, purplish to blue, white or red (in cultivated plants) **I. nil**

35. Sepals coriaceous to chartaceous, if herbaceous, then lacking setaceous to hispid trichomes with swollen bases.

40. Sepals 1.5–2 mm long, accrescent to 5 mm in fruit. Corollas campanulate, yellow, glabrous **I. minutiflora**

40. Sepals 4–40 mm long. Corollas funnelform, white to lavender, blue or purple, glabrous or pubescent.

41. Sepals 2.5–4 cm long **I. ampullacea**

41. Sepals less than 2 cm long.

42. Outer sepals basally truncate to rounded, herbaceous.

43. Sepals more or less equal, white-pilose; outer sepal tips acute, not acuminate. Corollas blue to bluish, 5 cm long, 4–5 cm wide, the tube white ______ **I. decasperma**

43. Sepals equal or unequal, hirsute to hispid; outer sepal tips mostly acuminate, rarely acute. Corolla pink-purple to blue, 8–12 cm long, 6–12 cm wide.

44. Sepals more or less equal or the outer 2 slightly shorter, the outer triangular-ovate, 14–16 mm long, 6–8 mm wide, truncate to rounded at the broad base, apically acute to acuminate, hirsute. Corollas 8–12 cm long and wide, pink-purple, the outers surface pubescent ______ **I. laeta**

44. Sepals unequal, the outer ovate, 9–21 mm long, 5–11 mm wide, basally truncate, apically acuminate, the middle sepals asymmetrical, ovate, 9–19 mm long, 3–8 mm wide, acuminate, the inner sepals ovate-lanceolate, 9–20 mm long, 2–4 mm wide, antrorsely hispid, at times sericeous. Corollas 5.5–8 cm long, 6–7 cm wide, blue to violet, glabrous ______ **I. pubescens**

42. Outer sepals basally acute, coriaceous to chartaceous.

45. Sepals coriaceous.

46. Annuals. Stems usually with soft "prickles" (aculeae). Outer sepals more or less equal in length, more or less acute and cuspidate, with small appressed-puberulent indumentums ______ **I. parasitica**

46. Perennials. Stems without aculeae. Outer sepals unequal in length, acute to obtuse, glabrous or canescent.

47. Sepals ovate-lanceolate, broadly elliptic to oblong, 4–8.5 mm long, 3–6 mm wide, the outer sepals acute, the inner sepals obtuse to obtuse-mucronate, the outer muricate or more often with wings on the lower portion, glabrous or pubescent only toward the apex. Corollas slightly pubescent at the apices of the lobes ______ **I. pedicellaris**

47. Sepals broadly oblong to broadly ovate, 7–10 mm long, 4–6 mm wide, the outer broadly acute to obtuse, the inner rounded to obtuse, the outer smooth, the upper margins somewhat scarious, glabrous or the outer 2 sepals sericeous on the outer surfaces. Corollas glabrous ______ **I. scopulorum**

45. Sepals chartaceous.

48. Sepals 6–7 mm long, oblong to narrowly elliptic-oblong, obtuse to acute, mucronulate-caudate, glabrous or sparsely pubescent, always conspicuously ciliate. Corollas 1–2 cm long, lavender, glabrous inside ______ **I. triloba**

48. Sepals 8–15 mm long, oblong, abruptly acuminate, glabrous or pubescent. Corollas 4–7 cm long, lavender with a tube darker within or sometimes white, pubescent inside near the base ______ **I. batatas**

Ipomoea alba L., Sp. Pl. 1:161. 1753. Type: INDIA: "Munda-valli" in Rheede, Hort. Ind. Malab. 11:103. t. 50. f. 1–2 (1692) (LECTOTYPE!).

Convolvulus aculeatus L., Sp. Pl. 155. 1753. Type: CARIBBEAN: Plukenet, Phytographia t. 276, f. 3, 1694 (LECTOTYPE!). *Calonyction aculeatum* (L.) House, Bull. Torrey Bot. Club 31:590. 1904.

Ipomoea bona-nox L., Sp. Pl., ed. 2, 1:2.228. 1762. New name for both *I. alba* L. and *Convolvulus aculeatus* L. *Calonyction bona-nox* (L.) Bojer, Bull. Torrey Bot. Club 31:590. 1904.

MOONFLOWER

Herbs, perennial, twining, the stems with a base becoming somewhat woody, to 10 m or more, the stems usually aculeate or warty, at times rooting at the nodes, glabrous, rarely pubescent. **Leaves** 5–15 cm long and wide, broadly ovate to almost triangular, entire to 3–5-lobed, glabrous or rarely pubescent. **Inflorescences** monochasial or dichasial, axillary or terminal. **Flowers** 1–3 on glabrous peduncles. Sepals 10–15 mm long, ovate, apically acute and with a somewhat fleshy acumen or caudate extension. Corollas salverform, the tube 9–15 cm long, white with green lines within, the limb white with a star of 5 green lines, glabrous. **Capsules** 2–3 cm long, ovoid, tan to black, glabrous, 4-valved. Seeds 1–4, ovoid, 10–12 mm long, straw-colored to black, glabrous. $2n = 30$.

Sonora.—Secondary forests and margins, especially moist areas. Known from two Sonora records: North-central Sonora in oak woodland, ca. 940 m, and southeastern Sonora in tropical deciduous forest at about 500 m. Flowering September–November.

General distribution.—Sinaloa southward and perhaps in all Mexican states; southeastern United States; Mesoamerica; Colombia, Venezuela, Guyanas, Ecuador, Perú, Brasil, Argentina; Caribbean. Often cultivated; native to tropical America. Flowering September–May.

Apparently first recorded in the New World by Oviedo (1526). This plant was probably first carried around the world for its medicinal seeds. Later it was spread for the nocturnal, fragrant flowers. Determining the region of nativity of this species within the New World is particularly difficult since it was carried from at least Cuba around the world in the early 1500s by the Spanish and probably the Portuguese. However, the center of diversity is tropical North America (McDonald 1993a). Typically, the plants are associated with wetlands, the seeds being distributed by water. Seeds arrive on the coasts of the British Isles with regularity, and surprisingly a few of them are viable and germinate. The occurrence in southern Sonora may be part of the native range, or may result from cultivated plants that have escaped.

Mpio Álamos: Canyon above Aduana, among rocks in shady canyon near water, 1 Nov 1939, *Gentry 4815*! **Mpio Cucurpe:** Floodplain near Rancho Agua Fría, E of Cucurpe, 940 m, *Van Devender 6 Sep 1976*!

Ipomoea ampullacea Fernald, Proc. Amer. Acad. Arts 33:89. 1897. TYPE: MEXICO. GUERRERO: near Acapulco, Oct 1894–Mar 1895, *Palmer 483* (HOLOTYPE: GH!; ISOTYPES: K! US! (TROPICOS listed an isotype at NY, but it was not found there by Jackie Kalunki and Thomas Zanoni of NY, pers. comm. 2011).

Perennial **herbs** from a tuberous root, the stems woody below, retrorsely hispid. **Leaves** 8–10 cm long, almost as wide, cordate to broadly ovate, entire or 3-lobed, remotely appressed sericeous. **Inflorescences** dichasial, axillary. **Flowers** 1–4 on peduncles 10–12 mm long. Sepals 2.5–4 cm long, ovate, apically acuminate to obtuse, and becoming spatulate-attenuate with age, the outer ones appressed sericeous, the inner ones glabrous on the margins, sericeous on the dorsal regions. Corollas funnelform, white, 3–4 cm long, pubescent on the outer surface. **Capsules** 8–10 mm long and wide, almost globose, brown, glabrous. Seeds 1–4.

Sonora.—Known in the state from a single record in pine-oak forest, 1220 m. Flowering in September.

General distribution.—Sinaloa, Guerrero, Edo. Mexico, especially tropical deciduous forests. The occurrence of this species in pine-oak woodland in Sonora seems to be an anomaly as compared with its general distribution.

Mpio Yécora: Río Maycoba at MEX 16 (20.5 km W of Maycoba, 28.6 km E of Yécora), 28°22'15"N, 108°45'30"W, common, to 2 m in shrubs, 1220 m, 26 Sep 1998, *Reina-G. 98-1735*!

Ipomoea ancisa House, Ann. N.Y. Acad. Sci. 18:187. 1908. TYPE: MEXICO. CHIHUAHUA: 22–24 Aug 1899, *Nelson 6276* (HOLOTYPE: US!; ISOTYPES: F!, incorrectly reported from NY). McDonald (2001: 80) mistook the "N" used by House (1908: 188) for an abbreviation for "NY" and considered that specimen the HOLOTYPE. In fact, House used "N" for what is now "US" (Smithsonian) and that is where the HOLOTYPE resides, although it is marked as an "isotype" on an annotation label.

ROMERIA DE LA SIERRA

Erect, suffrutescent **shrubby** perennials, 1–1.5 (2) m tall, the stems erect or ascending, glabrous. (John Palting, personal communication 28 September 2011, found the roots of a few plants to be deep and relatively thick but not tuberous.) **Leaves** ovate in outline, 3.5–11 cm long, 2–5 cm wide, irregularly pinnately divided into 6–9, obtuse-tipped divisions, the lobes linear to filiform, entire to irregularly toothed or lobed, 1–7.5 (8.7) cm long, 1–2 mm wide, glabrous; the petioles 7–15 mm long. **Inflorescences** of solitary (rarely 2) flowers. Flowers on peduncles 3–12 cm long, the pedicels 1–1.5 cm long, accrescent and recurved in fruit; fruiting peduncles and pedicels becoming somewhat woody; peduncles and pedicels with squamose, caducous bracts. Sepals unequal, the outer slightly shorter than inner, broadly elliptic to ovate, 6–10 mm long, 4–8 mm wide, smooth, obtuse or truncate, rarely acute, the margins scarious. Corollas funnelform, 5–12 cm long, white to pale lavender, the tube whitish, glabrous, the limb 4–7 cm wide. **Capsules** pear-shaped to ovoid, 1.5–1.8 cm long, 1.1–1.7 cm wide. Seeds 4, 7–10 mm long, ellilpsoid, gray-brown, puberulent.

Sonora.—A narrow endemic in mountains in eastern Sonora and western Chihuahua, 1220–1500 m in

Sonora and to ca. 2000+ m in adjacent Chihuahua. Juniper-oak woodland and pine-oak forest. Flowers and fruits July–September. This large morning glory, sometimes locally common, can be a spectacular sight towards the end of the summer rainy season with its many, large flowers open in early morning among the bright green, feathery foliage. John Palting (personal communication 30 Sep 2011) and Van Devender found it abundant in the Sierra de Bacadéhuachi in early Sep 2011. Palting wrote, "The stout plants in the sun were spectacular in bloom (100 flowers or more). Upon blooming the largest plants are a round mound about 3 feet high. They become more decumbent in the shade and bloom less. This is definitely a plant with high ornamental value." The flowers produce jasmine-like fragrance.

Gentry (1942: 213) reported the herbage of *Ipomoea ancisa* in the upper Río Mayo region of Sonora and adjacent Chihuahua "is decocted and drunk for stomach ailments."

Both *I. ancisa* and *I. sescossiana* are erect, shrubby perennials with pinnately compound leaves bearing very slender lobes, and are xenogamous with large bee-pollinated flowers (McDonald 2001). *I. sescossiana* occurs in Chihuahua and might be found in easternmost Sonora. Some specimens of *I. ancisa* from Sonora have been incorrectly attributed to *I. sescossiana*. The much smaller leaves and darker flowers readily distinguish *I. sescossiana*.

Mpio Bavispe: Río de Bavisipe region, Piedra Parada, *White 3672*!; Cañón de Huépari, N of Aribabi, 4300 ft, *White 2691*! **Mpico Huachineras:** 4 mi (by road) N of Colonia Aribabi, 5000 ft, 5 Oct 1965, *Turner 65-62*! **Mpio Nácori Chico:** Ranchito Pinos Altos, Sierra Nacori, *Robinson 2 Aug 69*! **Mpio Yécora:** Along Hwy 16, 10.3 mi E of Yécora, 3.1 mi W of Arroyo Los Pilares crossing, 28°22.5'N, 108°49.5'W, 1475 m, 8 Sep 1995, *Fishbein 2546*!; Ejido Los Aserraderos, 28°0'40"N, 109°03'W, 1300 m, epithermal bleached soils, *Martin 6 Nov 1986*!; Arroyo Agua Caliente (La Soledad), 8 km S of Maycoba on road to Moris (Chihuahua), 28°19'40"N, 108°39'20"W, 1500 m, 26 Sep 1997, *Van Devender 97-1263* (FTG-FAU!); 16.7 km NE of Yécora on MEX 16, grassland on rocky slope in oak woodland, 28°22'52"N, 108°49'33"N, 1410 m, uncommon 0.4–0.8 m tall shrub on rocky slope, flowers white with light pink outside on very base, open 9:00 a.m., fragrant jasmine odor, 2 Sep 2000, *Van Devender 2000-633*! **CHIHUAHUA: Mpio Janos:** Carreteras, border of Chihuahua and Sonora, flowers white, 26–28 Aug 1939, *White 2552*!

Ipomoea arborescens (Humb. & Bonpl. ex Willd.) G. Don, Gen. Hist. 4:267. 1838. TYPE: MEXICO. GUERRERO: Inter Acaguisotla et Chilpancingo, *Humboldt & Bonpland 3927* (HOLOTYPE: B-W-679, microfiche!; ISOTYPE: P, not seen). *Convolvulus arborescens* Willd., Enum. Pl. 1:204. 1809.

PALO SANTO, PALO BLANCO; TREE MORNING GLORY; *JÚTUGUO* (Mayo)

Trees 3–15 m tall, the trunk to 50 cm diameter, the bark gray, whitish or yellowish, stems with abundant latex, tomentose when young with trichomes 0.1–2.5 mm long, becoming glabrescent. **Leaves:** blades often 9–19 cm long, 6–9 cm wide, ovate to lanceolate, often glabrescent or pubescent below (especially among var. *pachyleuta*) (velvety below particularly in the southern end of the range near Mexico City), the apex acuminate, the base cordate, with trichomes longer that those on the branches; petioles of larger leaves often 6–8 cm long. **Inflorescences** terminal or axillary, monochasial, racemose, forming compound-cymose clusters. **Flowers** in 1 (2) per cyme. Sepals 6–14 mm long, ovate to rarely orbicular, more or less equal, tomentose, the apex obtuse to obtuse-mucronate. Corollas 4–6 cm long, funnelform, tomentose at least on the lobes, white, with green, yellowish, or puplish within the tube. **Capsules** 17–25 mm long, 4-valvate, brown, glabrous. Seeds 1–4, 10–16 mm long, brown, pilose on the margins with trichomes 10–15 mm long.

Howard Scott Gentry (1942: 213) wrote, "A spectacular tree 7–10 m high, with smooth, white-gray bark like the hide of a hippopotamus. It flowers in winter when leafless, holding a high, thin spread of white corollas like stars against the morning sky. These stars soon fall upon the ground, where the deer eat them. With the summer rains, the tree forms dense foliage, which on the characteristically recurved branches is somewhat plumelike, especially from a distance." The flowers an important early spring food source for migrating hummingbirds (Martin et al. 1998).

Sonora.—Sonoran desert, thornscrub, tropical deciduous forest, and lower oak and pine zones. These trees generally leaf out with the first summer-monsoon rains and fall away as the rains cease in fall, usually around September and October. Flowering during cooler months, when the trees are essentially leafless, mostly November–April and sometimes with a few flowers into May; near sea level–1100 m. The flowers open in the late afternoon or early evening and may remain open much or all of the day during cooler weather. Many flowers, however, tend to fall before sunrise.

General distribution.—Mexico at least in Chiapas, Chihuahua, Guerrero, Jalisco, Michoacán, Morelos, Oaxaca, Puebla, Querétaro, and Sinaloa.

Ipomoea arborescens can be confused with *I. pauciflora* M. Martens & Galeotti of Mesoamerica. Farther south in its range, one may distinguish *I. arborescens* by the pubescent sepal and leaves that are silky pubescent below. However, in Sonora *I. arborescens* does not have those silky leaves. That paucity of indument led Gentry to recognize *I. arborescens* var. *glabrata*. There are two distinctive taxa in Sonora and adjacent Chihuahua and Sinaloa, which may warrant recognition as species. In Sonora the varieties apparently are allopatric, although in the vicinity of Aduana, near Álamos, they were observed growing intermixed in a disturbed tropical deciduous forest habitat.

Ipomoea arborescens has been used medicinally by the Guarijios and Mayos including a remedy for snakebite and to alleviate the pain of a scorpion sting, and also to treat toothache. The wood is burned to produce smoke to keep away mosquitoes. The soft, spongy, and moisture-rich wood is used as emergency fodder for cattle. It is chopped up for cattle feed (Gentry 1942, 1963; Yetman and Felger 2002; Yetman and Van Devender 2002). The Tepehuan used the wood in bows for violins (Pennington 1969). They also used the light-weight wood for foreshafts in the composite arrow.

Selected references.—Austin et al. (2005), Felger et al. (2001), Gentry (1942), Martin et al. (1998), Turner et al. (1995).

KEY TO VARIETIES

1. Sonoran desert to tropical deciduous forest and lower oak woodland. Bark of trunks light-colored, often appearing whitish or grayish white, but not yellowish. Flowers white with yellow or diffuse pale purple dots and short bands within the tube __________ **I. arborescens var. arborescens**

1. Tropical deciduous forest and oak woodland. Bark yellowish. Flowers white with solid or almost solid dark purplish within the tube __________ **I. arborescens var. pachylutea**

Ipomoea arborescens (Humb. & Bonpl. ex Willd.) G. Don var. **arborescens**

Ipomoea arborescens var. *glabrata* Gentry, Publ. Carnegie Inst. Wash. Publ. 527:212. 1942. When Gentry made this combination he cited the correct protologue by Rose, but incorrectly listed A. Gray as the author. Since the varietal name by Rose transferred to *I. arborescens* was a later homonym of var. *glabrata* A. Gray, we are treating Gentry's action as a "new name." However, we consider var. *glabrata* to be a synonym of *I. arborescens* (Austin et al. 2005).

Ipomoea murucoides var. *glabrata* Rose, Contr. Natl. Herb. 1:107. 1891, not A. Gray (1887). TYPE: MEXICO. SONORA: Alamos, Mar 26–Apr 8, 1890, *Palmer 316* (HOLOTYPE: US!, ISOTYPE: GH!).

PALO SANTO, PALO BLANCO; TREE MORNING GLORY; *JÚTUGUO* (Mayo)

Sonora.—This variant is widespread through the range of the species (except where var. *pachyleuta* occurs) in the Sonoran desert, coastal and foothills thornscrub, tropical deciduous forest, and sometimes in lower oak zones; near sea level to ca. 1090 m. The flowers in Sonora are visited by bees, hawkmoths, and hummingbirds, and south of Sonora by bats.

General distribution.—Sonora southward to Chiapas including Sinaloa, Guerrero, Michoacán, Morelos, Oaxaca, and Puebla.

Mpio Álamos: San Bernardo, Lower and Tropical Sonoran, valleys, Palo Santo, tree 20 to 30 ft high with white-gray trunk and limbs, now leafless, holding a high spread of white corollas like stars against the morning sky, these stars soon fall upon the ground where the deer eat them, 23 Nov 1934, *Gentry 1158*! **Mpio Arizpe:** 10 km N of Sinoquipe on Son 89, foothills thornscrub, 30°14'13"N, 110°13'45"W, uncommon 4–6 m tree, 16 Sep 2000, *Reina-G. 2000-726*! **Mpio Bacadéhuachi:** 10 mi (by road) SW of Colonia Aribabi, 4000 ft, thorn forest, 5 Oct 1965, *Turner 65-73*! **Mpio Carbó:** 21 mi S (by road) of El Oasis, 12 Aug 1958, *Turner 136*! **Mpio La Colorada:** 13.4 km W of Tecoripa on Mex 16, Plains of Sonora desertscrub, 28°37'17"N, 110°05'30"W, 532 m, common 6–7 m tree, most in fruit but a few white flowers, 12 May 2008, *Reina-G. 2008-147*! **Mpio Cucurpe:** 14.2 km NW of Sinoquipe on road to Cucurpe, 30.19222°N, 110.35861°W, 29 Nov 2000, *Reina-G. 2000-875*! **Mpio Guaymas:** Microondas Avispas, Sierra Baviso, S end of Sierra Libre, 28°29'N, 111°02'W, 600 m, tree 6 m tall, 11 Aug 1985, *Felger 85-815*!; Cerro El Vigía, 420 m, shrub 4 m tall, 5 Sep 1980, *Felger 80-17*. **Mpio Hermosillo:** E of Batamote, ca. 45 km N of Hermosillo on Mex 15, Plains of Sonora desertscrub/foothills thornscrub, 29°29'09"N, 110°59'55"W, 515 m, common 4–6 m tree, flowers white with light yellow inside throat, open all day, 27 Dec 2000, *Reina-G. 2000-889*!; 5 mi N of Hermosillo, 900 ft, 23 Feb 1933, *Shreve 6066*! **Mpio Huatabampo:** Tierra y Libertad vicinity 5.4 km E of Camahuiroa on road to Diez de Abril, 3.75 km W-NW (by air) of Melchor Ocampo, 26.57500°N, 109.3000°W, flowers white with magenta centers, 25 Dec 1993, *Friedman 343-93* (ASU!). **Mpio Moctezuma:** Granitic hills 15.8 km NE of Mazocahui on road to Moctezuma, 975 m, in full leaf and sparse flower from summer rains, 5 Jul 1971, *Hastings 71-203*! **Mpio Ónavas:** Rancho La Mula, 5 km W of Agua Amarilla on Mex 16 (km 195 E of Hermosillo), tropical deciduous forest, 28°29'16"N, 109°21'59"W, 900 m, very common 3–10 m tall tree, flowers white with a little magenta in throat, 17 Feb 1993, *Reina-G. 97-118* (FAU-FTG!). **Mpio Opodepe:** Rancho Carrizal, foothills thornscrub on basalt slope with *Carnegiea*, *Stenocereus thurberi*, *Ipomoea arborescens*, 900 m, very common tree 3–5 m tall, flowers whitish w light pink tint deep inside throat (very few flowers), 22 May 2009, *Reina-G. 2009-211*! **Mpio San Miguel de Horcasitas:** Hills at first crossing of Río San Miguel S of Horcasitas, 18 Sep 1934, *Shreve 6696*! **Mpio Villa Pesqueira:** 3 mi (by road) S of Mazocahui, 1 Apr 1959, *Turner 59-63*!

Ipomoea arborescens (Humb. & Bonpl. ex Willd.) G. Don var. **pachylutea** Gentry, Publ. Carnegie Inst. Wash. Publ. 527:213. 1942. Type: MEXICO. Sonora: Sierra de Álamos, Tropical Sonoran & Upper Sonoran, principally with the oaks, *palo santo amarillo*, Mex., tree with yellowish bark and heavy foliage, flower white with purple throat, 9 Feb 1937, *Gentry 3000* (holotype: ARIZ!; isotypes: ARIZ!, MO!, UC!, US!).

Palo santo amarillo; tochiyó, tochiguó (Guarijío), *jútuguo* (Mayo)

Tree 7–8 m tall. Petioles, 3–7 cm long; blades often 8–18 cm long. This variety is distinct from the tautonymic *I. arborescens* farther south in its range, and may warrant taxonomic revision. The wood is harder than the lowland *I. arborescens*. See Austin et al. (2005) for details.

Tropical deciduous forest, oak woodland, pine-oak forest; 400–1200 m.

Mpio Álamos: Algodones, Sierra Charuco, high Tropical Sonoran and low Upper Sonoran, arroyos and slopes, *palo santo amarillo*, tree as high as 15 m, often slender and few-branched, bark yellow, wood harder than lowland *I. arborescens*, 21 Jul 1932, *Gentry 2299* (paratype!); 7.5 mi W of Álamos, 29 Jan 1964, *Krizman 13*!; Sierra de Álamos, rocky and canyon bottoms, 2000–3000 ft, palo santo amarillo, large trees with massive trunks & yellowish bark browning with age, 8–15 m high, petioles and twigs with milky juice, 4 Nov 1939, *Gentry 4888*!; 4 km SW of Santa Barbara, *Martin 15 Mar 1990*! **SINALOA. Mpio Badiraguato:** Las Mesas, Sierra Surotato, 25 Aug 1941, oak-*Ipomoea* savanna, volcanic ash, ca. 3000 ft, vernacular: *palo blanco*, tree with yellow bark, co-dominant with oak, 25 Aug 1941, *Gentry 6144*!

Ipomoea aristolochiifolia G. Don, Gen. Hist. 4:277. 1838. Type: VENEZUELA: *Humboldt & Bonpland 679* (isotype: B!, barcode: B-W-03661-01-0). *Convolvulus aristolochiifolius* Kunth, Nov. Gen. Sp. (quarto ed.) 3:102. 1819, not Mill. (1768).

Ipomoea tuerckheimii Vatke ex Donn.-Sm., Bot. Gaz. 40:8. 1905. Type: GUATEMALA: Alta Verapaz, *von Turckheim 386* (isotype: US!).

Ipomoea austin-smithii Standl., Publ. Field Mus. Nat. Hist, Bot. Ser. 18:566. 1938. Type: COSTA RICA:. *Brenes 16899* (holotype: F!).

Ipomoea tweediei of authors, not Hooker (1843).

Ipomoea oocarpa Benth., Bot. Voy. Sulphur 136. 1845. Type: ECUADOR: Guayaquil, *Sinclair s.n.* (holotype: K!, photo F!).

Ipomoea viscosa Wiggins, Contr. Dudley Herb. 4:21, pl. 2. figs. 1–4. 1950. Type: MEXICO. Sonora: [Mpio San Pedro de la Cueva], between Tepopa and Batuc, corolla blue, peduncles viscid, stems trailing, 5–6 ft long, 28 Sep 1934, *Wiggins 7507* (holotype: CAS!; isotype: US!).

Ipomoea peninsularis Brandegee, Zoe 5:168. 1903. Type: MEXICO. Baja California [Sur]: W slope of cape region, Nov 1902, *Brandegee s.n.* (isotype: US!).

Ipomoea cordata L.B. Sm. & B.G. Schub., Contr. Gray Herb. 127:31–32. 1939. Type: MEXICO. Guerrero: Coyuca, Cutzamala, 15 Nov 1934, *Hinton 6984* (isotype: US!).

Annual **herbs,** the stems twining, delicate, 1–3 m long, glabrescent to puberulent. **Leaves** 4–8(–10) cm long, cordate to ovate-cordate, entire, more or less glabrous. **Inflorescences** cymose, with flowers on long peduncles that pass between the basal lobes of the leaves. **Flowers** 1–6. Sepals 3–5 mm long, ovate, more or less equal, rugose on outer surfaces. Corollas 20–25 mm long, campanulate, the throat pale purple, the tube cream without, glabrous. **Capsules** 9–10 mm long, ovoid, brown, glabrous. Seeds 1–4, 4–5 mm long, black to brown, puberulent.

Recognized by the small pale flowers on peduncles that pass between the basal lobes of the leaves. Also, it is distinctive by having rugose sepals and small, lavender corollas.

Sonora.—Eastern Sonora, in Chihuahuan desert, oak woodland, and tropical deciduous forest; 180–1290 m. Flowering September–October.

General distribution.—Arizona; Baja California Sur, (probably in Chihuahua but no records found), Coahuila, Guerrero, Jalisco, Edo. Mexico, Michoacán, Morelos, Oaxaca, Sinaloa, Veracruz; Mesoamerica; Colombia, Venezuela, Ecuador, Perú, Bolivia, Brasil.

Mpio Agua Prieta: Isolated hill NE of Sierra Anibácachi, Rancho La Calera, ca. 10 km (by air) SW of Agua Prieta, 1287 m, 1 Oct 2005, occasional annual vine, *Van Devender 2005-1627*! **Mpio Álamos:** Rancho Mezquite Quate, Arroyo de Álamos, ca. 6 km (by air) SE of Álamos, rare annual, 300 m, 2 Oct 1992, *Bertelsen 92-133*!; Barranca Pozo Azul above junction with Arroyo Santa Bárbara, ca. 3 km S of Rancho Santa Bárbara (E-NE of Álamos), 900 m, oak woodland with tropical elements, solitary annual vine, sterile, 5 Oct 2006, *Van Devender 2006-1224*! **Mpio San Javier:** Cañón Lo de Campa, 28°32'N, 109°44'33"W, 480 m, 29 Sep 1996, *Varela-E. 96-361* (FTG-FAU!). **Mpio San Pedro de la Cueva:** Between Tepopa and Batuc, type of *I. viscosa* (above). **Mpio Soyopa:** Arroyo Los Garambullos, 0.5 km SE of Río Yaqui bridge on Mex 16, 3.3 km S, 1.5 km E of Tónichi, 28.5694°N, 109.55°W, 180 m, uncommon vine along river bank, flowers blue, drying purple, open at 7:00 a.m., 29 Sep 2000, *Van Devender 2000-750* (USON!).

Ipomoea barbatisepala A. Gray, Syn. Fl. N. Amer., ed. 2, 1:212. 1886. TYPE: U.S.A. TEXAS: *Wright 507* (HOLOTYPE: GH!, ISOTYPE: US!).

Annual **herbs,** the stems low-climbing, glabrous. **Leaves** orbicular-ovate in outline, 3–8 cm long, 1.5–8.5 cm wide, glabrous, with or without glandular dots, basally cordate, deeply 5–7 lobed, the lobes lanceolate and narrowed toward base, acute to acuminate; petioles 1–5.5 cm long. **Inflorescences** cymose, axillary. **Flowers** 1–3 on peduncles 2–6 cm long, glabrous or remotely appressed hairy, the pedicels 4–5 mm long, erect in fruit; bracts foliaceous, elliptic to linear, 5–6 mm long. Sepals ± equal, 10–12 mm long, 1–2 mm wide, lanceolate, with elongate narrowly linear tips typically erect to spreading in flower, reflexed in fruit, the bases slightly dilated, hispid-pilose. Corollas funnelform, 1.6–2(–2.5) cm long, glabrous, blue to light rosy-purple or white, the limb 1.8–2 cm wide, the throat yellow, glabrous. **Capsules** glabrous, 8–9 mm long, rounded, apiculate, 2–3-locular. Seeds 1–6, 4–5 mm long, pyriform, dark brown to black, appressed pubescent.

Sonora.—Desert grassland, thornscrub, tropical deciduous forest, and oak woodland; 200–1300+ m. Flowering at least August–September.

General distribution.—Arizona, New Mexico, Texas; Baja California Sur, Sinaloa, disjunct to Oaxaca. Flowering July–December.

In many ways this species resembles *I. hederacea*, which may grow with it, but *I. barbatisepala* is more delicate, more of the leaves are lobed, and the corollas are typically smaller. The two have sepals that are almost identical, but the pubescence is mostly near the base in *I. hederacea* and extends all the way to the tip in *I. barbatisepala*.

Mpio Bavispe: Arroyo Púlpito, near Colonia Oaxaca, 30 Jul 1938, *White 746*! **Mpio Ímuris:** 10 km NE of Ímuris on MEX 2, 1300 m, desert grassland, abundant on roadside, flowers magenta with white throat, closed at 11:30 a.m., mesquite scrub on slope, 15 Sep 2000, *Van Devender 2000-696*! **Mpio Navojoa:** Near Masiaca, Río Mayo, 200 m, 8 Oct 1992, *Van Devender 92-1126*! **Mpio San Javier:** 5 km E of turnoff to San Javier on Mex 16, 28.5481°N, 109.7231°W, 560 m, tropical deciduous forest, uncommon annual on roadside, flowers blue, throat with white, sepals drying purple, open 7:20 a.m., 29 Aug 2000, *Van Devender 2000-463* (USON!). **Mpio Yécora:** 1.9 km W of Tepoca, 675 m, 22 Sep 1997, *Van Devender 97-1016*!

Ipomoea batatas (L.) Lam., Tabl. Encycl. 1:465. 1791. TYPE: INDIA: herb. Linnaeus (LINN-77.5 S!). *Convolvulus batatas* L., Sp. Pl. 154. 1753.

Batatas edulis (Thunb.) Choisy, Mem. Soc. Phys. Genève 6:435. 1834. TYPE: JAPAN: *Thunberg* (HOLOTYPE: UPS!).
Ipomoea triloba of authors, not L.

CAMOTE; SWEET POTATO

Perennial herbs, the stems twining or prostrate, to 5 m or more, pubescent with appressed to erect trichomes, less often glabrous. **Leaves** 5–10 cm long, broadly ovate to cordate, entire to dentate or 5–7-lobed, the apex acuminate, glabrous to pubescent. **Inflorescences,** axillary, in monochasia or dichasia. **Flowers** (1–)3–∞. Sepals unequal, 8–15 mm long, oblong, the two outer shorter than inner and abruptly acuminate, glabrous or pubescent. Corollas (3–)4–7 cm long, funnelform, lavender or sometimes white, with a tube darker within, pubescent within near the base. **Capsules** infrequent, 4–5 mm long, rounded, brown, pubescent or glabrous. Seeds 1–4, 3–4 mm long, tan to brown, glabrous. $2n = 60, 84, 90$.

Sonora.—Cultivated in gardens and occasional found in the southern margin of the Sonoran desert, coastal and foothills thornscrub, and tropical deciduous forest, especially in disturbed areas in densely vegetated areas such as washes. Flowering at least March, April, September, and October.

General distribution.—Mexico; Central America; Argentina, Bolivia, Brasil, Chile, Colombia, Ecuador, Guyanas, Perú, Paraguay, Uruguay, Venezuela; Caribbean; a pantropical cultigen. Potentially flowering all year if not harvested.

Selected references.—Austin (1978), Bohac et al. (1993, 1995).

Mpio Álamos: El Rancheria crossing of Río Cuchujaqui, ca. 22.5 km S of Álamos on road to El Chinal, 26.85°N, 108.917°W, 200 m, common annual on dense bank in tropical deciduous forest, flowers pink, 10 Oct 1992, *Van Devender 92-1146* (ASU!). **Mpio Guaymas:** Guaymas, *Chan & Folkner 25 Apr 1960*!; 1.3 mi S of Mex Hwy 15 on road to Las Guásimas, 8 m elev., in shrubs and trees along drainageway, petals pink with magenta center, rare, 9 Oct 1985, *Felger 85-1160*! **Mpio Huatabampo:** 6.8 km S Camahuiroa, 10 km W-SW Melchor Oocampo, 26.5389°N, 109.292°W, 10 m, common perennial vine in trees to 4 m, flowers purple, 20 Oct 1994, *Friedman 438-94* (ASU!).

Ipomoea bracteata Cav., Icon. 5:51, t. 477. 1799. TYPE: MEXICO. GUERRERO: *Nee s.n.* (ISOTYPES: MA, photo!). *Exogonium bracteatum* (Cav.) Choisy ex G. Don, Gen. 4:264. 1838.

JICAMA; CA'MORI (Guarijío); *TOSAGÜIRA* (Mayo)

Lianas, perennials, the stems twining, 2–6 m long, glabrous or less often lightly hirsute to strigose. **Leaves** 1.5–9.5 cm long, 1.2–7 cm wide, ovate, basally cordate, at times undulate or with small marginal teeth, apically acuminate or mucronulate, glabrous or slightly pubescent; petioles 1–2.5 cm long. **Inflorescences** solitary or in terminal monochasial capitula—forming specacular upright to pendent sprays several to more than 30 cm long with bright pink-purple bracts and darker-colored flowers. **Flowers** (1)2–7, on peduncles greatly reduced, to 2 mm long, the pedicels to 2 mm long; bracts foliose, ovate, 1.8–4.3 cm long, 1.8–4.8 cm wide, persistent, herbaceous, pink-purple, glabrous, the apex acute to obtuse, mucronate. Sepals ± equal or the inner ones slightly longer than the outer ones, 6–9 mm long, 2–3 mm wide, glabrous, chartaceous to membranaceous, the margins scarious, the apex acute to obtuse, aristate. Corollas 2.5–3.8 cm long, 4–7 mm wide, salverform, glabrous, magenta, rose, or (rarely) greenish. **Capsules** 6–19 mm long, 4–8 mm wide, glabrous, conic, brown, 1 or 2 locular. Seeds 1(2), 4–5 mm long, 2–3 mm wide, rounded, brown, puberulent.

Sonora.—Coastal and foothills thornscrub, tropical deciduous forest, and oak woodland in southern and central Sonora; near sea level–1020+ m. Often flowering when leafless or nearly so in winter and dry seasons, at least December–May.

As the common name *jícama* (from Nahuatl *xicama* or *xicamatl*, where *camatl* refers to the mouth) suggests, the roots are eaten like those of the legume (*Pachyrhizus erosus*) called by the same name (Gentry 1942; Standley 1920–1926). *Ipomoea bracteata* is as an indigenous food resource in the Río Mayo region of southeastern Sonora. "The tuberous roots are in high repute among the natives for their edibility, 'like yams', but they are deep and hard to dig out" (Gentry 1942: 218). The root is reported to be sweet and was widely eaten. The vine has been used extensively as rope or twine to secure bundles. It is said to twist well and be long lasting (Yetman & Van Devender 2002).

General distribution.—Baja California Sur, Chihuahua, Guanajuato, Guerrero, Jalisco, Edo. México, Michoacán, Morelos, Nayarit, Oaxaca, Sinaloa, Veracruz.

This species reminds some of *Bougainvillea* (Nyctaginacae), hence the name 'bugambilia' in southern Mexico. However, the similarity is superficial as *I. bracteata* is adapted for bird pollination and *Bougainvilla* for moths. The two share only colored bracts.

Mpio Álamos: San Bernardo, 10 Feb 1935, *Gentry 1293*!; Caramechi, 3-10 Dec 1934, Lower Sonoran, arroyos, *hicama*, Mex, *kamoli*, vine running 20 feet or more up on trees and shrubs, roots edible, *Gentry 1172* (ARIZ!, MO!). **Mpio Arizpe:** 10 km (by air) WNW of Sinoquipe, 30°10'52"N, 110°20'26"N, 948 m, rocky slope, foothills thornscrub, 3 Apr 2012, Van Devender 2012-370. **Mpio Guaymas:** Yaqui Region, 8 mi by road NE from Mex Hwy 15 at Estacion Vicam, 190 ft, rich coastal thornscrub, shaded arroyo on N-facing bank, not common, 12 Mar 1989, *Felger 89-90*! **Mpio Hermosillo:** La Pintada, 49 km al S de Hermosillo por la Carr. Fed. 15, 28.5833°N, 110.9617°W, 250 m, enredadera grande, flores tubulares pequeñas encerradas por una gran bractea de color rosa brillante, en invierno cuando no tiene hojas, 18 Apr 1993, *Búrquez 93-51* (USON!). **Mpio Huatabampo:** 500 m N-NE Camahuiroa, 26°32'55"N; 109°16'45"W, 5 m elev, uncommon vine to 4 m, bracts pink, 16 Mar 1994, *Friedman 32-94* (ASU!). **Mpio Navojoa:** Cerro Prieto, 15 km E of Navojoa, 27.0847°N, 109.2583°W, 17 Apr 1993, *Wiens 93-010*! **Mpio Ónavas:** Agua Amarilla (Los Pinitos), 15 km W-NW of San Nicolás on Mex 16, 28.4858°N, 109.3589°W, red volcanic barren with relict *Pinus durangensis-Quercus albocincta* woodland, 900 m, 11 Mar 1996, *Van Devender 96-35*! **Mpio Rosario:** 19 mi N of Tezopaco, 1230 ft, 25 Mar 1975, *McLaughlin 499*! **Mpio San Javier:** Rd to San Javier off Hwy 16, 13 Mar 1989, *Rondeau 89-100*! **Mpio San Pedro de la Cueva:** Rancho El Paraje del Bichi, 9.4 km W of Rancherias on road to San Pedro de la Cueva, Sierra Las Acequias, 29.28°N, 109.6728°W, 744 m, locally common, flowers purple, foothills thornscrub, 27 Apr 2004, *Reina-G. 2004-445*! **Mpio Tepache:** Arroyo Ranchería, 14.6 mi by rd

S of Tepache, 560 m, 25 Apr 1971, *Turner 71-58*! **Mpio Yécora:** Arroyo San Nicolás, E of Tepoca, *Monson 12 May 1988*!; 3 km ENE de San Nicolás sobre el camino a Yécora (Sonora 16), 29.452°N, 109.15806°W, hierba trepadora, perenne, brácteas y flor lila, 7 May 1995, *Reina-G. 95-266* (USON!). **Mpio Ures:** 10 km W-SW of Mazocahui on SON 89, foothills thornscrub/tropical deciduous forest transition, 29°30'02"N; 110°10'20"W, 715 m, 29 Nov 2000, *Reina-G. 2000-879*!

***Ipomoea cairica** (L.) Sweet, Hort. Brit. 2:287. 1826. *Convolvulus cairicus* L., Syst. Nat. ed. 10, 922. 1759. "Convolvulus Aegyptius" Vesling en Alpinio, Pl. Aegypti 73 & 74 (1640) (LECTOTYPE!).

Perennial vines, the stems to 5 m or longer, twining but also lying on the ground, glabrous. **Leaves** 3–10 cm long, 3–10 cm wide, glabrous, ovate to orbicular, palmately divided to the base into 5-lobes, these lanceolate or ovate-lanceolate to ovate or elliptic, the basal segments acuminate, the two basal segments generally lobulate or otherwise parted, mostly with pseudostipules (small leaves from the axillary buds at the base of the petiole), acute to obtuse at the apex. **Inflorescences** cymose. **Flowers** 1 to few. Sepals 4–6.5 mm long, more or less equal, or the outer sepals slightly shorter, ovate, obtuse to acute, the inner sepals wider, obtuse, glabrous but frequently somewhat tuberculate. Corollas 4.5–6 cm long, rarely shorter, funnelform, usually blue-purple or white, with a reddish-purple throat, glabrous. **Capsules** 1–1.2 cm long, more or less globose, straw-colored or brown, glabrous. Seeds 1–4, globose, 5–6 mm long, brown, densely short tomentose or at times also with long silky trichomes on the margins.

Sonora.—Known from one collection from 1939. Due to wide naturalization in other parts of the world the species is included. Future searching may reveal additional records for Sonora.

General distribution.—Naturalized in Alabama, Florida, Louisiana; cultivated in Arkansas, California, Texas?; Mexico (at least in Oaxaca); South America; West Indies; Africa; Asia; Australia. Cultivated in the tropics and subtropics around the world; nativity uncertain, perhaps Africa.

Mpio. Álamos: Álamos, cultivated ornamental on back fence, reported as native to the mountains E of Álamos, 29 Oct 1939, *Genry 4782* (MO!).

Ipomoea capillacea (Kunth) G. Don, Gen. Syst. 4:267. 1837. TYPE: COLOMBIA: between San Miguel and Río Pures, Nov 1801. *Humboldt & Bonpland s.n.* (HOLOTYPE: P, microfiche seen, photos F!, GH!; ISOTYPES: P(2)!). *Convolvulus capillaceus* Kunth, Nov. Gen. Sp. Pl. 3:97. 1819.

Ipomoea muricata Cav., Icon. 5:52. 1799, not Jacquin (1798). TYPE: MEXICO. GUANAJUATO: Oct, *Cavanilles s.n.* (HOLOTYPE: MA!; ISOTYPE: MA!). *Ipomoea muricatisepala* Matuda, Ann. Inst. Biol. Méx. 34:124. 1964. New name for *I. muricata* Cav.

Perennial **herbs** with erect to ascending glabrous stems, from an underground elongate tuber. **Leaves** with blades sessile, incised and appearing compound, the segments usually 5, filiform, 5–15 mm long. **Inflorescences** axillary, solitary. **Flowers** on peduncles 5–7 mm long, the pedicels 3–6 mm long, reflexed in fruit. Sepals ± equal, 5–6 mm long, the outer one 2 mm wide, the inner ones 3 mm wide, acute to obtuse and mucronate apically, the outer sepals elliptic to oblong, the inner sepals ovate, muricate-tuberculate at least on the midvein. Corollas 3–4 cm long, funnelform, lavender to reddish purple, the limb 2–2.5 cm wide, glabrous. **Capsules** ± globose, glabrous, 4–5 mm wide, apiculum 1 mm long. Seeds 1–4, 3 mm long, ovoid, black to dark brown, shortly erect hispid.

Sonora.—Oak woodland and pine-oak forest in eastern Sonora; 1100–2100 (to 2500 m in nearby SW Chihuahua). Flowering August–October.

General distribution.—Arizona, New Mexico, Texas; Baja California (norte) and Sur, Chihuahua, Coahuila, and southward to Puebla; Central America; South America.

See comments under *I. muricata* and also *I. plummerae* for potentially confusing species.

Mpio Álamos: Sierra de Álamos, 1200 m, 20 Aug 1994, *Steinmann 94-74!*; Vallecito, 3 km SW of Santa Bárbara, 1100 m, *Martin 4 Oct 1990*! **Mpio Cananea:** Hwy 2, S of Cananea, in hills, 1372–1585 m, south-facing steep hill, oak grassland, perennial from tuber, to 1 ft, slightly twining on tips, flowers magenta, narrowly funnelform to 3 cm, sepals muricate/tuberculate, 26 Aug 2003, *Kamp 445* (COCHISE!). **Mpio Naco:** San José Mountains, 3 Aug 1893, *Mearns 1628* (US, not seen, cited by McDonald 1995). **Mpio Nacozari de García:** El Tajo, Río Fronteras, 20 Aug 1941, *White 4059* (GH, specimen not relocated, cited by McDonald 1995). **Mpio Yécora:** Arroyo Otro Lado, 1–2 km NNE of Yécora, 1520 m, 28°23'49"N, 108°54'48"W, 7 Sep 1995, flowers purple, *Van Devender 95-840*!; Mesa de los Coronados, S side of Mesa del Campanero, 28°19'30"N, 109°01'40"W, 2100 m, flowers pink, 1 Sep 2000, *Van Devender 2000-585*!; Mesa el Campanero, Arroyo Largo, tributary of Barranca El Salto, pine-oak forest, 2000 m, 6 Sep 1996, *Van Devender 96-396*!

Ipomoea cardiophylla A. Gray, Syn. Fl. N. Amer., ed. 2, 1:213. 1886. Type: U.S.A. Texas. Hudspeth Co.: Hueco Mts., E of El Paso, 13 Oct 1849, *Wright 511* (holotype: GH!). According to McDonald (1982) the locality and collection number are from Wright's field notes discussed by Johnson (1940).

Ipomoea aristolochiifolia of authors, not G. Don (1838).

Annual **herbs,** glabrous, the stems twining, 1–5 m long, branching, green or red, smooth or with small warts on stems. **Leaves** with blades 2.4–5.5 cm long, 3.2–6.7 cm wide, ovate, entire, apically acuminate, attenuate, membranous, basally cordate, with petioles 1.2–10.3 cm long. **Flowers** monochasial, dichasial, or solitary. Sepals 4–6 mm long, 1.5–2 mm wide, equal, ovate-lanceolate, acute, with a thick, muricate, raised midrib, margins hyaline. Corollas 2–3 cm long, funnelform, dark blue, the throat white, the interior yellow, glabrous. **Capsules** 6–12 mm long, ovoid, tan brown when dry, glabrous. Seeds 4, 4–6 mm long, ellipsoid, dark brown-black, puberulent.

Sonora.—This is a Chihuahuan desert species and is likely to occur in northeastern Sonora. It has been found within less than 10 km of Sonora, in the Mule Mountains near Bisbee in southeastern Arizona.

General distribution.—SE Arizona, SW New Mexico, W Texas; Chihuahua, Coahuila, Durango, Guanajuato, Nuevo Leon, Oaxaca, San Luis Potosi.

Andrew McDonald (1982: 259–261) rediscovered this species in Texas and it was later realized that it also occurred in Arizona (Mason et al. 1986). Austin (1991, 1992, 2006) subsequently discussed the species in Arizona. Unfortunately, the distribution map in Austin (2006: 95) has the legend reversed on *I. cardiophylla* and *I. aristolochiifolia.*

U.S.A. ARIZONA. Cochise Co.: Mule Mountains, N of hwy between Huachuca Terrace and Palominas, 8 Sep 1961, *Goodding 206-61*!; 5 mi S of Tombstone, *Walker 24 Sep 1975*!; US 80, 5.4 mi S of Tombstone city limits, just N of mile post 324, limb blue, throat yellow, fibrous root system, generally rare, but locally abundant, limb mostly wilted at 11 a.m., 4000 ft, 7 Sep 1989, *Austin 7608* (ASU!).

***Ipomoea carnea** Jacq. subsp. **fistulosa** (Mart. ex Choisy) D.F. Austin, Taxon 26:237. 1977. Type: BRAZIL: *Martius 2398* (lectotype: M!). *Ipomoea fistulosa* Martius ex Choisy in DC., Prodr. 9:349. 1845.

Ipomoea carnea Jacq., Stirp. Amer. Hort. pl. 18. 1763, as to species, not variety. Type: COLOMBIA: Cartagena, illustration by Jacquin pl. 18. 1763 (lectotype!).

Batatas crassicaulis Benth., Bot. Voy. Sulphur 134. 1845. Type: ECUADOR. Guayas: Guayaquil, *Sinclair s.n.* (holotype: K!). *Ipomoea crassicaulis* (Benth.) B.L. Rob., Proc. Amer. Acad. Sci. 51:530. 1916.

Shrubs 1.5–2+ m (typically erect and free-standing; sometimes to 4 m outside of Sonora), puberulent or less often glabrous, with milky sap, stems becoming woody, hollow when dry. **Leaves** 10–25 cm long, often almost as wide, entire, broadly ovate, ± orbicular to lanceolate, apically acuminate to somewhat obtuse, puberulent to glabrescent. **Inflorescences** monochasial or dichasial. **Flowers** 1-∞, on peduncles glabrous or pubescent. Sepals 3–7 mm long, ± orbicular, the apices rounded, glabrous or more often puberulent. Corollas 4–8 cm long, funnelform, usually rosy-purple to lavender, less often white, with a darker purplish throat, pubescent without. **Capsules** 1.3–2 cm long, conic, brown, glabrous. Seeds 1–4, 10–12 mm long, ellipsoid, dark brown to tan or gray, woolly with dark gray to brown trichomes. $2n = 30$.

Sonora.—Widely cultivated across the lowland regions of Sonora and rarely escaping, such as in coastal thornscrub and tropical deciduous forest, near sea level–270 m. Flowering at almost any time of year; near sea level to at least 420 m in cultivation.

General distribution.—This subspecies is planted as an ornamental in many warm and tropical dry regions of the World including: Arizona, California,Texas; Chiapas, Chihuahua, Guerrero, Jalisco, Michoacán, Morelos, Nayarit, Oaxaca, San Luis Potosí, Sinaloa, Tamaulipas, Veracruz; Mesoamerica; Brazil, Bolivia, Colombia, Paraguay, Peru, Venezuela; Caribbean. It is probably native at least to the Amazon basin in South America.

Subspecies *fistulosa* differs from subsp. *carnea* in having lanceolate leaves and being a shrub rather than a liana, and subsp. *carnea* is not in cultivation.

Mpio Álamos: NW edge of El Mesquital, 5.6 km SE of Río Cuchajaqui on road to Güirocoba, escaped cultivar, 270 m, 23 Sep 1994, *Van Devender 94-771*! **Mpio Gen. Plutarco Elias:** Quitovac, cultivated in dooryard garden of Papago family, 1 Jan 1982, *Nabhan 295*! **Mpio Her-**

mosillo: Hermosillo, 29.075°N, 110.983°W, 190 m, 2 m shrub in yard, flowers lavender, open at 9:00 a.m., 17 Sep 2000, *Van Devender 2000-740* (USON!). **Mpio Navojoa:** Estación Don on MEX 15, La Jaula (S of Navojoa), 2 Dec 2007, *Reina-G. 2007-1116*!

Ipomoea chilopsidis Standl., Publ. Field. Mus. Nat. Hist, Bot. Ser. 17:206. 1937. Type: MEXICO. Chihuahua: Guasaremos, Río Mayo, Upper Sonoran; oak and pine rims, shrub two to five m high, few and irregularly branched, flowers white with purple throat, singularly of the high and arid crags, 16 Aug 1936, *Gentry 2391* (holotype: F!; isotypes: ARIZ 76041!, 273794! MO!, K!, US!).

Multiple-stem small **trees** and large **shrubs** 2–5 m tall, the stems broadly ridged on drying, glabrous. **Leaves** mostly 10–17.5(–20) cm long, 0.5–1.3 cm wide, with 18–30 pairs of secondary veins, entire, linear, apically acute, basally cuneate, glabrous; petiole 0.5–1.2 cm long. **Inflorescences** monochasial, terminal on reduced branches. **Flowers** 1(–3) on peduncles 0.4–2.2 cm long, glabrous except inner surfaces of sepals. Sepals 12–16 mm long, 7–9 mm wide, ovate, about equal or the outer ones slightly shorter than the inner ones, apically obtuse to acute, the inner surfaces short-pubescent. Corollas 8–9.5 cm long, 8–9 cm wide, funnelform, white with a purple throat. **Capsules** 18–22 mm long, conic, brown, glabrous. Seeds often 4, 10–15 mm long, oblong, brown, woolly with long trichomes on the ventral margins.

Sonora.—High and arid rock ridges and on indurated ash in woodland, often with *Acacia pennatula*, *Dodonaea viscosa*, and *Quercus chihuahuensis*; 1000–1300 m. Flowering documented May–November.

General distribution.—Oak woodland in southeastern Sonora and southwestern Chihuahua; 1000–1800 m.

The leaf shape of this shrub makes it unique among the *Ipomoea* in the Americas. As the species name indicates, the leaves resemble those of *Chilopsis linearis* (Bignoniaceae).

Mpio Álamos: Sierra Saguaribo, 1 km E of El Chiribo, in *Dodonaea*-dominated scrub, 1300 m, 24 Aug 1992, *Steinmann 93-284*!; 5 km SW of Santa Bárbara, 27°05.5'N, 108°45'W, indurated ash with *Dodonaea* and *Quercus chihuahuensis*, 1100 m, large white bell-shaped flowers near the top of a 4 m tall shrub with multiple stems 14 May 1990, *Jenkins 90-162* (ARIZ!, UCR!); Mesa la Lagunita, 27°58'20"N, 109°06'30"W, basalt soil, 1100 m, *Martin & Clothier 6 Nov 1986*! **CHIHUAHUA. Mpio Batopilas:** Barranca de Batopilas near Creel–La Bufa road, N rim of canyon, 8.3 km by road above canyon-bottom bridge, ca. 5000 ft, 9 Jun 1963, *Felger 8078b*!; Barranca de de Batopilas, 5 mi S of Quirare, rocky semi-tropical scrub, 5000 ft, 21 Aug 1967, *Marin CF39* (UCR!); La Bufa, canyon Rio Batopilas, short tree forest, barancan oak forest, 3300–3600 ft, near dwellings and trail between old and new settlement, 10 Aug 1971, *Bye 1977* (UCR!); Sierra Madre Occidental between Creel and La Bufa, canyon of Rio Batopilas, on canyon floor near mouth of creek called Arroyo San Fernando, 3330–4180 ft. 27 Jun 1982, *Siplivinsky 3999* (UCR!).

Ipomoea costellata Torr., Bot. Mex. Bound. 149. 1859. Type: U.S.A. Texas: *Wright 505* (lectotype: GH!, isolectotypes: F!, BM!, MO!, NY!, US!).

Ipomoea futilis A. Nelson, Univ. Wyoming Publ. Sci. 1:65. 1924. Type: U.S.A. Arizona: *Hanson 1016* (RM!).

Ipomoea pusilla Brandegee, Univ. Calif. Publ. Bot. 4:382. 1913. Type: MEXICO. Veracruz: *Purpus 6152* (holotype: UC!; isotypes: F!, GH!, NY!, P!, US!).

Herbs, annual, from a slender taproot; stems erect at first, in age trailing or twining at the tips, 2–3 m long, glabrous. **Leaves** with blades ± sessile or on petioles 1–3 cm long, deeply palmately divided with the lateral divisions two-cleft (pedatisect), the segments 5–9, linear or linear-lanceolate, 7–25 mm long, glabrous. **Inflorescences** mostly solitary, axillary. **Flowers** on peduncles 1–3(–7) cm long, the pedicels 15–25 mm long, erect in fruit. Sepals slightly unequal, the outer ones 3–5 mm long, 1–2 mm wide, the inner ones 4–6 mm long, 2–3 mm wide, oblong-lanceolate, acute, mucronulate, scarious margined, at least the inner slightly rugose along the veins. Corollas 10–12 mm long, 5–10(14) mm wide, pale lavender to pink, usually with a white throat. **Capsules** ± globose to ellipsoid-globose, 4–5 mm wide, with a 1–2 mm caducous apiculum, tan, glabrous. Seeds 3 or 4, 3 mm long, ovoid, black, glabrous.

Sonora.—Southern and eastern margins of the Sonoran desert, Chihuahuan desert, grassland, coastal and foothill thornscrub, tropical deciduous forest, oak woodland, and pine-oak forest; 50–1550+ m. Flowering August–November.

General distribution.—Arizona, New Mexico, Texas; Baja California Sur, Chihuahua, Coahuila, Nuevo León, Tamaulipas south to Chiapas; introduced into South America.

This widespread species is self-fertilizing (McDonald et al. 2011); indicators are the annual habit and the inconspicuous small flowers.

Mpio Agua Prieta: Hill NE of Sierra Anibácachi, Rancho La Calera, 10 km (by air) SW of Agua Prieta, 31.2330°N, 109.6314°W, 1287 m, Chihuahuan desertscrub, very common annual vine on limestone slope, flowers lavender with white throat, 12 Aug 2006, *Reina-G. 2006-405*! **Mpio Álamos:** Arroyo Menditero at crossing of Álamos–El Chinal road & down to río Cuchujaqui, 12 km (airline) S of Álamos, near 26°54'48"N, 108°55'W, 2450 m, tropical deciduous forest on slopes, 5 Oct 1992, *Sanders 12611* (UCR!); Arroyo Guajaráy, 19 Mar 1993, *Steinmann 93-151*! **Mpio Bacadéhuachi:** 9.7 km (by air) E of Bacadéhuachi, Sierra de Bacadéhuachi, 29°47'47"N, 109°02'05"W, 1151 m, desert grassland, uncommon vining annual; flowers lavender, 3 Sep 2011, *Reina-G. 2011-476* (USON!). **Mpio Bavispe:** Arroyo Púlpito, near Colonia Oaxaca, 3 Aug 1938, *White 761*! **Mpio Cucurpe:** 19 mi E of Magdalena, 12 Sep 1934, *Shreve 6642b*!; Near Rancho Agua Fría, E of Cucurpe, *Van Devender 6 Sep 1976*! **Mpio Hermosillo:** 10 mi S of Hermosillo, rocky cerro slope, 6 Sep 1939, *Gentry 4554*! **Mpio Ímuris:** Magdalena Canyon, 11 mi NE of Ímuris, 10 Sep 1934, *Shreve 6624*! **Mpio La Colorada:** 4 mi NE of Colorado, between Colorado and Mazatán, 400 m, 6 Sep 1941, *Wiggins & Rollins 315* (ARIZ!, GH!). **Mpio Moctezuma:** 21.4 km S-SE of Moctezuma on SON 117 to Tepache, 29°38'26"N, 109°34'09"W, 697 m, basalt plain with open dwarf thornscrub, flowers lavender, 9 Oct 2003, *Van Devender 2003-1226*! **Mpio Navojoa:** 1 mi SW of Mesa Masiaca (S of Navojoa), coastal thornscrub, common annual in disturbed roadbed, flowers purple, 7 Oct 1992, *Van Devender 92-1064*! **Mpio Santa Cruz:** Rancho Los Fresnos, Nature Conservancy reserve in upper San Pedro River drainage, US-Mexico border, 31.3205°N, 110.37°W, 5100 ft, grassland with isolated patches of oak-mesquite woodland, in fruit, 25 Nov 2006, *Boyle 7977*! **Mpio Villa Hidalgo:** Oputo [= Villa Hidalgo], 1150 m, 3 Nov 1890, *Hartman 196* (GH!). **Mpio Ures:** Rancho El Fluta, Sierra de Mazatán, oak woodland, 29°06'N, 110°12'50"W, 1260 m, flowers lavender, 9 Oct 2004, *Reina-G. 2004-1241*! **Mpio Yécora:** 16.7 km NE of Yécora, grassland in oak woodland, 1410 m, flowers lavender turning pink then magenta, 2 Sep 2000, *Van Devender 2000-642*!

Ipomoea cristulata Hallier f., Meded. Rijks Herb. Leiden 46:20. 1922. TYPE: MEXICO: *Schumann 17* (SYNTYPE: B, not seen); *Aschenborn 364* (SYNTYPE: B, not seen); VALLE DE MEXICO, 1865, *Bourgeau 1061* (SYNTYPE: G-DC!); SAN LUIS POTOSI, 1875–79, *Schaffner* (SYNTYPE: B, not seen, M, not seen). New name for *Quamoclit gracilis* Hallier f., Bull. Herb. Boiss. 7:416. 1899.

Ipomoea coccinea of authors, not L. (1753).
Ipomoea coccinea var. *hederifolia* sensu Kearney & Peebles, not L. (1759).

STAR MORNING GLORY

Annual **herbs,** the stems twining, glabrous or pilose on the nodes. **Leaves** with blades 1.5–10 cm long, 1–7 cm wide, ovate, the lower leaves typically entire and the upper leaves 3- or 5-parted, or all palmately parted or lobed, the margins irregularly dentate, the base cordate to ± truncate, the lobes rounded to acute, apically acute to acuminate or rarely obtuse, mucronate, glabrous or pilose below; petioles 2–9 cm long. **Inflorescences** cymose or rarely solitary. **Flowers** 3–7, on peduncles 3–6(–25) cm long, the pedicels 5–14 mm long, reflexed in fruit; bracts 1–3.5 mm long, linear-lanceolate to ovate, aristate. Sepals unequal, the outer ones oblong, 3–3.5 mm long, 2–2.5 mm wide, obtuse and rounded to ± truncate apically, muricate or smooth, with a ± terminal arista 3–5 mm long, glabrous, the inner sepals oblong, 4–5.5 mm long, 3–3.5 mm wide, apically truncate, with a ± terminal arista 2.5–3.5 mm long. Corollas 1.8–2.6 cm long, salverform, red or red-orange, glabrous, the limb 1–1.5 cm wide. **Capsules** ± globose, 7–8 mm wide, with an apiculum 2 mm long. Seeds 1–4, 3.5–5 mm long, ovoid, black to dark brown, finely tomentose. $2n = 30$.

Sonora.—Through much of the state except western Sonora northwest of the Guaymas region. Sonoran and Chihuahuan deserts, coastal and foothills thornscrub, tropical deciduous forest, grasslands, oak woodland, and pine-oak forest; 35–2000 m. Flowering April–November.

General distribution.—Arizona, New Mexico, Texas; Baja California Sur, Chihuahua, Coahuila, Nuevo León, Tamaulipas south to Edo. México and Distrito Federal.

This and the related *I. hederifolia* are commonly visited by butterflies and hummingbirds. The small, red-flowered ipomoeas, making up the *I. cristulata* complex, are widespread in warm regions of the Americas and often distinguished by subtle traits. Sepals are unequal and the inner ones 4–5.5 mm long in *I. cristulata*, distinguishing it from *I. hederifolia* with ± equal sepals, the inner ones being 1.3–5 mm long. Also, fruits are typically recurved on their pedicels in *I. cristulata* and always erect in *I. hederifolia*.

McDonald (pers. comm., June 2012) has correctly pointed out that these plants, except for the lobing of the leaves, are indistinguishable from *I. cholulensis*. He considers *I. cristulata* nothing more than desert forms of a more widespread *I. cholulensis*. For the moment we maintain them as separate species but point out the similarities so that future students can evaluate the relationships.

Mpio Agua Prieta: Hill NE of Sierra Anibácachi, Rancho La Calera, ca. 10 km (by air) SW of Agua Prieta, 31°13'59"N, 109°37'53"W, 1287 m, annual vine, flowers red, 2 Oct 2004, *Van Devender 2004-1113*! **Mpio Álamos:** San Bernardo, 24 Aug 1935, *Gentry 1627*! **Mpio Fronteras:** 2.6

mi S of Esqueda, 22 Jul 1960, *Felger 4045*! **Mpio Guaymas:** Cañón Nacapule, 18 Nov 1985, *Felger 85-1310*! **Mpio Hermosillo:** Cañón Las Chivas, Sierra Libre, al Sur de la ciudad de Hermosillo, por la Carr. Fed. 15, 28.583°N, 110.96528°W, 8 Oct 1997, *Búrquez 97-501* (USON!). **Mpio Huatabampo:** 7 km NW Ejido Nacapul in Arroyo Jeberojaquia, 1.2 km NE of Melchor Ocampo, 20 Oct 1994, *Friedman 443-94*! **Mpio Ímuris:** 17.1 km NE of Ímuris on MEX 2, 30.87470°N, 110.7310°W, 9 Sep 2002, *Doan 1203* (ASU! mixed collection, *I. cristulata* and *I. barbatisepala*). **Mpio Magdalena de Kino:** 11 mi S of Ímuris, upper edge of desert, 4 Sep 1980, *Felger 80-12*. **Mpio Nacozari de García:** 2 mi E of rd junction 13 mi S of Curicachi, among *Quercus emoryi*, 4550 ft, 7 Sep 1961, *Mason 2072*! **Mpio Nogales:** Camino Nogales–Santa Cruz, 31°19'04"N, 110°43'37"W, 1257 m, bosque encino, 15 Aug 2001, *Sánchez-Escalante N-059*! **Mpio Santa Cruz:** Rancho Los Fresnos, Nature Conservancy reserve along US-Mexico border, 31.3205°N, 110.37°W, 1555 m, grassland with sparse mesquite and oak, corolla bright red, 21 Sep 2006, *Boyle 7840*! **Mpio Yécora:** Near Los Vallecitos, 14.7 km E of Yécora on MEX 16, pine-oak forest, 28°22'38"N, 108°50'03"W, 1470 m, 10 Sep 1996, *Van Devender 96-521*!

Ipomoea decasperma Hallier f., Bull. Herb. Boissier 5:386, t. 14, 1897. Type: MEXICO. [Estado de México]: Montagne de Zacoalco, près Guadalupe, Vallée de Mexico, 28 Août. 1865, *Bourgeau 797* (Lectotype designated here: G [G00342886]!; isolectotype: G [G00342885]!, P [P00622222, P00622223, P00622224!]). Syntypes: Dans les buissons du mt. Zacoalco près Guadalupe, Vallée de Mexico, 10 Jul 1865, *Bourgeau 497* (G [G00342883]!, P [P00622225, P00622226]!); Vallée de Mexico, Pédrégal, 15 Sep 1865, *Bourgeau 792* (G [G00342884]!, P [P00622227, P00622228, P00622229]!); *Schmitz 108* (W, not seen). The specimen selected as lectotype (G00342886) is the most complete of the sheets cited; it also has the root in longitudinal section and fruits of the illustration (t. 14) on p. 1301 of Hallier's publication.

Ipomoea oreophila House, Ann. New York Acad. Sci. 18:195. 1908. Type: MEXICO. Hidalgo: rocky hills, Lens Station, 8300 ft, 24 Aug 1905. *Pringle 10034* (holotype: GH!, isotypes: F!, NY!, US!).

Perennials from a large, thickened root, the stems 1–1.5 m long, twining, finely white-pubescent, becoming glabrous with age. **Leaves** 3–5 cm long, 3–4 cm wide, entire or trilobate, or almost 5-lobed, white-pilose, somewhat sagittate to cordate, the apex acute, mucronulate; petioles 2–3.5 cm long, white-pilose. **Inflorescences** with axillary peduncles 3–20 cm long, white-pilose. **Flowers** solitary on slender pedicles 8–10 mm long, pilose; bracts 2–4 mm long, linear, pilose. Sepals 10-15 mm long, 7-8 mm wide at the base, herbaceous, more or less equal, pubescent, triangular-ovate, acute (not attenuate), white-pilose. Corollas blue to bluish, 5 cm long, 4–5 cm wide, the tube white. **Capsules** about as long as the calyx, glabrous, 5-valved, 5-locular, often 10-seeded, the 5 valves often bifid; pericarp chartaceo-ligneus, brownish. Seeds 1–potentially 10, 4 mm long, discoid, black, with short erect trichomes.

Sonora.—East-central part of the state in pine-oak forest, 1300 m. Flowering August–September.

General distribution.—Hidalgo, Michoacán, Edo. Mexico, Sinaloa, Zacatecas; reported from Chiapas (*Nelson 3149*, NY and GH, neither seen).

This perennial species is similar to and might be confused with annual *I. purpurea*. The sepals of *I. decasperma* lack the setose trichomes of *I. purpurea*; leaves of *I. purpurea*, while variable, are not sagittate as in *I. decasperma*.

Mpio Yécora: Tributary of Arroyo de Pilares near bridge, 24.7 km W of Maycoba on MEX 16, 1300 m, oak woodland with scattered pines in shady, narrow, steep canyon, rare annual or perennial on shady slope, flowers open 10:00–11:00 a.m., blue with lavender throat, drying magenta, 2 Sep 2000, *Reina-G. 2000-622, 2000-627* (USON!).

Ipomoea hederacea Jacq., Collect. Bot. 1:124, pl. 36, 1787 [title page 1786]). Type: "AMERICAS" (actually cultivated in the botanical garden in Vienna), *Jacquin s.n.* (W!). Lectotypification by Austin, Taxon 35:356. 1986 was in error (ineffective, according to the Code) since Jacquin did not mention the Dillenius plate.

Ipomoea desertorum House, Ann. New York Acad. Sci. 18:203. 1906. Type: U.S.A. Arizona: *Thurber 29* (holotype: NY!, isotype: US!).
Ipomoea hederacea var. *integriuscula* A. Gray, Syn. Fl. N. Amer. ed. 2, 2:433. 1886. Type: U.S.A: East Florida, *Curtiss* (holotype: GH!).
Ipomoea hirsutula pro parte.

Trompillo, *trompillo azul*, *trompillo morado*; ivy-leaf morning-glory; *hehe quiijam* 'plant that-curls-around-it,' *hataaij* 'what is spun (like a top)' (Seri)

Annual **herbs,** the stems twining, often 2–3+ m long, densely to sparsely pubescent throughout. **Leaves** with blades ovate to ± orbicular, (2–) 3.5–13 cm long and about as wide, entire to 3- or 5-lobed, basally cordate, the lobes apically acute to acuminate, pubescent; petioles to 12 cm long, rarely longer. **Inflorescences** cymose. **Flowers** 1–3(–6), on peduncles 5–10 cm long, the pedicels 3–7 mm long, erect in fruit; bracts foliaceous, elliptic to lanceolate, 5–8 mm long. Sepals ± equal, 12–25 mm long, 4–5 mm wide, herbaceous, lanceolate, abruptly narrowed from the ovate base into a narrow linear-lanceolate apex, usually curved, at least in fruit, the apex sometimes strongly curved, densely long-hirsute at least on the basal ⅓. Corollas funnelform, 2–3.7(–4.5) cm long, light blue or pinkish to lavender, with the inside of the tube white or pale yellow, the limb 1.7–3.5 mm wide. **Capsules** ± globose, somewhat depressed, 8–12 mm wide, enclosed within the sepals. Seeds 1–4, pyriform, dark brown to black, densely hairy with short trichomes, 4–4.8 mm long. $2n = 30$.

Sonora.—Nearly statewide, this is the most widespread convolv species in Sonora, where it is a common summer-rainfall annual, often along washes, canyons, and playas, but also open areas, in natural and disturbed areas including roadside habitats and cultivated ground. Sonoran desert, grassland, and tropical deciduous forest. In desert regions and elsewhere it is often seasonally common in densely vegetated, brushy arroyo bottoms and playa margins; near sea level–1900 m. Flowering August–November.

General distribution.—Arizona, New Mexico, Texas, southeastern United States; Baja California Sur, Chihuahua, Nuevo León, Tamaulipas, south to Guerrero, Oaxaca, Chiapas; South America. Widespread in the Americas; adventive in the Old World. (See discussion under *I. nil*).

Leaf shape in this species, and perhaps in many others, is under simple genetic control and is useless for recognition of varieties (Elmore 1986). While Elmore's paper that leaf variability is a simple genetic trait is the only publication typically known in English-speaking countries, that shape control has long been known in Japan where studies of the genetics of this and the related *I. nil* began to be published in the 1800s.

Mpio Agua Prieta: 5 mi S of Agua Prieta, flowers closed in day, 7 Sep 1960, *Felger 3972*!; Colonia Morelos, fls blue, *trompillo*, 2600 ft, 15 Sep–4 Oct 1941, *White 4425*! **Mpio Álamos:** 14 km SE of Álamos, 350 m, flowers purple, 12 Oct 1992, *Van Devender 92-1294*!; Arroyo Menditero at crossing of Álamos–El Chinal road & rio Cuchujaqui, 12 km (airline) S of Álamos, near 26°54'48"N, 108°55'W, 2450 m, tropical deciduous forest on slopes, 5 Oct 1992, *Sanders 12561* (UCR!). **Mpio Benjamín Hill:** Rancho el Peñascoso, 1.9 km W of Benjamín Hill, 30.1603°N, 111.1508°W, 704 m, flowers purple, 17 Oct 2003, *Reina-G. 2003-1186*! **Mpio Carbó:** 12.3 mi by Tecolote road (1.2 mi N of El Oasis) W of MEX 15, 725 m, 24 Aug 1982, *Reichenbacher 1064* (ASU! mixed collection, upper buds are *I. hederacea*, the full flower at bottom is *I. nil*). **Mpio Cucurpe:** 8.7 mi NE of Cucurpe, oak grassland, 3800 ft, *Toolin 3 Oct 1979*! **Mpio Guaymas:** 1 km N of Bahía San Carlos on old rd from San Carlos to Bahía Algodones, 21 Oct 1984, *Felger 84-195*! **Mpio Villa Pesqueira:** 15 mi NE of Mátape on road to Batuc, corolla bright blue, 10 Sep 1941, *Wiggins & Rollins 453*! **Mpio Puerto Peñasco:** 6 km W of Los Vidrios, corollas blue, annual vines climbing in mesquite shrubs, 25 Oct 1992, *Felger 92-965*! **SONORAN ISLANDS:** Tiburón, E side, vicinity of Zozni Quimpla, 28.98596°N, 112.21394°W, 23 Nov 2006, *Wilder 06-349*! (see Felger & Wilder 2012 for additional records).

Ipomoea hederifolia L., Syst. Nat, ed. 10, 925. 1759. TYPE: based on *Quamoclit hederae folio trifido*, Plumier in Burm., Pl. Amer., fasc. 4:82, t. 93, f. 2, 1756 (LECTOTYPE!). *Quamoclit hederifolia* (L.) G. Don, Gen. Hist. 4:259. 1838. *Quamoclit coccinea* var. *hederifolia* (L.) House, Bull. Torrey Bot. Club 36:599. 1909.

Ipomoea coccinea of authors, not L. (1753). *Quamoclit coccinea* of authors, not (L.) Moench.

Herbs, annual, the stems twining, herbaceous, to 4 m long, glabrous. **Leaves** ovate to ± orbicular, 2–15 cm long, (3) 5- or 7-lobed, glabrous or puberulent. **Inflorescences** with dichasial primary branches, followed by monochasial branches. **Flowers** 5–18. Sepals glabrous, 1.3–5 mm long, ± equal, oblong to elliptic, obtuse or truncate, the two outer ones with a ± terminal arista 1.6–6 mm long. Corollas 1.4–3 cm long, salverform, red to red-orange, glabrous. **Capsules** 6–8 mm long, ± globose, brown, glabrous. Seeds 1–4, 4–5 mm long, pyriform, tan or black, with inconspicuously pilose rows of trichomes along the sides. $2n = 28, 30$.

Sonora.—Widely scattered in coastal and foothill thorscrub, tropical deciduous forest, oak woodland, and pine-oak forest, in natural and disturbed habitats, and one historic record at the desert edge (at Guaymas); near sea level–1800 m. Mostly flowering September and October.

General distribution.—Texas eastward in USA; Baja California Sur, Chihuahua, Coahuila, Guanajuato, Guerrero, Hidalgo, Jalisco, Michoacán, Morelos, Nayarit, Nuevo León, Oaxaca, Puebla, Queretaro, San Luis Potosí, Sinaloa, Tamaulipas, Yucatan; Mesoamerica; Argentina, Bolivia, Brazil, Colombia, Guyanas, Ecuador, Peru, Venezuela; Caribbean. Naturalized in Africa, Asia, and Australia.

Plants in Arizona are typically misidentified as this species, but are actually *I. cristulata*. No specimens of *I. hederifolia* from Arizona have been found. Sepal size is the best way to distinguish the two: in *I. hederifolia* both outer and inner sepals are 1.3–5 mm long, *I. cristulata* has outer sepals 3.5 mm long and inner sepals 4–5.5 mm long.

Mpio Álamos: Arroyo Mentidero, at crossing of Álamos–El Chinal road, Río Cuchujaqui, 26.9133°N, 108.917°W, 240 m, tropical deciduous forest, scarce annual vine with red flowers, 6 Oct 1992, *Sanders 12669* (UCR!). **Mpio Guaymas:** Guaymas, 1887, *Palmer 310* (US, cited by O'Donell 1959b: 51, not seen). **Mpio Ímuris:** Rancho La Pantera, ca. 20 km NE of Ímuris on MEX 2, 30.8853°N, 110.709°W, 1120 m, uncommon vine, flowers salmon, open at 12:30 p.m., sycamore stand in rocky canyon in oak woodland, 15 Sep 2000, *Van Devender 2000-690*! **Mpio Navojoa:** Summit of Cerro Prieto, vicinity of microwave station, 15 km E of Navojoa above road to Álamos, 27.25°N, 109.283°W, 400 m, thorn forest, scarce 1.5 m high vine on shrubs beside the road, flowers red, 5 Sep 1989, *Sanders 9307* (UCR!). **Mpio Ónavas:** Ónavas, bosque, 200 m, Pima Bajo = *vipsumar*, 12 Oct 1986, *Rea 1232*! **Mpio San Pedro de la Cueva:** Between Tepupa and Batuc, 28 Sep 1934, *Wiggins 7499* (CAS!); N of Mazatán, between Mátape and Mazatán, 1680 ft, 11 Sep 1941, *Wiggins & Rollins 470* (CAS! MO!).

Ipomoea heptaphylla Sweet, Hort. Brit. 372. 1830. TYPE: INDIA: WEST BENGAL: grown in Botanical Garden at Calcutta, *Roxburgh plate 1950* (LECTOTYPE designated by Verdcourt 1961: 11). Manitz (1983: 179) pointed out that Sweet created a new name and not a new combination, thus making it the earliest for this species. We have reviewed the information Manitz gives, examined the lectotype (Roxburgh 1824), and concur with his conclusions. *Convolvulus heptaphyllus* Roxb., Fl. Ind. (ed. Carey and Wallich) 2:66. 1824, not *C. heptaphyllus* Rottler in Willd. (1803). *Ipomoea heptaphylla* (Roxb.) Voigt, Hort. Suburb. Calcutt. 360. 1845.

Ipomoea wrightii A. Gray, Syn. Fl. N. Amer. 2:213, 1878. TYPE: U.S.A. TEXAS: *Wright* (HOLOTYPE: GH!).
Ipomoea spirale House, Muhlenbergia 3:40. 1907. TYPE: MEXICO. SONORA: Jaqui [Yaqui] river, 1864, *Palmer 24* (HOLOTYPE: US!).
Ipomoea pulchella of authors, not Roth (1821).

Herbs, annual, the stems twining or prostrate, 2–8 m long, glabrous. **Leaves** petiolate, 1–4 cm long and wide, 5-foliolate, the lobules lanceolate to linear-lanceolate, sessile, apically acute, glabrous. **Inflorescences** axillary and terminal. **Flowers** usually solitary, with filiform peduncles as long as or longer than the petioles, often spirally twirled. Sepals ± equal, 5–7 mm long, ovate to oval, apically obtuse to rounded, glabrous. Corollas 1.8–3 cm long, funnelform, glabrous, rosy (or sometimes white) with the interior of the tube red-violet. **Capsules** 8–10 mm long, globose, brown, glabrous. Seeds 1–4, 4–6 mm long, ovoid, brown, finely pubescent.

Sonora.—Coastal thornscrub of the coastal plain in southwest part of the state, apparently not common. Margins of temporarily flooded or swampy places including roadside; below ca. 50 m. Flowering September–October.

General distribution.—Texas, SE USA; Mesoamerica; Argentina, Brasil, Ecuador, Paraguay, Peru; pantropical.

Although no one knows where this species is native, it shares no obvious relatives in the New World. It may well be an Old World species and perhaps is related to *I. cairica*, which is probably native to Africa. *Ipomoea heptaphylla* has been confused at least with *I. cairica* and is morphologically more similar to that species and others like it in Africa than those elsewhere. Roxburgh (1824) pointed out that the plant appeared unexpectedly in the nursery at the botanical garden in Calcutta, but he did not think it native, at least in his region.

Verdcourt (1961: 11) thought that the plant climbed with the spiraled peduncles. Although Austin has seen this plant few times, no note was made of the peduncles behaving like tendrils. Perhaps someone examining living plants in the field will be able to clarify the role of the spiraled structures.

Mpio Bácum: 1.7 mi on Mex. Hwy 15 SE of junction of road to Pitahaya (= Belem on Río Yaqui), 27°45'N, 108°24'W, 10 m, coastal plain of thornscrub surrounding an apparently perennial pond densely shaded by *Prosopis glandulosa*, rare, climbing in mesquite tree at edge of pond, 11 Oct 1985, *Felger 85-1264*! **Mpio Navojoa:** Navojoa, water edge of river back-water, limb and tube white, throat purple, 27 Oct 1939, *Gentry 4746*!

Ipomoea imperati (Vahl) Griseb., Cat. Pl. Cub. 203. 1866. TYPE: Imperato, Hist. Nat. 671, unnumbered illustration as "Convolvulus marino" (1672) (LECTOTYPE!). *Convolvulus imperati* Vahl, Symb. Bot. 1:17–18. 1790.

Convolvulus littoralis L., Syst. Nat., ed. 10, 924. 1763. TYPE: based on *Convolvulus foliis obtusis*, Plumier, Pl. Amer. 79, t. 90, f. 2, 1756 (LECTOTYPE!), not Blume (1826), or Boissier (1879).
Ipomoea stolonifera (Cyrillo) J.F. Gmel., Syst. Veg. 345. 1796. *Convolvulus stoloniferus* Cyrillo, Pl. Rar. Neap. 1:14. t. 5, 1788. TYPE: based on the plate (LECTOTYPE!).

Herbs, perennial, the stems prostrate, rooting at the nodes and often underground, reaching 5 m or more in length. **Leaves** 1.5–8 cm long, sometimes linear to ovate or oblong, lobed or not lobed, the size and shape variable. **Inflorescences** axillary, monochasial. **Flowers** solitary, rarely 2 or 3; opening early in the morning. Sepals 1–1.5 cm long, unequal, oblong, the outer two sepals shorter, acute to obtuse, glabrous. Corollas 2.5–5 cm long, funnelform, white with a yellow throat, sometimes purplish within the base, glabrous. **Capsules** 1–1.5 cm long, rotund, straw-colored when mature. Seeds 1–4, 8–10 mm long, rotund, clear-brown, tomentose along the margins. $2n = 30$.

Sonora.—Coastal thornscrub on beaches and dunes in the southwestern corner of the state, near sea level.

General distribution.—Texas, Florida; Baja California Sur, Campeche, Guerrero, Jalisco, Nayarit, Quintana Roo, San Luis Potosí, Sinaloa, Tabasco, Tamaulipas, Veracruz; Mesoamerica; Brazil, Colombia, Guyanas, Bolivia, Ecuador, Venezuela; Caribbean; pantropical. This beach species is more common in the Atlantic region than the Pacific. Flowering all the year.

Mpio Huatabampo: 0.6 km E of Camahuiroa on beach, common sand-stabilizing rhizomatous perennial herb, flowers white, 8 May 1996, *Friedman 37-96*!; Camahuiroa, 26.5167°N, 109.267°W, on beach sand; flowers white, 8 Oct 1992, *Van Devender 92-1067*!

Ipomoea laeta A. Gray, Proc. Amer. Acad. 22:439. 1887. TYPE: MEXICO. JALISCO: Río Blanco, Jun–Oct 1886, *Palmer 341* (HOLOTYPE: GH!, ISOTYPES: K!, MO!, US!, NY!, PH!).

Perennial **herbs** from a large, oblong root; stems twining, densely white tomentose-pilose with appressed trichomes. **Leaves** with blades 3–7 cm long and wide, suborbicular in outline, deeply 3- or 5-lobed, basally cordate, lobes apically acute to acuminate, pubescent like stems; petioles 1–6 cm long, pubescent like stems. **Inflorescences** 1-flowered. **Flowers** on peduncles about as long as the petioles, pedicels 0.5–1 cm long; bracts 0.5–1 cm long, linear-lanceolate to lanceolate. Sepals more or less equal or the outer two slightly shorter and triangular-ovate, 14–16 mm long, 6–8 mm wide, truncate to rounded at the broad base, apically acute to acuminate, hirsute. Corollas 8–12 cm long and wide, funnelform, blue to pink-purple, pubescent on the outer surface. **Capsules** 12–14 mm long, ovoid, glabrous, surrounded by the sepals. Seeds not seen.

Sonora.—Pine-oak forest in mountains of the upper Río Mayo region along the Chihuahua border close to southeastern Sonora, and expected in immediately adjacent Sonora.

General distribution.—Chihuahua, Hidalgo, Jalisco, Nayarit, Queretaro.

The species is similar to *I. pubescens* and *I. decasperma* but is easily separated from them, when in flower, by the pubescent and notably large corollas.

CHIHUAHUA. Mpio Chínipas: Arroyo Hondo, Sierra Charuco, flower blue with purple ribs ["ribs" = interplicae], 11 Sep 1935, *Gentry 1788*!

***Ipomoea ×leucantha** Jacq., Icones Pl. Rar. 2:10, t. 318, 1788. TYPE: Jacquin, Icon. Rar. 2. t. 318 (LECTOTYPE!). *Convolvulus dentatus* Blanco, Fl. Filip. 89. 1837; ed. 2, 66. 1845, not Vahl (1794); ed. 3, 1:123, t. 31 (as *I. commutata* Roem. & Schult.). TYPE: plate t. 31 (LECTOTYPE!).

Ipomoea blancoi Choisy in DC., Prodr. 9:389. 1845. Based on *Convolvulus dentatus* Blanco.
Ipomoea triloba of authors, not L.

Annual **herbs,** the stems twining or procumbent, glabrous to sparsely hairy. **Leaves** with blades 2–8 cm long, 2–7 cm wide, broadly ovate to orbicular, entire, dentate to 3 or 5 lobed, basally cordate, the apex acute to obtuse; petioles 2–3 cm long. **Inflorescences** axillary, mostly sub-umbellate cymose, less often 1-flowered. **Flowers** on pedicels (4–) 10–30 mm long, erect in fruit; bracts scale-like. Sepals ± equal, (8–)10–14 mm long lanceolate-acuminate, mucronate, glabrous. Corollas funnelform, 0.6–1.5(–2) cm long, white to lavender or pink, the throat often darker, the limb mostly less than 1 cm wide. **Capsules** ± globose, 7–8 mm wide, bristly hirsute. Seeds 1–4, 3.2–4 mm long, ovoid, black to dark brown, glabrous.

Sonora.—Widespread across the state, but apparently not at higher elevations. Disturbed sites, often a weed in cultivated fields and gardens, and coastal and foothills thornscrub and tropical deciduous forest; 20–850 m. Flowering at least August–October.

General distribution.—Arizona, New Mexico, Texas; scattered sites in Mexico, including Sonora to Veracruz; Central America; Caribbean; South America.

Widespread weed in disturbed habitats from southern United States, including Arizona, to Argentina and Peru. This plant is a stable hybrid between *I. cordatotriloba* Dennst. (*I. trichocarpa* Elliott) and *I. lacunosa* L. (Abel and Austin 1981; Austin 1978). *I. lacunosa* is usually totally autogamous (selfing) whereas *I. cordatotri-*

loba, with larger flowers, is usually allogamous (outcrossing; McDonald et al. 2011). The honeybee, introduced from the Old World, carries pollen from one species to the other and is the only insect known to move between the two. However, certain other pollinators, when present, will visit *I. lacunosa* and the hybrid. Presumably the hybrid is moved, as it has been around the world, as a contaminant in seeds of cultivated plants.

Mpio Álamos: Near Álamos, abandoned milpa, lavender flowers, 1200 ft, 28 Oct 1939, *Gentry 4767*!; Rancho San Pedro, E entry to El Cajón along Río Cuchujaqui, 500 m, 10 Nov 1988, Martin & *Jenkins 88-26*!; Álamos, in streambed, 390 m, flowers pink, 2 Feb 1992, *Van Devender 92-154*!; Canyon Estrella, 1 Oct 1933, *Gentry 426Ma*! **Mpio Benjamín Hill:** 24 km S of Rancho El Seri, 8.2 km S of Rancho El Carrizo (16.9 km W of MEX 15 at 20.5 km S of Benjamín Hill), mesquite bosque, 29°58'58"N, 111°15'24"W, 755 m, 22 Aug 2007, *Van Devender 2007-890*! **Mpio Guaymas:** Near Mori, Yaqui country, marginal to water standway on heavily brushed coastal plain, 26 Oct 1939, *Gentry 4743*! **Mpio Huatabampo:** 6.8 km S of Camahuiroa, 10 m elev, flowers purple, 20 Oct 1994, *Friedman 438-94*! **Mpio Navojoa:** Navojoa, water edge of river back-water, 27 Oct 1939, *Gentry 4747*! **Mpio Ónavas:** Ónavas, near fields, fls pale rose pink in center to pale magenta at edges, 11 Oct 1986, *Rea 1210*! **Mpio San Luis R.C.:** 5 km S of San Luis, roadside and irrigation ditches in agricultural fields, corolla pinkish, open in early morning, 6 Oct 1985, *Felger 85-1032*! **Mpio Yécora:** Santa Ana 2 km E-NE of town just beyond Bermudez Junction, major trail to milpas, 28°22'40" N, 109°08' W, 950 m, *Otts, Martin, et al. 10 Oct 1988.*

Ipomoea longifolia Benth., Pl. Hartw. 16. 1839. Type: MEXICO. Zacatecas: *Hartweg 97* (holotype: K!; isotypes: NY!, P!); other sheets with species #97 (species numbers?) are from Chihuahua (K!) and Leon (BR!, LD!).

Large perennial **herbs** forming large tuberous roots, somewhat fleshy, rhizomatous, glabrous, the stems long, trailing, decumbent, or ascending. **Leaves** with blades linear to oblong-lanceolate, often 10–12(–20) cm long, 2–4 cm wide, entire, glabrous; petiole 0.5–1.7 cm long. **Inflorescences** mostly solitary. **Flowers** on peduncles 3.5–4(–11) cm long, the pedicels 2–3.5 cm long, mostly erect in fruit. Sepals ovate, the outer ones 12–14(–17) mm long, 6–7 mm wide, the inner ones 15–20 mm long, 7–8 mm wide, coriaceous, glabrous. Corollas funnelform, 7–10 cm long, the limb whitish to cream-white, 7–8 cm wide, the throat purple or deep reddish purple. **Capsules** ovoid, 14–16 mm wide, with an apiculum 2–3 mm long. Seeds 1–3(4), 10–11 mm long, ovoid, brown, with long pilose indumentum on the margins and near the apex.

Sonora.—North-central and northeast part of the state in grassland, oak woodland, foothills thornscrub, and tropical deciduous forest; 975–1850 m. Flowering April–September.

General distribution.—Southeastern Arizona and northern Mexico in Aguascalientes, Chihuahua, Durango, Guanajuato, Jalisco, Queretaro, San Luis Potosí, Zacatecas.

The flowers are open in the evening and are pollinated by moths, although there have been reports of bees also visiting (Austin 1986).

Mpio Bacanora: 21 km W of Bacanora on road to La Estrella, S slope of Sierra Batamote, ca. 1100 m, 2 Oct 1990, *Reina-G. 99-870*! **Mpio Cananea:** Sierra de los Ajos, 20 mi N of Bacoachi, 1625 m, white corolla with deep red-violet throat, 25 Jul 1993, *Fishbein 1259!* **Mpio Cucurpe:** 1 mi W of Rancho Agua Fria on road to Cucurpe, desert grassland, flowers white with purple throat, 18 Aug 1991, *Van Devender 91-677*!; 8.7 mi ENE of Cucurpe, 3800 ft, *Toolin 4 Oct 1979.* **Mpio Ímuris:** 17.1 km NE of Ímuris on MEX 2, 30.8747°N, 110.731°W, 4313 ft, oak woodland, 9 Sep 2002, *Doan 1207* (ASU!); 5 km W-SW of Cuitaca, 48 km NE of Ímuris on Mex 2, oak woodland, 1210 m, 15 Sep 2000, *Van Devender 2000-684*! **Mpio Nacozari de García:** 5 km N of Nacozari, oak grassland, 24 Jul 1960, *Felger 3653*!; 2 mi E of Mex Hwy 12 on road to La Angustura, oak grassland, *Baker 17 Aug 1984*! **Mpio San Felipe de Jesús:** Vicinity El Llano, 9.5 mi W of San Felipe, Sierra de los Locos, *Hole & Martin 11-12 Aug 1980*! **Mpio San Pedro de la Cueva:** Sierra Batuc, 8 mi NE of Mátape, corollas white faintly tinged with purple on the limb, deep purple in the throat, 9 Sep 1941, *Wiggins & Rollins 414*! **Mpio Santa Cruz:** 20 km E of Nogales on road to Santa Cruz, S extension of Patagonia Mountains, oak woodland, 31.3172°N, 110.721°W, very common prostrate perennial vine, flowers white, purple-pink inside tube, stamens and pollen white, open late afternoon to early morning, 17 Jul 2001, *Reina-G. 2001-535*!

Ipomoea madrensis S. Watson, Proc. Amer. Acad. Arts 23:281. 1888. Type: MEXICO. Chihuahua: Pine plains, base of the Sierra Madre, Sep 1887, *Pringle 1338* (holotype: GH!, isotypes: F!, K!, MO!, NY!, RSA!, US!).

Perennial **herbs,** roots tuberous, the stems erect, scandent, or less often twining, 4–50 cm long, mostly branched from the base, glabrous. **Leaves** variable, the first ones usually elliptic, rhombic, or narrowly lanceolate, 1.5–5 cm long, 3–20 mm wide, occasionally lobed, the lobes to 6 mm long, 5 mm wide, margins entire or irregularly dentate, apex acute, mucronulate, the base attenuate, the distal leaves sometimes grading into palmatisect laminas with 3–5 segments, about equal or unequal, filiform, linear, or lanceolate, 7–42 mm long, 1–6 mm wide, the outer segments often shorter than the inner ones, margins entire, apex obtuse or acute, the base attenuate, glabrous; petioles almost absent or 2–10 mm long. **Inflorescences** monochasial axillary cymes.

Flowers 1 or 2 on peduncles 2–10 mm long, the pedicels 6–10 mm long, often subtended by a deciduous bracteole ca. 3 mm long and 2 mm wide. Sepals more or less equal or the outer ones slightly smaller than the inner ones, broadly elliptic, 6–8 mm long, 4–6 mm wide, coriaceous, the midrib muriculate, the margins entire, barely hyaline, the apex acute. Corollas funnelform, 3–4 cm long, the limb 2.5–3 cm wide, blue-purple, glabrous. **Capsules** depressed, almost globose, 5–6 mm wide, brown, chartaceous, glabrous. Seeds often 4, ca. 2 mm wide, rotund, dark brown, puberulent.

Sonora.—East-central and southeast Sonora in mountains near the Chihuahua border in oak woodland and pine-oak forest; 1240–2120 m. Flowering July–October.

General distribution.—Southwestern Chihuahua and southward in the Sierra Madre Occidental and altiplano of central Mexico and the Valley of Mexico; Aguascalientes, Chihuahua, Distrito Federal, Durango, Edo. México, Michoacán, Nayarit.

Although not immediately obvious, this species is likely related to *I. capillacea* and *I. plummerae*.

Mpio Álamos: Rancho El Rayo, between Las Chinacas and La Lobera, 1500 m, *Martin 18 Aug 1991*!; 3.6 km below (SW) Rancho Santa Bárbara, 27.108611°N, 108.730833°W, 1240 m, oak woodland, flowers purple, 3 Oct 2006, *Van Devender 2006-1142*! **Mpio Yécora:** Mesa Grande, 28°26'30"N, 108°59'W, willow oak-Apache pine-juniper, 1800 m, *Martin 12 Aug 1987*!; Sonora-Chihuahua [border], summit of Mesa El Campanero between Yécora, Sonora and Bermúdez, Chihuahua, 28°20'N, 109°02'W, pine-oak forest, 2121 m, 1 Aug 1985, *Turner & Martin 85-30*!; Yécora, 28°22'25"N, 108°55'30"W, 1540 m, *Trauba 19 Aug 1997* (FTG-FAU!); Mesa el Campanero, 2000 m, flowers purple, 6 Sep 1996, *Van Devender 96-397*!

Ipomoea meyeri (Spreng.) G. Don, Gen. Hist. 4:275. 1838. Type: of unknown origin. *Meyer* in herb. Willdenow (B-W!). *Convolvulus meyeri* Spreng., Syst. Veg. 1:597. 1825 [1824].

Ipomoea isostemma House, Ann. New York Acad. Sci. 18:207. 1908. Type: COSTA RICA: Nicoya, Jan 1900, *Tonduz 13680* (holotype: NY!, isotype: fragment US!).

Ipomoea chiapensis Brandegee, Univ. Calif. Publ. Bot. 6:60. 1914. Type: MEXICO. Chiapas: Tonalá, Oct 1902. *Purpus 6907* (holotype: UC!; isotypes: BM!, F!, NY!, MO!, US!).

Ipomoea brachypoda Benth., Bot. Voy. Sulphur 135. 1844. Type: MEXICO. Guerrero: Acapulco. *Sinclair s.n.* (lectotype K!, lower left specimen of mixed collection; lower right specimen is *I. aristolochiifolia*); Panama: Isle of Taboga, Bay of Panama. *Anonymous s.n.* (syntype: not seen); Colombia [Ecuador on label in Bentham's handwriting, but someone else has written "Not"]. 1842. *Sinclair* (syntype: K!).

Ipomoea iodantha Brandegee, Univ. Calif. Pub. Bot. 4:383. 1913. Type: MEXICO. Baja California [Sur]: Cape Region, La Mesa, 31 Oct 1902, *Brandegee s.n.* (holotype: UC! barcode 105204, photo MEXU!).

Herbs, annual, the stems twining, herbaceous, to 3 m long, glabrous or somewhat pilose. Leaves (2–)4–10 cm long, 2–7 cm wide, ovate, entire or slightly hastate-trilobed on the basal lobes, apex acute, acuminate, glabrous. **Inflorescences** in dichasial glomerules. **Flowers** 1–3(–9); bracts foliaceous, resembling the sepals. Sepals 1–2 cm long, equal, lanceolate, acuminate, the base hirsute, the apex glabrous and attenuate, spreading to reflexed. Corollas (1–)2–3 cm long, funnelform, blue, purplish or rose, with the throat white or yellow, glabrous. **Capsules** 7–10 mm long, conical, clear brown, glabrous. Seeds 1–4, 4–8 mm long, pyriform, light to dark brown, pubescent with short trichomes.

Sonora.—Southeastern Sonora along riparian arroyos or canyons in tropical deciduous forest; ± 200 m. Flowering at least in September and October. (See discussion under *I. nil*).

General distribution.—Baja California Sur, Chiapas, Distrito Federal, Guerrero, Jalisco, Michoacán, Oaxaca, Quintana Roo, Sinaloa, Veracruz, Yucatan; Mesoamerica; Colombia, Ecuador, Peru, Venezuela; Caribbean.

Phylogenetic evidence (McDonald et al. 2011) indicates this is sister to *I. variabilis* (Schltdl. & Cham.) Choisy and distant from *I. hederacea* and *I. nil*. Sepal morphology has suggested otherwise but the 2-locular capsules agree with phylogenetic results.

Mpio Álamos: 6 km SE of Álamos, 30 Sep 1992, *Bertelsen 92-134*!; Güirocoba crossing of Río Cuchujaqui, 12 km SSE of Álamos, 4 Oct 1992, *Van Devender 92-914*!; El Rancheria crossing of Río Cuchujaqui, 22.5 km S of Álamos, 200 m, shady bank above river in tropical deciduous forest, flowers pink, 10 Oct 1992, *Van Devender 92-1149*!; Arroyo Menditero at crossing of Álamos–El Chinal road & down to rio Cuchujaqui, 12 km (airline) S of Álamos, near 26°54'48"N, 108°55'W, 787 ft, tropical deciduous forest on slopes, 5 Oct 1992, *Sanders 12560* (UCR!).

Ipomoea minutiflora (M. Martens & Galeotti) House, Muhlenbergia 5:71. 1909. TYPE: MEXICO. OAXACA: dans les haies de Sola, avec le *C. tenuifolius*, à 5000 pieds. Fl. jaune-citron. Septembre. *Galeotti 1372* (HOLOTYPE: BR!; ISOTYPES: G!, K!). *Convolvulus minutiflorus* M. Martens & Galeotti, Bull. Acad. Roy. Sci. Bruxelles 12:262. 1845.

Ipomoea filipes Benth. ex Meisn., Fl. Bras. 7:274. 1869. TYPE: BRAZIL. PARÁ: In vicinibus Santarém, May 1850, *Spruce 700* (HOLOTYPE: M!; ISOTYPES: GH!, TCD!, NY!).

Ipomoea gracillima Peter, Nat. Pflanzenfam. 4(3a):30. 1891. TYPE: VENEZUELA: *Fendler 2089* (GOET!, bar code GOET 005720). McDonald (Fl. Veracruz 77:77. 1994) designated the protologue lectotype, but this is ineffective as it is not based on either a specimen or an illustration (Staples et al. 2012).

Herbs, annual, the stems twining or prostrate, herbaceous, 1–3 m long, hispid. **Leaves** 1–4.5 cm long, 1–6.5 cm wide, ovate, entire, the apex acute, acuminate, glabrous. **Inflorescences** in monochasia. **Flowers** 1–3. Sepals 1.5–2 mm long, accrescent to 5 mm in fruit, equal, broadly elliptic to lanceolate, margins scarious, the apex acute, attenuate, hispid or pilose. Corollas 0.4–1.5 cm long, campanulate, yellow, changing to orange with age, glabrous. **Capsules** 4–5 mm long and wide, rounded, brown to straw-colored, glabrous. Seeds (1–) 4, 2–3 mm long, rounded, brown, puberulent-furfuraceous.

Sonora.—Mountains in central and southeast parts of the state in foothills thornscrub, tropical deciduous forest, oak woodland, and pine-oak forest (including altered soils), often in riparian canyons and in shaded forests; 240–1400 m. Flowering October to December.

General distribution.—Baja California Sur, Campeche, Chiapas, Chihuahua, Colima, Guerrero, Jalisco, Michoacán, Nayarit, Oaxaca, Puebla, Sinaloa, Veracruz; Mesoamerica; Brasil, Colombia, Venezuela.

This autogamous weedy species is related to *I. microsepala*, an allogamous sister species (McDonald et al. 2011).

Mpio Álamos: Arroyo el Mentidero at El Chinal road, 11.3 km S of Álamos, 26°54'45"N, 108°55'05"W, tropical deciduous forest, 240 m, 5 Oct 1992, *Van Devender 92-954*!; El Rincon Viejo, Arroyo El Aquaje, 3.4 km (by air) N of Álamos, Sierra de Álamos, tropical deciduous forest, 27°03'55"N, 108°56'W, 480–520 m, 23 Sep 1993, *Van Devender 93-1073*!; El Palmarito Canyon, 27°04.2'N, 108°45.3'W, 580 m, 23 Oct 1992, *Jenkins 92-79*!; Abandoned orchard of Tepopa N-NW of Chiribo, 27°19'N, 108°43.5'W, 1100–1400 m, upper tropical dry forest including riparian evergreen woods, lower edge of *Pinus oocarpa* and *Quercus pennivenia* with *Dodonaea*, *Martin 22 Aug 1992*!; Steep rocky canyon above La Aduana on Sierra de Álamos, tropical deciduous forest, flowers yellow-orange, 26 Sep 1991, *Van Devender 91-731A*!; Arroyo Mentidero, 12 km S of Álamos, 6 Oct 1992, *Sanders 12647*!; Carical [sic] road, Álamos, *Martin 10 Oct 1990*!; Sierra Saguaribo, ca. 2 km NE of La Vinateria, 1300 m, orange flowers, 24 Aug 1993, *Steinmann 93-278*!; E side of Sierra de Álamos, lower Cañón Las Piedras in the area of the tinajas, 26°59'N, 108°57.3'W, 700 m, 11 Oct 1992, *Sanders 12860*!; Pinal, Sierra Charuco, 9 Sep 1935, *Gentry 1687*! **Mpio Villa Pesqueira:** 3 mi NE of Mátape, between Mátape and Batuc, 8 Sep 1941, *Wiggins & Rollins 395*! **Mpio Yécora:** Agua Amarilla (Los Pinitos), 15 km W-NW of Tepoca, 24.7 km W-NW of San Nicolás on MEX 16, red volcanic barren rock with relict *Pinus durangensis–Quercus albocinta* woodland, 28°08'20"N, 109°20'23"W, ca. 900 m, flores amarillas camiando a naranjas, 6 Sep 1995, *Reina-G. 94-439*!; 1 km E of Santa Ana on road to MEX 16, 940 m, 9 Sep 1996, *Reina-G. 96-534*!

Ipomoea muricata (L.) Jacq., Pl. Rar. Hort. Schoenb. 3(2):40–41, t. 323, 1798, not Cav. (1799 [1794]). TYPE: INDIA. GUJARAT: habitat in Suratte, *Bradd* (LINN 218.18!). *Calonyction muricatum* (L.) G. Don. Gen. Hist. 4:264. 1837. *Convolvulus muricatus* L., Syst. Nat. ed. 12, 2:156. 1767; Mant. Pl. 44, 1767.

Ipomoea turbinata Lag., Gen. Sp. Pl. 10. 1816. Nom. illegit. (superfluous name for *I. muricata* (L.) Jacq.). TYPE: INDIA: India, Suratte, herb. Linnaeus (LINN 218.18), not *Convolvulus muricatus* Blanco (1837).

Ipomoea calderoni Standl., J. Wash. Acad. Sci. 14:242. 1924. TYPE: EL SALVADOR: at San Salvador, 1922, *Calderón 883* (HOLOTYPE: US!).

Herbs, annual, herbaceous, the stems twining or prostrate, to 3–4 m long, glabrous or glabrescent, sometimes with herbaceous "spines" (aculeae) resembling trichomes. **Leaves** 7–18 (25+) cm long; blades ovate to orbicular, entire to 3- or 5-lobed, basally cordate, apically acuminate, glabrous; petioles well developed, sometimes reaching 19 cm long. **Inflorescences** axillary and terminal, cymose. **Flowers** 1–5. Sepals 6–8 mm long, glabrous, oblong to ovate, accrescent in fruit to 12–14 mm long, at least the 2 outer sepals with caudate-fleshy apices 4–6 mm long. Corollas nocturnal, sometimes opening in the late afternoon (e.g., *Van Devender 2000-510*), 3–7.5 cm long, salverform although the upper part of the tube widens near the campanulate limb, glabrous, the limb whitish when first open, becoming lavender by morning, the throat purple or pink inside. **Capsules** 1.8–2 cm long, ovoid-acuminate, with a long apiculum, brown, glabrous. Seeds 1–4, 8–10 mm long, ovoid, brown or sometimes black, glabrous.

Sonora.—Central and mostly southeastern part of the state in tropical deciduous forest, ca. 150–790 m. Flowering at least August–November.

General distribution.—Texas and Arkansas to Florida; Mexico including Baja California Sur, Chihuahua, Coahuila, Guerrero, Jalisco, Edo. México, Sinaloa; Argentina, Ecuador, Peru, Venezuela. Native to Mexico and adventive in the southern United States and South America, and also naturalized in many parts of the Old World. This species has been widely spread through the southeastern United States as a contaminant in soybean seeds (Gunn 1969a, 1972). It continues to be dispersed and established in new areas.

Confusion between names for *I. capillacea* and *I. muricata* began in the 1800s and a new layer of confusion was added by Gunn (1969a, 1969b, 1972). What these authors failed to realize, or at least point out, in addition to the nomenclatural problems, is that *I. capillacea* is a day-flowering plant and *I. muricata* is nocturnal. This was clarified by Staples et al. (2005). *Ipomoea capillacea* is a morning-flowering herb with corollas 3–4 cm long while *I. muricata* is an evening- and night-flowering vine with corollas 3–7.5 cm long. The leaves are also notably different: *I. capillacea* has nearly sessile highly dissected leaf blades with linear segments and *I. muricata* has petiolate entire to 3- or 5-lobed blades. The current residual confusion involves Gunn's conclusions so the earlier problems will not be addressed. The underlying problem is that Gunn (1969b) used the wrong date for the names involved, rejecting *I. muricata* (L.) Jacq. (1798) and using *I. turbinata* Lag. (1816). Staples et al. (2005) provide details on Gunn's error and the proper interpretation, including the complexities of the name changes between *I. muricata* and *I. turbinata*.

Selected references.—Austin and Jansson (1988), Gunn (1969a & b, 1972), Staples et al. (2005).

Mpio Álamos: Gūirocoba crossing of Río Cuchujaqui, flowers white with purple centers, 4 Oct 1992, *Van Devender 92-904*!; San Bernardo, annual vine forming dense green growth over low bushes and seeding heavily, peduncles thick and fleshy, seeds large, brown, 13 Oct 1961, *Gentry 19267*!; Sejaqui by Río Mayo above San Bernardo, sandy bottomland, 1000–1500 ft, vine with blue flowers climbing over shrubs, seeds abundantly, Nov 1958, *Gentry 17651*!; Arroyo el Mentidero at El Chinal road, 11.3 km S of Álamos, 26°54'45"N, 108°55'05"W, 240 m, 5 Oct 1992, *Van Devender 92-997*!; Arroyo el Mentidero at El Chinal road, 11.3 km S of Álamos, 26°54'45"N, 108°55'05"W, 240 m, flowers lavender inside with purple throat, opening early evening, 6 Oct 1992, *Van Devender 92-1030*!; 1 km S of Yocogigua, 109°01'55"W, 160 m, 24 Sep 1993, *Van Devender 93-1082* (FTG-FAU!). **Mpio Ónavas:** Rancho La Mula, 28 km SE of Río Yaqui on Mex 16, 28°28'50"N, 109°22'W, 790 m, tropical deciduous forest, locally common perennial vine, flowers lavender with purple center, whitish outside, opening 5:30–6:00 p.m., 30 Aug 2000, *Van Devender 2000-510*! **Mpio Navojoa:** Summit of Cerro Prieto vicinity of microwave station, 15 km E of Navojoa above road to Álamos, near 27°05'N, 109°17'20"W, 1300 ft, thorn forest with *Acacia*, *Bursera*, etc, vine growing over shrubs, flowers white fading to pink, 5 Sep 1989, *Sanders 9262* (UCR!). **Mpio San Javier:** Cerro Verde, San Javier, 28°34'N, 109°43'50"W, short-tree forest, *Martin 8 Oct 1988*! **Mpio Sahuaripa:** Arroyo Los Tarais, cañón Gordehuachi, 26.3 km N of Sahuaripa on road to Moctezuma, 29.2764°N, 109.3406°W, 487 m, 14 Sep 2006, *Reina-G. 2006-831*! **Mpio Soyopa:** Arroyo Los Garambullos, 1.5 km E of Tónichi, 28°34'10"N, 109°33'00"W, 180 m, abundant vine along river bank, flowers white, tube pink inside, drying pink, open before sunrise, petals falling off easily, 29 Sep 2000, *Van Devender 2000-747*!

Ipomoea nil (L.) Roth, Catal. Bot. 1:36. 1797. TYPE: Dillenius, Hort. Eltham. 1:96. t. 80, f. 91, 1732 (LECTOTYPE!). *Pharbitis nil* (L.) Choisy, Mem. Soc. Phys. Genève 439. 1833. *Convolvulus nil* L., Sp. Pl. ed. 2, 219. 1762.

Ipomoea hederacea of authors, not Jacq. (1786).

Herbs, annual, herbaceous, the stems twining or prostrate, to 3–4 m long, hispid, the trichomes yellow. **Leaves** ovate to ± orbicular, 5–15 cm long, 2–14 cm wide, entire to 3- or 5-lobed, the apices acuminate, hirsute. **Inflorescences** cymose, dichasial. **Flowers** 1–4. Sepals 1.5–2.5(–3) cm long, ± equal, linear-lanceolate, basally narrowly ovate, the base densely hispid with yellow trichomes, hispid to strigose on the upper parts, or distally glabrous. Corollas (2–)3–6 cm long, funnelform, purplish to blue, at times white or red, the tube white or yellow within, glabrous. **Capsules** 8–12 mm long, rounded-depressed, 3-locular, brown, glabrous. Seeds 1–4(–6), 4–9 mm long, dark brown to black, densely short-pubescent. $2n = 30$.

Sonora.—Near the margins of the Sonoran desert, coastal and foothill thornscrub, and tropical deciduous forest, in disturbed as well as natural habitats; 50–ca. 1400 m. Growing and flowering mostly following warm weather rains, especially August–October.

General distribution.—Mexico (probably most or all states); Mesoamerica; Argentina, Bolivia, Brasil, Colombia, Guyanas, Ecuador, Venezuela; Caribbean; cultivated and introduced into the Old World.

The seeds have been utilized as a laxative (Austin 2000c). There are three species of somewhat similar-appearing morning glories that are often confused. One is *I. nil*, characterized by long, straight, subulate sepals, in tropical regions worldwide. The second is *I. hederacea*, also characterized by long sepals, but curving and with an ovate base and abruptly attenuate apex, in temperate regions by latitude or higher elevations in tropical latitudes. The third member is *I. purpurea*, which has short fat sepals and is worldwide.

Ipomoea nil and *I. hederacea* can be hybridized with difficulty (Yoneda and Takenaka 1981). Historically they were geographically isolated. Superficially *I. nil* seems similar to *I. hederacea*, but detailed morphological and molecular genetics show that they are not as close as they may seem. Furthermore, *I. nil* seems closer to *I. eriocalyx* Mart. of South America than to *I. hederacea* (Austin et al. 2001).

Selected references.—Austin (2000c), Austin et al. (2001), McDonald et al. (2011).

Mpio Agua Prieta: Colonia Morelos, 2600 ft, flowers blue, juice milky, 15 Sep–4 Oct 1941, *White 4110*! **Mpio Álamos:** Álamos, 16 Oct 1936, *Gentry 2929*!; Algodones, 9 Sep 1935, *Gentry 1683*!; San Bernardo, tropical Sonoran, valley, 6 Sep 1935, *Gentry 1670*!; Between Rancho La Junta on Río Mayo and Guajaráy on Arroyo Guajaráy, 27°35'15"–27°36'N, 108°52'–108°55'45"W, 220–270 m, 18 Mar 1993, *Van Devender 93-433*!; Güirocoba crossing of Río Cuchujaqui, 12.3 km (by air) S-SE of Álamos, 26°56'15"N, 108°53'W, 260 m, 28 Jan 1992, *Van Devender 92-24*!; SE edge Álamos, 380 m, 10 Mar 1993, *Van Devender 93-108*!; Rancho La Junta, 1 km upstream from Mesa Colorada, 3 km (by air) N-NE of Burapaco, junction of Arroyo Guajaráy and Río Mayo, 27°35'15"N, 108°52'W, 220 m, 17 Mar 1993, *Van Devender 93-390*! **Mpio Arizpe:** Rancho Agua Caliente, 3 km S-SE of Arizpe, foothills thornscrub, 30°19'37"N, 110°11'33"W, 920 m 16 Sep 2000, *Reina-G. 2000-736*! **Mpio Carbó:** 12.3 mi by Tecolote road (1.2 mi N of El Oasis) W of MEX 15, 725 m, 24 Aug 1982, *Reichenbacher 1064* (ARIZ!; mixed collection, upper buds are *I. hederacea*, the full flower at bottom is *I. nil*, ASU!). **Mpio Cucurpe:** Canyon botttom, Palm Canyon, SE of Magdalena, 1 Oct 1979, *Toolin 430*!; Floodplain near Rancho Agua Fria, E of Cucurpe, *Van Devender 6 Sep 1976*! **Mpio Hermosillo:** 15 mi S of Hermosillo, mesquite bottomland, 6 Sep 1939, *Gentry 4564*! **Mpio Huachineras:** Horconcitos, Río Huachinera, flowers blue, 6 Sep 1940, *White 3733*! **Mpio Ímuris:** 8 km NE of Ímuris on Mex. 2, mesquite scrub on slopes above rocky canyon, uncommon herbaceous vine on disturbed roadside, flowers closed at 11:30 a.m., 15 Sep 2000, *Van Devender 2000-703* (ASU!). **Mpio Moctezuma:** 18.1 km S-SE of Moctezuma on road to Tepache (SON 117), 29.6583°N, 109.6103°W, 632 m, basalt cobble plain with dwarf foothills thornscrub, uncommon herbaceous vine, flowers white with tips drying purple, 14 Sep 2006, *Reina-G. 2006-827*! **Mpio Navojoa:** Navojoa, 27 Oct 1939, *Gentry 4752a*! **Mpio San Javier:** 1.6 km NW of San Javier turnoff on Mex 16, 28°34'23"N, 109°46'09"W, 490 m, flowers blue, open at 6:47 a.m., tropical deciduous forest, 28 Aug 2000, *Van Devender 2000-481*! **Mpio Soyopa:** Yaqui River, El Toledo, 28°34'N, 109°33'50"W, 200 m, *Martin 8 Oct 1988*!; Río Yaqui bridge on MEX 16, just S of Tónichi, 200 m, 21 Sep 1997, *Reina-G. 97-943*! **Mpio Yécora:** 3 km N of Tepoca on MEX 16, tropical deciduous forest, 28°27'18"N, 109°15'38"W, 770 m, 10 Sep 1994, *Búrquez 94-090* (FTG-FAU!); 0.9 mi W of Santa Rosa, 3120 ft, 9 Aug 1976, flowers blue fading purple, *Goldberg 76-254*!; La Concepción, 29°19'25"N, 109°02'20"W, 650 m, *Trauba 18 Jul 1997* (FTG-FAU!); Santa Ana 2 km E-NE of town just beyond Bermudez Junction, 28°22'40" N, 109°08' W, 950 m, *Martin, Ottis, et al. 10 Oct 1988*! **Mpio unknown:** near 50-mile Pass, W of Rancho Verruga, 23 Oct 1932, *Shreve 6026*!

Ipomoea parasitica (Kunth) G. Don, Gen. Hist. 4:275. 1838. Type: VENEZUELA: *Humboldt & Bonpland 660* (holotype: B, microfiche!). *Convolvulus parasiticus* Kunth, Nov. Gen. Sp. (quarto ed.) 3:103. 1818 [1819].

Ipomoea perlonga B.L. Rob., Proc. Amer. Acad. Arts 21:319–320. 1894. Type: MEXICO. Jalisco: Tequila, 15 Oct 1893, *Pringle 4519* [incorrectly published as *4531*] (holotype: GH!, isotypes: BKL!, F!, GOET!, K!, MA!, NY!, P(3)!, PH!).

Herbs, annual, the stems twining, herbaceous, to 2–7 m long, with fleshy tubercles on the older parts, or smooth, glabrous or glabrate. **Leaves** 5–10 cm long, 6–9 cm wide, entire, cordate to broadly cordate, apically acuminate to rounded and cuspidate, lightly pubescent or glabrous above, mostly glabrous below. **Inflorescences** usually simple cymes, less often compound-cymose. **Flowers** 2–10. Sepals 4–6 mm long, more or less equal, the outer ones ovate to ovate-lanceolate, more or less acute and cuspidate, with small appressed-puberulent indumentum. Corollas 2.5–3 cm long, funnelform, purple, sericeous on the interplicae. **Capsules** 10–12 mm long, ovoid to ovoid-globose, reflexed, glabrous. Seeds 1–4, 6–7 mm long, narrowly ellipsoidal, brown, with small puberulent indumentum or glabrous.

Sonora.—Eastern Sonora in Chihuahuan desert, foothills thornscrub, tropical deciduous forest, and riparian in oak woodland; 260–1290 m. Flowering November to February. Although not known from the United States, its occurrence at Agua Prieta suggests that it might be found in nearby Arizona.

General distribution.—Baja California Sur, Chiapas, Chihuahua, Guanajuato, Guerrero, Jalisco, Edo. México, Michoacán, Morelos, Nayarit, Oaxaca, Sinaloa, Veracruz; Mesoamerica; Brazil, Colombia, Peru, Venezuela.

These plants contain an ecdysone that was considered at one time as a potential insecticide. Subsequently, the same or similar compounds were found in *I. nil* and became commercially known as "kaladana" (Austin 2000c).

Mpio Agua Prieta: Isolated hill NE of Sierra Anibácachi, Rancho La Calera, 10 km (by air) SW of Agua Prieta, 31.2331°N, 109.6314°W, 1287 m, uncommon annual vine on rocky slope; flowers purple, Chihuahuan desertscrub on limestone, 2 Oct 2004, *Van Devender 2004-1117*! **Mpio Álamos:** Álamos, 21 Oct 1961, *Gentry 19349*!; Algodones, 700 m, 9 Sep 1935, *Gentry 1682*! **Mpio Arizpe:** Agua Caliente, 19 km N of Ímuris, 5 km N of Mesa del Romero on Mex 15, cottonwood-willow forest in ciénega, 30.9531°N, 110.8525°W, 980 m, herbaceous vine to 3.5 m in tree, dried flowers purple, closed in midday, 15 Aug 2001, *Reina-G. 2001-656*! **Mpio Cucurpe:** Palm Canyon, 17 mi SE of Magdalena, 27 Sep 1990, *Van Devender 90-468A*! **Mpio Imuris:** Puente Caliente, Rancho Agua Caliente, 3 km S of Arizpe on SON 89, 30.3269°N, 110.1925°W, 920 m, foothills thornscrub, very common, flowers magenta with white tube, white sepals extending into corolla, 16 Sep 2000, *Reina-G. 2000-739*! **Mpio Villa Pesqueira:** 2.5 mi N of Mátape, between Mátape and Batuc, 2350 ft, 11 Sep 1941, *Wiggins & Rollins 467*! **Mpio San Javier:** W side of Sierra del Aliso, N of Cerro El Halcón, deep canyon with permanent water and *Platanus racemosa* gallery forest, 28°38'15"N, 109°43'30"W, 800 m, 31 Jul 1996, *Búrquez M. 96-328* (FTG-FAU!); Cerro Verde, SW of San Javier, 28°33'55"N, 109°44'10"W, 800 m, 30 Sep 1996, *Varela E. 96-415* (FTG-FAU!); Arroyo El Carbón, near San Javier, 28°35'N, 109°42'40"W, 700 m, 5 Oct 1996, *Varela E. 96-431* (FTG-FAU!).

Ipomoea pedicellaris Benth., Bot. Voy. Sulph. 135. 1845. TYPE: HONDURAS: Valle, Gulf of Fonseca, Tiger Island, *Sinclair s.n.* (LECTOTYPE: K!); MEXICO. GUERRERO: *Sinclair s.n.* (SYNTYPE: K!; ISOSYNTYPES: BM!, K!). Austin (1997) had not seen either of the syntypes nor had he seen the paper where Cyrillo Nelson (Fontqueria 44:58. 1996) selected the Honduras specimen as lectotype. McDonald was also in error when he annotated the Honduras specimen as the holotype in October 1982.

Ipomoea grayi Rose, Contr. U.S. Natl. Herb. 1:107. 1891. TYPE: MEXICO. SONORA: Álamos, 16–30 Sep 1890, *Palmer 710* (LECTOTYPE: US!; ISOLECTOTYPE: (2) K!); MEXICO. CHIHUAHUA: Aug–Nov 1885, *Palmer 102* (SYNTYPES: NY!, US!).

Ipomoea breedlovei L.O. Williams, Fieldiana, Bot. 32:188. 1970. TYPE: MEXICO. CHIAPAS: wooded slope 9 km N of Tuxtla Gutiérrez along road to El Sumidero, Mun. of Tuxtla Gutiérrez, alt. 2200 ft, 18 Oct 1965, *Breedlove 13871* (HOLOTYPE: F!, ISOTYPES: CAS!, DS!, MICH!).

MANTELA DE MARÍA, TROMPILLO; JÍCURE 'TWISTED YARN' (Mayo)

Lianas, perennial, the stems 2–10 m long, twining with a woody base, often winged, the younger parts herbaceous, smooth to somewhat winged, glabrous or pubescent. **Leaves** 3.5–14 cm long, 3–12 cm wide, ovate, often broadly ovate, entire or 3- or 5-lobed, chartaceous, basally cordate, apically acuminate, glabrous or pubescent on both surfaces at least near the base. **Inflorescences** cymose, axillary. **Flowers** (2–)5–15(–35). Sepals unequal; the 2 outer sepals 4–7 mm long, ovate-lanceolate, broadly elliptic to oblong, acute, muricate or more often with wings on the lower portion; inner sepals 5–8.5 mm long, obtuse to obtuse-mucronate, coriaceous, the margins scarious, glabrous or pubescent only toward the apex. Corollas 5–9 cm long, funnelform, purple, slightly pubescent at the apices of the petals. **Capsules** 10–19 mm long, ovoid, brown, apiculate, glabrous. Seeds 1-4, 6–7 mm long, ellipsoid, brown, minutely puberulent or glabrescent.

Sonora.—Central and southern parts of the state in coastal and foothills thornscrub and tropical deciduous forest; ca. 50–550 m. Flowering September to November. The seeds, ground, roasted, and boiled, were used by the Guarijíos as a purgative (Gentry 1942). The Guarijíos also used a morning glory, possibly this species, as follows: "If a woman does not wish to have a child, she will sometimes eat the seeds of *trompillo*, grinding up the seeds, mixing the gruel into water, and drinking it" (Yetman & Felger 2002:193). The Mayos consider the herbage of this fast-growing summer vine to be valuable forage for cattle and goats (Yetman and Van Devender 2002).

General distribution.—Chiapas, Chihuahua, Colima, Guerrero, Hidalgo, Jalisco, Michoacán, Morelos, Nayarit, Oaxaca, Puebla, San Luis Potosí, Sinaloa, Tamaulipas, Veracruz; Mesoamerica.

Selected reference.—Austin (1997).

Mpio Álamos: San Bernardo, 24 Aug 1935, *Gentry 1616*; Río Mayo Raft Trip, confluence of Río Mayo with San Ignacio, 27°55'N, 108°47'W, *Jenkins & Rondeau 26 Sep 1991*!; 23.3 mi by road W of Álamos, *Soule & Krizman 28 Aug 1964*!; Arroyo el Mentidero at El Chinal road, 11.3 km S of Álamos, 26°54'45"N, 108°55'05"W, 240 m, 20 Sep 1993, *Van Devender 93-855*!; Álamos, 28 Sep 1991, *Van Devender 91-755*!; Gueybampo, E edge of Arroyo Tojibampo, 26°42'30"N, 109°16'W, 50 m, 22 Sep 1994, *Van Devender 94-713*!; 0.3 km E of Tojibampo (S side of the Sierra de Álamos), 26°48'50"N, 108°58'W, 240 m, 21 Sep 1994, *Van Devender 94-659*!; Arroyo Huirotal, Rancho Las Uvalamas, E slopes of Sierra de Álamos, 550 m, vine 6–8 m in trees, flowers purple, 13 Sep 1994, *Van Devender 94-564* (ARIZ!, ASU!). **Mpio Huatabampo:** 1 km SE of Cerrillos, 9.5 km SE Melchor Ocampo, 40 m, flowers purple, 21 Sep 1994, *Friedman 347-94* (ASU!). **Mpio La Colorada:** 7 mi NE of Colorado, between Colorado and Mazatán, climbing vine to 8 or 10 m, corolla rich purple, 6 Sep 1941, *Wiggins & Rollins 323* (CAS!); 3.5 km SE de San Jose de Pimas, 8 km antes del entronque a rancho San Francisco, por carretera 16, cerca del km 76 de Hermosillo, 28°41'45"N, 110°10'25"W, 380 m, 6 Sep 1995, *Reina-G. 95-428*! **Mpio Navojoa:** Teachive de Masiaca, 75 m, 21 Sep 1994, *Van Devender 94-670*!; Near Las Guásimas, road from Navajoa–Álamos, sandy bottomlands, thorn forest, seeds used as purgative, *Mantela de Maria*, 5 Nov 1939, *Gentry 4880*!

Ipomoea pes-caprae (L.) R. Br. in Tuckey subsp. **brasiliensis** (L.) Ooststr., Blumea 3:533. 1940. Type: based on illustration by Plumier, Descr. Pl. Amer. t. 104, 1693 (lectotype!). *Convolvulus pes-caprae* L., Sp. Pl. 159. 1753. Type: herb. *Linnaeus* (LINN 218.59!).

Convolvulus brasiliensis L., Sp. Pl. 159. 1753.

BATATILLA, *CHURRISTATE DE PLAYA*; *BEJUCO DE PLAYA*; BEACH MORNING GLORY, RAILROAD VINE, GOAT-FOOT MORNING GLORY, BAYHOPS

Herbs, perennial, the stems mostly prostrate on beaches, rarely twining, fleshy, to 10 m long (usually much shorter in Sonora), glabrous, and with milky sap. **Leaves** 3–10 cm long, 5–10 cm wide, ovate to reniform, basally rounded, truncate to cordate, apically normally emarginate, the blade with 2 glands near the base. **Inflorescences** axillary, monochasial and/or dichasial. **Flowers** 1–5. Sepals 5–11 mm long, equal or unequal, elliptic, ovate-elongate to orbicular, glabrous. Corollas 5–6 cm long, funnelform, pinkish or lavender, the throat darker within, glabrous. **Capsules** 1.5–2.2 cm long, rounded, straw-colored or brown with purplish patches, glabrous. Seeds 1–4, 8–9 mm long, rounded, densely brown-tomentose. $2n = 30, 60$.

Sonora.—Cultivated on beaches from the vicinity of Bahía Kino southward and sometimes weakly established, and perhaps native or at least established on beaches along coastal thornscrub in extreme southwestern Sonora; near sea level. Flowering at least during the warmer months.

General distribution.—This species occurs on beaches and coastal dunes worldwide; subsp. *brasiliensis* is widespread in the New World tropical shores. Texas; Baja California (norte) and Sur, Chiapas, Guerrero, Jalisco, Michoacán, Oaxaca, Sinaloa, Tamaulipas, Veracruz; Mesoamerica; Brasil, Colombia, Ecuador, Guyanas, Peru, Venezuela; Caribbean. Subspecies *pes-caprae* occurs in a narrow range in the Indian Ocean. A close relative, *I. asarifolia* (Desrousseaux) Roemer & Schultes, has been introduced into wetlands in the American tropics (Austin 2005).

Selected reference.—St. John (1970).

Mpio Hermosillo: Bahía Kino, on coastal sand dunes growing wild on seaward facing aspect of dune faces, *Lindsay 12 Jun 1989*! **Mpio Huatabampo:** Huatabampito vicinity 4 km (by air) S of Moroncorit, 26.6917°N, 109.587°W, common perennial vine in sand dunes near houses, 23 Sep 1994, *Friedman 344-94* (ASU!); 1.7 km (by air) S of Las Bocas, 26.65°N, 109.331°W, sea level, solitary perennial herb in sand, milky latex when stem broken, 9 May 1996, *Friedman 43-96* (ASU!).

Ipomoea plummerae A. Gray. Syn. Fl. N. Amer., ed. 2, 1:suppl. 434. 1886. Type: U.S.A. Arizona: 1882, *Lemmon 2839* (holotype: GH!; isotype: UC(2)!).

Ipomoea egregia House, Torreya 6:124. 1906. New name for *I. cuneifolia* A. Gray. *I. cuneifolia* A. Gray, Proc. Amer. Acad. Arts 19:90. 1883. Type: U.S.A. Arizona: *Lemmon 2837* (holotype: GH!; isotypes: MO!, UC!, US!), not *I. cuneifolia* Meisn. in Mart. (1869). *Ipomoea plummerae* var. *cuneifolia* (A. Gray) J.F. Macbr., Publ. Field Mus. Publ. Nat. Hist. Bot. Ser. 11:4. 1931.

Perennial **herbs** with globose, tuberous roots, the stems erect to procumbent, ascending, not twining or only slightly at tips, glabrous. **Leaves** 1–3 cm long, orbicular in outline, palmately and pedately lobed (rarely cuneate-obovate in which case the apex is laciniate-dentate), basally cordate, the lobes acute, glabrous; petioles 2–5 mm long. **Inflorescences** solitary. **Flowers** on peduncles 1.5–2.5 cm long, erect or reflexed in fruit; bracts caduceus. Sepals unequal; outer sepals 5–8 mm long, 2–3 mm wide, oblong, obtuse to acute, mucronate, muricate at least along the midrib; inner sepals 7–9(–10) mm long, 3–4 mm wide, broadly ovate, acute to acuminate, muricate on the midrib or glabrous. Corollas funnelform, 2.5–3.1 cm long, purple, glabrous, the limb 1.8–2.2 cm wide. **Capsules** ± globose, 5–6 mm wide, with an apiculum to 5 mm long. Seeds 1–4, 2–2.5 mm long, ovoid, black to dark brown, finely tomentose.

Sonora.—At least in southern Sonora, coastal thornscrub and in pine-oak forest in southeastern Sonora near the Chihuahua border. Also southeastern Arizona near the border and expected in nearby Sonora and perhaps elsewhere in mountains in eastern Sonora. Open rocky slopes. 20–above 1250 m. Flowering April–October;

General distribution.—Arizona, New Mexico, Texas; Chihuahua, Coahuila, Distrito Federal, Durango, Hidalgo, Jalisco, Edo. México, Michoacán, Puebla, Veracruz, Zacatecas; Argentina, Bolivia, Peru. McDonald (1995) recognized several widespread varieties, with the Sonoran population being var. *plummerae*.

Although McDonald (1995) recognized var. *cuneifolia* as distinct, DFA has seen individual populations in southern Arizona with both "var. *cuneifolia*" and "var. *plummerae*" growing intermixed. We suspect that the two "varieties" are nothing more than variants in leaf shapes.

This species is easily confused with *I. capillacea*. Leaf segments are <1 mm wide in *I. capillacea*, and >1 mm wide in *I. plummerae*. Also, *I. capillacea* is an erect herb, while *I. plummerae* is a prostrate or rarely twining herb.

Selected reference.—McDonald (1995).

Mpio Álamos: Cliffs 5 km W of Chiribo, Sierra Saguaribo, 1400 m, pine-oak woods, *Martin 24 Aug 1993*. **Mpio Yécora:** Yécora, 28°22'25"N, 108°56'W, 1540 m, 6 Sep 1995, *Reina-G. 96-373*. **CHIHUAHUA. Mpio Buenaventura:** Río Santa Maria, 10 km SW of Buena Ventura [Buenaventura], 2100 m, 14 Aug 1989, *Jenkins et al. 89–311*.

Ipomoea pubescens Lam., Tabl. Encycl. 1:465. 1791 [1793]. Type: AMERICA: collector unknown (isotype: K!).

Ipomoea heterophylla Ortega, Nov. Pl. Descr. Dec. 1:9. 1707. Type: MÉXICO: horto Regio, 1797. *Ortega* (lectotype MA!, photo FTG-FAU!).
Ipomoea lindheimeri var. *subintegra* House, Ann. New York Acad. Sci. 18:196. 1908. Type: U.S.A. Arizona: *Lemmon 2835* (holotype: GH!).

Perennial **herbs** from a large, oblong root; stems twining, hirsute with retrorse trichomes. **Leaves** with blades 2–8 cm long, 2–9 cm wide, ovate, nearly entire with the margins sinuate, or 3- or 5-lobed and palmate, basally cordate, the lobes elliptic to ovate, hirsute with antrorse trichomes, at times sericeous, apically acute to obtuse, mucronate; petioles 2–5 cm long. **Inflorescences** 1- or 2-flowered. **Flowers** on peduncles 15–18 mm long; pedicels 3–10 mm long, erect in fruit; bracts 5–12 mm long, subulate, acuminate. Sepals unequal; outer sepals, 9–21 mm long, 5–11 mm wide, ovate, basally truncate, acuminate; middle sepals 9–19 mm long, 3-8 mm wide, asymmetrical, ovate, acuminate; inner sepals 9–20 mm long, 2–4 mm wide, ovate-lanceolate, antrorsely hispid, at times sericeous. Corollas 5.5–8 cm long, funnelform, blue to violet with a white throat, glabrous, the limb 6–7 cm wide. **Capsules** 10–12 mm wide, ± globose, surrounded by the sepals. Seeds (1–) 3–6, 5–6 mm long, ovoid, brown to black, densely hairy with velvety trichomes.

Sonora.—Mountains in eastern Sonora. It grows in south-central and southeastern Arizona near the border and is expected in nearby Sonora. Oak woodland and pine-oak forests, especially rocky areas and near streambeds; ca. 1200–2000 m. Flowering August–September.

General distribution.—Arizona, New Mexico, Texas; Chihuahua, Durango, Hidalgo, Michoacán, Queretaro, San Luis Potosí; disjunct to South America.

The Arizona plants have larger flower than those listed from South America by O'Donell (1959a) and there is perhaps more than one taxon involved. McDonald et al. (2011) have placed all the large-flowered plants of northern Mexico and the SW United States in *I. lindheimeri*. We cannot agree because the sepals are distinct within the populations that we have studied in Sonora and Arizona. McDonald (pers. comm., June 2012) says that he has found what appear to be hybrid swarms between the typical *I. lindheimeri* with narrow lanceolate-linear, cuneate sepals and plants of *I. pubescens* with broadly ovate, basally truncate sepals. We have not seen such populations and maintain them as separate species until future studies can be made of their relationships.

Selected reference.—Austin (1991).

Mpio Álamos: Sierra Saguaribo, Chiribo, 1400 m, *Martin 24 Aug 1993*!; Sierra Sahuaribo, ca. 2 km (by air) NE of La Vinateria, 27°17'30"N, 108°41'30"W, 1300 m, 24 Aug 1993, *Steinmann 93-275*! **Mpio San Felipe de Jesús:** Cajón Infierno, northern Sierra Aconchi, 4480–5120 ft, oak woodland, rare, one patch along streambottom in narrow part of canyon, 18 Sep 1982, *Reichenbacher 1139*! **Mpio Yécora:** Restaurant La Palmita, 9.5 km W of Restaurant Puerto de la Cruz on Mex 16 (km 258 E of Cd. Obregón), N side of Mesa del Campanero, 28°22'18"N, 109°03'53"W, 1460 m, oak woodland, locally common on grassy slope in shady canyon, flowers blue with white throat, drying magenta, open 9:00 a.m., 31 Aug 2000, *Reina-G. 2000-561* (USON!).

Ipomoea purpurea (L.) Roth, Bot. Abh. Beobacht. 27. 1797. Type: Dillenius, Hort. Eltham. 1:100. t. 84, f. 97, 1732 (lectotype!).
Convolvulus purpureus L., Sp. Pl., ed. 2, 1:219. 1762.

Ipomoea hirsutula Jacq. f., Ecl. Pl. Rar. 1:63, t. 44, 1811 [1813]. Type: no specimen known, plate is the lectotype. *Pharbitis hispida* Choisy, Convolv. Orient. 56. 1833; Mem. Soc. Phys. Genève 438. 1833, nom. illegit. pro syn.
Ipomoea diversifolia Lindl., Edward's Bot. Reg. 23:pl. 1988. 1837. Type: based on *Dickson* (holotype: if extant OXF). *Ipomoea purpurea* (L.) Roth var. *diversifolia* (Lindl.) O'Donell, Lilloa 26:385. 1953.

Tutugiochski (Pima Bajo for "blue flower")

Annual **herbs;** stems twining, simple or branched. Plants loosely strigose to tomentose with three kinds of trichomes: short and appressed; retrorse and often large; and antrorse, oblique to erect trichomes that reach 4 mm long. **Leaves** 1–11 cm long, 1–12 cm wide, ovate, ±3-lobed or rarely 5-lobed, also entire, basally cordate, apically acute to acuminate, rarely obtuse, mucronate; petioles 1–14 cm long. **Inflorescences** cymose, axillary. **Flowers** (1–) 2–5, on pedicels 5–16 mm, erect in flower, reflexed and enlarged in fruit, reaching 25 mm long. Sepals ± equal; outer sepals 8–15 mm long, (1.5–) 2.5–4.5 mm wide, ovate-lanceolate or narrowly ovate-lanceolate to elliptic, acute to abruptly acuminate apically, more pubescent near the base; inner sepals 8–15 mm long, 2.5–3 mm wide, ovate-lanceolate, acute to abruptly acuminate. Corollas 2.5–4.3(–5) cm long, funnelform, glabrous, blue (white to purple in cultivated plants), white within the tube, the limb 2.4–4.8(–7) cm wide. **Capsules** ± globose to ovoid, 7–8(–10) mm wide, with an apiculum 2–4 mm long, 6-valvate. Seeds 3–6, 4–5 mm long, ovoid, black to dark brown, finely tomentose. $2n = 30$.

Sonora.—Widespread across the state except in the desert in the northwest; Sonoran desert, tropical deciduous forest, oak woodland, often in disturbed sites, cultivated fields, and grown as an ornamental. Flowering July–November; 100–2300 m.

General distribution.—Pantropical, widespread in North America, including Arizona, New Mexico, Texas; probably naturalized from Mexico where it is documented in all states except Baja California (norte) and the Yucatan peninsula.

This is an unusually variable species, at least in part due to cultivation. Cultivated forms are larger than the wild forms, but the size of flowers and sepals may vary even in the wild plants (see discussion under *I. nil*).

Mpio Álamos: Álamos, cultivated annual on fence near house, 20 Sep 1993, *Van Devender 93-822*! **Mpio Cananea:** 3 km S-SE of Cananea on Son 89, 30.9819°N, 110.2431°W, 1565 m, common in disturbed roadside, flowers closed at 5:20 p.m., 15 Sep 2000, *Van Devender 2000-676*! **Mpio Cumpas:** 5 km ESE of Jécori, road to Moctezuma, 26 Oct 1984, *Felger 84-379*! **Mpio Soyopa:** Loma Maderista, 3.5 km S of Tonichi, W side Río Yaqui, foothills thornscrub, 28°34'03"N, 109°33'25"W, 220 m elev, *Van Devender 2110-192*! **Mpio Yécora:** Yecora, 28°22'25"N, 108°56'W, 1540 m, in yard, 20 Oct 2000, *Reina-G. 2000-861*!; Along Arroyo El Kipor (Quipor), E of El Kipor on trail to Tierra Panda, 28°24'N, 108°33'35"W, 1640 m, 10 sep 1995, *Van Devender 95-943*!; Mesa de los Coronados, S side of Mesa del Campanero, 28°19'31"N, 109°01'40"W, 2100 m, flowes blue with lavender throat and white base, turning magenta, open 10:00 A.M, 1 Sep 2000, *Van Devender 2000-581* (ASU!).

Ipomoea quamoclit L., Sp. Pl. 159. 1753. Type: INDIA: herb. Clifford: 66, Ipomoea 1 (lectotype: BM-000558077!).

Convolvulus pennatus Desr. in Lam., Encycl. Méth. Bot. 3:567. 1789 [1792]. Type: Cette plante croît dans les Indes orientales, & est cultivée au Jardin du Roi (there are 2 sheets at P-LAM!, the one with the label in the lower left corner annotated as "Dict. no. 107" chosen here as lectotype; the second sheet is an isolectotype). *Quamoclit pennata* (Desr.) Bojer, Hortus Maurit. 224. 1837.

Quamoclit vulgaris Choisy, Mem. Soc. Phys. Genève 6:434. 1834. New name for *I. quamoclit* L.

Star morning glory, star glory

Herbs, annual, herbaceous, the stems twining to 5 m long, glabrous, or sometimes with glandular trichomes on the leaf surface (e.g., *Wiggins & Rollins 374*). **Leaves** 1–9 cm long, 0.5–4.5 cm wide, pinnatisected, with 9–19 pairs of linear lobes, glabrous. **Inflorescences** in monochasial cymes. **Flowers** 1–3. Sepals unequal, the outer sepals a little shorter than the inner ones, 4–8 mm long, elliptic, mucronate, glabrous. Corolla 2–3 cm long, salverform, red, glabrous. **Capsules** 6–10 mm long, conic, brown, glabrous. Seeds 1–4, 4–5 mm long, pyriform, black, with patches of short trichomes. $2n = 30$.

Sonora.—Southeastern and east-central Sonora. Tropical deciduous forest, often in thickets and edges of forests; 220–1500 m. Flowering June–October.

General distribution.—Texas, southeastern United States; Baja California Sur, Chiapas, Chihuahua, Guerrero, Jalisco, Edo. México, Michoacán, Nayarit, Oaxaca, Sinaloa, Tabasco, Veracruz, Yucatan; Mesoamerica; Argentina, Bolivia, Brasil, Colombia, Ecuador, Guyanas, Peru, Paraguay, Venezuela; Caribbean; introduced to the Old World and cultivated.

This species was almost certainly brought into cultivation by the Aztecs of central Mexico. The specific name has been claimed to be derived from the Greek *kuamos*, bean, and *klitos*, low, dwarf (De Théis 1810:242), but that is incorrect. In fact, the Oxford English Dictionary (OED online 2012) notes that the name came from Nahuatl; it was in European literature by the middle 1550s and on a herbarium specimen from 1583.

Mpio Álamos: Canyon Estrella, Álamos, 1 Oct 1933, *Gentry 408M*!; Álamos, 28 Oct 1939, *Gentry 4760* (MO!); San Bernardo, 15 Oct 1934, *Gentry 1059* (MO!); Arroyo Guajaráy, 310 m, 15 Mar 1994, *Fishbein 1560*!; Güirocoba crossing of Río Cuchujaqui, 12.3 km (by air) SSE of Álamos, 26°56'15"N, 108°53'W, 260 m, 4 Oct 1992, *Van Devender 92-937* (ASU!); Arroyo Los Cochis, NW side of La Gacela, 26°52'20"N, 108°52'10"W, 220 m, 2 Dec 1994, *Van Devender 94-876*!; El Guayabo crossing of Río Cuchujaqui, 2.6 km NE of Sabinito Sur, 14 km (by air) E-SE Álamos, 12 Oct 1992, *Van Devender 92-1227*! **Mpio La Colorada:** 10 mi S of Mazatán, between Mazatán and Colorado, herbage viscid, 7 Sep 1941, *Wiggins & Rollins 374* (ARIZ!, CAS!, MO!). **Mpio Sahuaripa:** Arroyo la Ventana, Rancho La Ventana, 32.6 km (by air) NNE of Sahuaripa, northern Jaguar Reserve, 29.3225°N, 109.10194°W, 745 m, rocky canyon, riparian forest in rocky stream canyon, foothills thornscrub on slopes, 1 Sep 2009, *Reina-G. 2009-698*! **Mpio Yécora:** 2.7 mi W of Santa Ana de Yécora, 2315 ft, 11 Aug 1976, *Goldberg 76-285*!; About 1.5 mi W of Santa Rosa, between mine and town, ca. 2770 ft, 10 Aug 1976, *Goldberg 76-258*!; E-NE of Santa Rosa just beyond Bermúdez Junction, 28°22'40"N, 109°08'W, *Martin 10 Oct 1988*!; 3 km NE of Santa Ana, 960 m, 9 Sep 1996, *Reina-G. 96-556*!

Ipomoea scopulorum Brandegee, Zoë 5:169. 1903. Type: MEXICO. Baja California [Sur]: Cape Region, 1902, *Brandegee s.n.* (holotype: UC!, photo FTG-FAU!).

Perennial twining **herbs,** with tuberous roots?, 1–2 m long, sparsely to densely pubescent throughout with simple and stellate trichomes. **Leaves** 6–8 cm long, 4–6 cm wide, cordate-ovate, entire, stellate-pubescent above and below; petioles 2–5 cm long. **Inflorescences** cymose or solitary, axillary. **Flowers** on peduncles 2–9 cm long, the pedicels 2–3 cm long, erect in fruit; bracts 2–3 mm long, subulate, caducous. Sepals 7–10 mm long, 4–6 mm wide, unequal, broadly oblong to broadly ovate, smooth, rounded to obtuse, the upper margins somewhat scarious, glabrous or less often sericeous on the outside of the outer two sepals. Corollas 6–8 cm long, 6–7 cm wide, funnelform, white with a purple throat or less often purplish throughout, glabrous. **Capsules** ovoid, 10–14 mm long, 8–10 mm wide. Seeds 1–4, 6–8 mm long, ovoid, brown, silky, with white or tawny trichomes 8–10 mm long on the margins, otherwise glabrous.

Sonora.—Southern to north-central parts of the state; Sonoran desert, coastal and foothills thornscrub, and tropical deciduous forest; 150–725 m. Flowering August–September.

General distribution.—Baja California Sur, Sinaloa.

Mpio Álamos: 2 mi N of Taymuco, corolla white with purple throat, 9 Aug 1980, *Lehto 24800* (ASU!); San Bernardo, large white flowers, attracting bees and small butterflies, 13 Aug 1934, *Gentry 1574*! (ARIZ!, MO!); 5 mi S of junction of Álamos–Navojoa road and road to Mocazari [Macúzari] Dam, *Warren & Goldberg 17 Aug 1975*! **Mpio Cajame:** Ciudad Obregón, malapias promontory in foothill valley, 29 Sep 1933, *Gentry 280*! **Mpio Carbó:** 12.3 mi by Tecolote Rd (1.2 mi N of El Oasis) W of Mex Hwy 15, 725 m, 29°46'40"N, 111°15'00"W, 22 Aug 1982, *Reichenbacher 1058*! **Mpio Huatabampo:** 9 km S of Estación Luis, 1 km W of Francisco Sarabia, Sinaloan thornscrub, 150 m, flowers white, 14 Aug 1994, *Friedman 221-94*!; 2.5 mi W of Hwy 15 on Hwy 176 to Huatabampo, ca. 14 mi (airline) E of Huatabampo, 109°24.5'W, 26°50'N, 50 m, coastal thorn scrub on flats, 7 Oct 1992, *Sanders 12706* (UCR!). **Mpio Navojoa:** Summit of Cerro Prieto, 15 km E of Navojoa, thorn forest, 400 m, flowers white, this plant wilts very quickly when cut, 5 Sep 1989, *Sanders 9261*!; SSW of Cerro Masiaca, E side of Hwy 15, 8.8 mi S of jct with Hwy 176, near 26°45'N, 109°18'W, 50 m, alluvial slope with thorn scrub forest, solitary vine growing 1.5 m high on a tree, 7 Oct 1992, *Sanders 12695* (UCR!). **Mpio Sahuaripa:** 8 km N of Río Yaqui on road to Tepache, tropical riparian in deep canyon with foothills thorncrub on slopes, 29°14'55"N 109°18'51"W, 422 m, solitary vine in shady area, flowers white, deep purple inside throat, open at 9:00 a.m., 17 Aug 2003, *Reina-G. 2003-937*! **Mpio Soyopa:** Río Yaqui, 0.5 km S of Hwy 16 crossing, Arroyo Garambullos, 28°34'N, 109°33'W, cliff face in riparian tropical deciduous forest with *Merremia palmeri*, 200 m, 14 Aug 1998, *Fishbein 3573*!; Arroyo Los Garamullos, 21 Aug 2000, *Reina-G. 2000-473*!; Río Yaqui bridge on MEX 16, just S of Tónichi, 200 m, 21 Sep 1997, *Reina-G. 97-968*! **CHIHUAHUA. Mpio Maguarichi:** Guasaremos, oak slope, flowers white, 5 Aug 1935, *Gentry 1558*!

Ipomoea seaania Felger & D.F. Austin, Sida 21:1296. 2005. Type: MEXICO. Sonora: Municipio Guaymas. Broad canyon, ca. 1 km north of Bahía San Carlos on old road to Bahía Algodones, 27 Feb 1985, *Felger & Devine 85-301* (holotype: ARIZ!; isotypes: MEXU!, MO!, NY! See label information below).

Openly-branched **shrubs** 1–4 m. tall, with multiple woody stems from the base, the upper twigs sometimes sinuous or moderately spiraling, sometimes becoming extremely slender. Herbage largely glabrous or glabrate except newest growth densely to sparsely short-pilose, the trichomes mostly spreading. **Leaves** drought deciduous, lanceolate to ovate, long shoot leaves often 2–8 cm long, 1.5–2 cm wide, the blades lanceolate to ovate, with 6–8(–10) lateral pairs of primary veins, the base obtuse to subtruncate, the apex obtuse to emarginate, the midrib often ending in a short mucrone, glabrous; petioles 8–15(–20) mm long, with a pair of glands, usually conspicuous, at the junction of petiole and blade, seen on the lower leaf surface. Spur branch leaves often 4–8 cm long, to 4–11 mm wide, linear to linear lanceolate with 6–10 lateral pairs of primary veins, the base obtuse to subtruncate, the apex obtuse or blunt, or sometimes shallowly emarginate, the midrid often ending in a short mucrone; petioles to 2–9(–13.5) mm long. **Inflorescences** of 1 or 2 (3) flowers, appearing solitary but cymose on short-shoots 2–5 mm long, these sometimes with a few small leaves; bracts 5–8 mm long, quickly deciduous, broadly oblong with an obtuse tip; peduncles very short, to 5 mm long, the pedicels 8–22 mm long. **Sepals** 12–17 mm long, 6–8 mm wide, broadly lanceolate to mostly ovate, puberulous to villous, the inner surfaces generally more densely hairy than the outer surfaces, the trichomes white, appressed to mostly ascending, and curly to straight. Inner (adaxial) sepals obtuse, the surfaces with trichomes 0.15–0.6 mm long; outer (abaxial) 2 sepals acute, slightly narrower and more sparsely pubescent than the inner 3, the trichomes 0.1–0.5 mm long, the sepal margins scarious and glabrous or glabrate. **Corollas** 4–6 cm long and 7–8 cm wide, showy, funnelform, glabrous, white with yellowish interplicae and a maroon band at inside base of the tube. Stamens 5, with 4 filaments 25–26 mm. long, the fifth stamen 23–24 mm long, filaments pubescent on the basal 4 mm; anthers 6–7 mm, long oblong, sagittitate; pollen spheroidal, spinulose. Ovary 3 mm long, glabrous; style 37–38 mm long, glabrous; stigma 2-globose.

Sonora.—Near the southern margin of the Sonoran desert where it is endemic to hills and mountains west of Bahía San Carlos, generally on rocky ridges, steep colluvium and rhyolite slopes of canyon sides and cliff base; near sea level–100 m. Although locally common, the San Carlos population is threatened by tourist development (Felger 1999). There are no other records for this unusual shrub. Flowering January–April.

Mpio Guaymas: Road outside Bahía San Carlos, 10 m, cliff base in hardened volcanic soil, NW slope, with *Euphorbia ceroderma, Mascagnia macroptera, Acacia willardiana*, open shrub, 1–1.5 m tall, 21 Feb 1977, *Ames 77-60* (paratype!); Between San Carlos Bay and Catch-22 airstrip, near sea level, 5 Jan 1983, *Daniel 2360!*; Road between San Carlos Bay and Catch-22 airstrip, 8 Mar 1985, *Daniel 3986* (CAS!); Canyon, ca. 4 km N of Bahía San Carlos, steep rocky canyon with dense desertscrub, shrub 1.8 m tall, scattered, not common, 6 Sep 1980, *Felger 80-36* (paratype!); Broad canyon, ca. 1 km N of Bahía San Carlos on old road to Bahía Algodones, 27.958889°N, 111.0625°W, 15 m, rhyolitic hillside, ca. 5 m above canyon bottom with riparian vegetation, sense desertscrub with ca. 60% cover of perennials: [38 associated species of perennials listed on the herbarium label]; shrub 2–3 m tall, in full flower, corollas white, locally common on steep rock hillsides, 27 Feb 1985, *Felger 85-301* (isotype!); 0.1 mi N of N end of San Carlos Bay, W-facing slopes above bay, 15 m, Sonoran desertscrub, shrub 2–3 m tall, 10 Oct 1985, *Felger 85-1232* (paratype!); San Carlos Bay, a canyon one mile N of the bay near Cerro Los Algodones, along the road to Rancho La Manga, 27.97°N, 111.07°W, 90 m, rocky volcanic ridge and adjacent stony canyon bottom: *Bursera, Prosopis, Jatropha, Croton sonorae, Acacia willardiana*, etc, scarce large shrub about 12 feet high with many stems from base, on floor of canyon above wash, flowers white with yellowish star pattern and maroon band in throat, 22 Mar 1983, *Sanders 3616*! (paratypes, ARIZ!, TEX!, UCR!).

Ipomoea sescossiana Baill., Bull. Mens. Soc. Linn. Par. 1:385. 1883. TYPE: MEXICO. SAN LUIS POTOSÍ: *Sescosse s.n.* (HOLOTYPE: P, not seen; ISOTYPE: US! ex herb. P).

Ipomoea pringlei A. Gray, Proc. Amer. Acad. Arts 22:307. 1887. TYPE: MEXICO. CHIHUAHUA: foot-hills of the Santa Eulalia and Mapula Mountains, 7 Sep 1886, *Pringle 782* (HOLOTYPE: GH!; ISOTYPES: BR!, GOET!, K!, LL!, MA!, MO!, NY!, P!, PH!, RSA!, TEX!, US!).

ROMERIA DE LA SIERRA

Perennial erect **herbs,** with tuberous roots, the stems shrubby, spreading, glabrous. **Leaves** 2–4 cm long, 0.5–1.5 cm wide, orbicular in outline, irregularly pinnately divided into 5–9 obtuse-tipped divisions, the lobes linear to filiform, entire or rarely toothed, glabrous; petioles 3–15 mm long. **Inflorescences** mostly of solitary flowers, at times 2 or 3 flowers. **Flowers** on peduncles 0.8–3.5(–8) cm long, the pedicels 0.6–1.5 cm long, accrescent and erect in fruit; bracts 2–3 mm long, lanceolate. Sepals 6–11(–13) mm long, 3–6(–8) mm wide, subequal, oblong-ovate, smooth, obtuse-rounded to emarginate or cuspidate, the margins scarious. Corollas 6–10 cm long, funnelform, rose-purple to purple, the tube whitish, glabrous, the limb 6–8 cm wide. **Capsules** 14–16 mm long, 10–14 mm wide, ovoid to almost globose. Seeds 1–4, 8–9 mm long, compressed ovoid, black, finely appressed tomentose.

Although not documented for Sonora, it occurs in Chihuahua near high elevations in east-central Sonora and is likely to turn up in the highlands of easternmost Sonora.

General distribution.—Chihuahua, Coahuila, Durango, San Luis Potosí, Zacatecas; 1000–2400 m. Flowering June–October.

This species is an erect herb with bee-flowers. This xenogamous species is sister to *I. ancisa* and *I. stans* (McDonald 2001; Ana Rita Simões, pers. comm. 23 Nov 2011).

CHIHUAHUA. Mpio Moris: La Cieneguita, Río Mayo Upper Sonoran, 10 Sep 36, *Gentry 2648*! [ca. 35 km E of Sonora]; **Mpio Madera:**

Chuichupa, Aug 1936, *Harde LeSueur 850*! [ca. 25 km E of Sonora]. **Mpio Temosachi:** NW of Yepómera on hwy 180, 2100 m, flowers mostly white, 31 Aug 1989, *Mayfield 274*! [84 km E of Sonora]; 1 mi beyond Madera junction 5 mi N of Yepómera, Río Yaqui region, 5500 ft, flower pale lavender, shrub, *Jenkins, Martin, & Moore 21 Jul 1986*!

Ipomoea tenuiloba Torr., Rep. U.S. Mex. Bound., Bot. 148–149. 1859. TYPE: U.S.A. TEXAS: hills and rocky places near Puerto de Paysano, Sep, *Bigelow* et al. (HOLOTYPE: NY!; ISOTYPE: US!).

Ipomoea lemmoni A. Gray, Proc. Amer. Acad. Arts 19:20. 1883. TYPE: U.S.A. Arizona [Cochise Co.] Near Fort Huachuca, cienega, Tanner's C[anon?] [Garden Canyon, Huachuca Mountains,] 1882, *Lemmon 2840* (HOLOTYPE: GH!, ISOTYPES: P!, US!). *Ipomoea tenuiloba* Torr. var. *lemmoni* (A. Gray) Yatsk. & C.T. Mason, Madroño 31:102. 1984.

Ipomoea leptosiphon S. Watson, Proc. Amer. Acad. Arts 23:280. 1888. TYPE: MEXICO. CHIHUAHUA: foothills of Sierra Madre, 1 Sep 1887, *Pringle 1337* (HOLOTYPE: GH!, photo F!; ISOTYPES: F!, K!, NY!, PH!, TEX!, US!)

Perennial **herbs,** with tuberous roots, the stems prostrate but twining near the tips, glabrous. **Leaves** 1–7 cm long, 3–10 cm wide, orbicular in outline, pedately 5–9 lobed, the lobes linear to lanceolate, 0.5–6.5 mm wide, entire, glabrous; petioles 2–38 mm long. **Inflorescences** mostly of solitary flowers. **Flowers** on peduncles 1–39 mm long, sessile or the pedicels to 8 mm long, recurved in fruit; bracts 1–3 mm long, linear to deltoid-attenuate. Sepals unequal; outer sepals 5–11.5 mm long, 2–3 mm wide, oblong-lanceolate, muricate along the midrib or almost smooth, the margins scarious, mucronate; inner sepals 8–9 mm long, 3–4 mm wide, obovate-acuminate, smooth, the margins scarious, glabrous. Corollas 4.5–10 cm long, funnelform or salverform, completely white or white with pale rose to purple limb, glabrous, the limb 3–3.6 cm wide. **Capsules** 4–8 mm wide, ± globose to broadly ovoid, with an apiculum 4–5 mm long. Seeds 1–4, 3.5–5 mm long, ovoid, black to dark brown, finely appressed tomentose. This delicate twiner has moth flowers that McDonald (2011) considered xenogamous.

Sonora.—Documented in Sonora with four specimens from mountains in the eastern part of the state, in hills and rocky sites, oak woodland and pine-oak forest; ca. 1280–1950 m. Flowering August–September.

General distribution.—Arizona, New Mexico, Texas; Chihuahua.

Two varieties are recognizable: Variety *tenuiloba* with 5–7 leaf divisions to 1.2 mm wide, a mostly white salverform corolla 6.5–10 cm long and the free portions of the filaments 8–11 mm long. Variety *lemmoni* (A. Gray) Yatsk. & Mason with 7–9 leaf divisions to 6.5 mm wide, a funnelform corolla 3.5–6.5 cm long, with a white tube and rose to purple limb and the free portion of the filaments 14–19 mm long. In some areas these varieties intergrade, and a specimen from northeast Sonora (*White 3474*) was considered an intermediate by Yatskievych and Mason (1984). The species is nocturnal and those studied in southern Arizona opened about 1:00 a.m. and often closed before dawn (Austin 1991).

Mpio Álamos: Sahuaribo and vicinity, 27°19'N, 108°34'W, 1550 m, *Martin 23 Aug 1992*! **Mpio Bavispe:** Sierra el Tigre, Las Tierritas de El Temblor, pine zone, 18–24 Aug 1940, *White 3474*! **Mpio Yécora:** 16.7 km NE of Yecora on Mex 16, grassland on rocky slope in oak woodland, 28.38°N, 108.8258°W, 1410 m, very common herbaceous perennial in dense herbs, flowers lavender with white throat, drying magenta, open at 9:30 a.m., 2 Sep 2000, *Van Devender 2000-640* (USON!); Yécora, 28.3636°N, 108.9228°W, 1540 m, grassland, locally common prostrate vine among bunch grasses, flowers white, open at 7:00 a.m., 5 Sep 2001, *Van Devender 2001-844*!

Ipomoea ternifolia Cav. var. **leptotoma** (Torr.) J.A. McDonald, Harvard Pap. Bot. 1:120. 1995. TYPE: MEXICO. SONORA: near Santa Cruz Valley. Sep 1851, *Thurber 977* (LECTOTYPE: GH!; ISOLECTOTYPE: NY!); 1851–52, *Wright 1614* (SYNTYPE: NY!; MO!, K!, mounted with *Palmer 231*). *Ipomoea leptotoma* Torr., Rep. U.S., Mex. Bound., Bot. 2(1):150. 1859. House (1908: 235) wrote that the *Thurber 977* specimen at GH was the "type." We consider all this as evidence that House effectively selected the *Thurber 977* specimen as the lectotype and that McDonald's (1995) selection of *Wright 1614* as the lectotype was superfluous.

Ipomoea divergens House, Muhlenbergia 3:40. 1907. TYPE: MEXICO. SONORA: Guaymas, 1887, *Palmer 231* (HOLOTYPE: US!, ISOTYPES: K!, GH!).

Ipomoea leptotoma var. *wootoni* Kelso, Rhodora 39:151. 1937. TYPE: U.S.A. ARIZONA: Santa Rita Mountains, 10 Sep 1914, *Wooton* (HOLOTYPE: US!).

Annual **herbs,** with a fibrous root system; stems slender and procumbent, twining at tips, glabrous. **Leaves** with blades pedately 5 or 7 parted, 1.5–3 cm long and wide, basally cordate, the segments linear, apically acute, glabrous to remotely setose; petioles to 2 cm long. **Inflorescences** of solitary flowers or cymose. **Flowers** 1 or 2, the peduncles slender, equaling or exceeding the leaves, the pedicels (10–)15–18(–20) mm long, erect in fruit; bracteoles 2–2.5 mm long, subulate. Sepals unequal; outer sepals 8–9 mm long, 2–3 mm wide, lanceolate; inner sepals 10–11 mm long, 3–4 mm wide, attenuate-acuminate, glabrous or hirsute at least on the three main veins and along the margins, otherwise membranaceous. Corollas 2.5–3.2 cm long, funnelform, purple (occasionally white), glabrous, the limb 3.2–4.6 cm wide. **Capsules** 3–5 mm wide, ellipsoid to ovoid depending on the number of seeds, with an apiculum 5 mm long or longer. Seeds 1–4, 5–6 mm long, ovoid, black and gray mottled, minutely appressed tomentose.

Sonora.—Statewide except the northwest; Sonoran and Chihuahuan deserts, foothills thornscrub, tropical deciduous forest, mesquite-grassland, and oak woodland; near sea level–ca. 2000 m. Flowering January and June–November.

General distribution.—The species, with 3 allopatric varieties, is widespread in deserts and tropical deciduous forests of southwestern United States to El Salvador. Variety *leptotoma*, the northernmost one, occurs in southeastern Arizona, southwestern Chihuahua, and most of Sonora and Sinaloa, and Baja California Sur. This species is self-incompatible and bee pollinated (McDonald 1995; McDonald et al. 2011).

Selected reference.—McDonald (1995).

Mpio Agua Prieta: Colonia Morelos, 2600 ft, 5 Oct 1941, *White 4619*! **Mpio Álamos:** Álamos, 16 Oct 1936, *Gentry 2928*!; 3.7 km N of Güirocoba, 450 m, abundant annual in field, flowers white, 23 Sep 1994, *Van Devender 94-759*!; El Guayabo (upper) crossing of the Rio Cuchujaqui 3 km NE of Sabinito Sur and 15 km (airline) ESE of Álamos, near 27°00'N, 108°47'W, 350 m, tropical deciduous forest, 12 Oct 1992, *Sanders 12891* (UCR!). **Mpio Babiácora:** 5 km W-SW of Mazocahui on SON 89, 29°31'31"32N, 110°08'07"W, 635 m, ocassional annual vine with white flowers among abundant purple-flowered plants on disturbed roadside, flowers open 3:45 p.m., foothills thornscrub, 16 Sep 2000, *Reina-G. 2000-714*!, *2000-715*! **Mpio Benjamín Hill:** 5 mi S of Benjamín Hill, 740 m, 8 Oct 1985, *Felger 85-1066*! **Mpio Cananea:** S side Sierra Mariquita, ca. 10 km NW of Cananea, ca. 2000 m, 1 Sep 1996, *Shortman 96-11*! **Mpio Carbó:** Hermosillo-Nogales road W of Carbo, 2 Sep 1934, *Shreve 6794*!; Rancho el Carrizo, 2400 ft, *Tomelson 7 Aug 1968*!; 2 km S of Los Chinos, 23 km N of El Oasis, foothills thornscrub, 665 m, flowers lavender, drying magenta, open 2:00 p.m., 6 Jan 2001, *Van Devender 2001-14*! **Mpio La Colorada:** 3 mi E of La Colorada, 1300 ft, 12 Jan 1981, *Fischer 6869*!; 4 km W of Cobachi (dirt road between paved roads to Tecoripa and Mazatan, *Van Devender 23 Nov 1978*! **Mpio Cucurpe:** Rancho Agua Fría, flowers white, *Van Devender 6 Sep 1976*!; 4 mi SW of Agua Fria, 30°19'N, 110°36'W, *Martin 3 Sep 1983*! **Mpio Cumpas:** 5 km ESE of Jécori, road to Moctezuma, 26 Oct 1984, *Felger 84-380*! **Mpio Fronteras:** 2.6 mi road S of Esqueda, mesquital, nocturnal purple flowers, 4200 ft, 7 Sep 1960, *Felger 4048*! **Mpio Guaymas:** Arroyo Las Pirinolas, road from Rancho San Antonio to Rancho San José de Robinson, 28.1112°N, 111.036667°W, 100 m, *Felger 01-742*! **Mpio Hermosillo:** La Puerca, 4 mi SW, between Hermosillo and Tastiota, along an arroyo, 4 Sep 1941, *Wiggins & Rollins 280*!; 1 km W of Los Horcones, 10 km W of San José de Pimas on MEX 16, 28.7431°N, 110.4197°W, 400 m, locally common albino-flowered (white fading to lavender) individuals, abundant purple-flowered annuals, roadside, Sonoran deserscrub, 9 Sep 1999, *Reina-G. 99-382A*! **Mpio Huatabampo:** 9 km SW of Melchor Ocampo, 40 m, common annual vine on shrubs, flowers purple, *Friedman 409-94* (ASU!). **Mpio Ímuris:** Agua Caliente, 19 km N of Ímuris on Mex 15, cottonwood-willow forest in ciénega, 980 m, flowers lavender with white tube, open 10:40 a.m, 4 Sep 2000, *Van Devender 2000-671*! **Mpio Moctezuma:** Moctezuma, 29.799°N, 109.677°W, 620 m, flowers lavender-pink with white throat, open 8:00 am, 14 Aug 2006, *Reina-G. 2006-468*! **Mpio Navojoa:** Summit of Mesa Masiaca microwave tower 6.5 km (by air) W-NW of San Jose de Masiaca, 26.78170°N, 109.295°W, 200 m, 19 Jan 1995, *Friedman 154-95* (ASU!); 2 km N of Teachive, SW end of Cerro Terúcuchi, foothills thornscrub, 26°48.1'N, 109°14.4'W, 100 m, 28 Sep 1996, *Reina-G. 96-582*! **Mpio Opodepe:** 5.6 mi on Méx Hwy 15 S of Benjamín Hill, 30.067°N, 111.083°W, 8 Oct 1985, *Felger 85-1066*! **Mpio Pitiquito:** 20 mi S of Pitiquito, 23 Oct 1932, *Shreve 6025*! **Mpio Soyopa:** El Novillo, 350 m, 24 Oct 1984, *Felger 84-247*!; Tónichi, hills above river, *Spicer 9 Sep 1941*!; Just S of Tónichi, 200 m, flowers purple, 21 Sep 1997, *Reina 97-966*!; 1.5 km S of Tónichi, 180 m, flowers lavender, open midday, 7 Jan 2001, *Reina 2001-28*! **Mpio Santa Cruz:** Rancho Los Fresnos, reserve in upper San Pedro River drainage, along US-Mexico border, 31.3206°N, 110.367°W, 1555 m, grassland with isolated patches of oak-mesquite woodland, corolla pink, 22 Sep 2006, *Boyle 7895*! **Mpio Trincheras:** Trincheras, 30°23'38"N, 110°31'43"W, *Meling 1 Oct 1986* (USON!). **Mpio Ures:** Ures, 29°25'30"N, 110°23'21"W, *Meling 19 Sep 1986* (USON!).

Ipomoea thurberi A. Gray, Syn. Fl. N. Amer. 2:212. 1878. Type: U.S.A. Arizona: *Thurber 966* (holotype: GH!).

Ipomoea gentryi Standl., Field Mus. Nat. Hist. 22:46. 1940. Type: MEXICO. Chihuahua: *Gentry 2497* (holotype: F!; isotype: MO!).

Glabrous perennial twining **herbs,** from an elongate, tuberous root, the stems trailing. **Leaves** with blades 1–5 cm long, 2–6.5 cm wide, sagittate to pedately 5 or 7 lobed, the lobes divergent, lanceolate, linear to oblong, basally sagittate, sparsely strigose; petioles 0.9–2 cm long. **Inflorescences** solitary. **Flowers** on peduncles 3–4 mm long, the pedicels 7–8 mm long, erect in fruit; bracts ca. 1 mm long, scale-like. Sepals 12–15 mm long, 3–4 mm wide, ± equal, lanceolate, acuminate apically, smooth, setaceous-caudate, obscurely warty at base or not. Corollas 5–8 cm long, funnelform-salverform, white with a rose limb and green tube (drying purple), opening in the evening, glabrous, the limb 5–6.5 cm wide. **Capsules** 6–7 mm wide, ± globose to ovoid, with an apiculum 4–5 mm long. Seeds 3–6, 3.5–4 mm long, ovoid, black to dark brown, finely tomentose.

Sonora.—Mountains of eastern Sonora in grassland, oak woodland, and pine-oak forest; at least 1150–1600 m. Flowering July–September. The flowers open at dusk when they are visited by hawkmoths, perhaps *Hyles lineata* and probably others. Also near the Sonora border in Cochise and Santa Cruz Counties in Arizona but not common.

General distribution.—South-central and southeastern Arizona; Chihuahua, Durango, apparently disjunct to Distrito Federal, Chiapas; Guatemala, Nicaragua.

Mpio Álamos: 1 mi E of Saguaribo, 1575 m, 23 Aug 1993, *Fishbein 1345*!; Rancho Santa Bárbara, 27°07'N, 108°43'W, 1200 m, *Smith & Rascon 18 Jul 1990*! **Mpio Bavispe:** Cañón de la Palomita, grassland, N of El Tigre, 3700 ft, 28 May 1941, *White 4159*! **Mpio Cananea:** Sierra de los Ajos, Hwy 89, 6.8 mi S of Arroyo Los Ajos, 30°51½'N, 110°04½'W, 1325 m, 26 Jul 1993, *Fishbein 1231*! **Mpio Nogales:** 10 km NW of Rancho El Diamante (on road to Saric from Mex 15), dense ocotillo scrub, 31°12'10"N, 111°507'12"W, 1176 m, rare, 17 Aug 2004, *Van Devender 2004-898*! **Mpio San Felipe de Jesús:** Vicinity El Llano, 9.5 mi W of San Felipe, Sierra de los Locos, *Hole & Martin 11-12 Aug 1980*! **Mpio Santa Cruz:** 3.5 km E of Nogales on road to Santa Cruz, 31.3167°N, 110.8817°W, 1215 m, common perennial vine on rocky, grassy slope, buds pale pink in late afternoon, grassland/oak woodland, 15 Aug 2001, *Reina-G. 2001-645*! **Mpio Sahuaripa:** Mesa Encinosa, 32.8 km (by air) NNE of Sahuaripa, Northern Jaguar Reserve, 29.3328°N, 109.1297°W, 1188 m, rocky mesa and slopes, open oak woodland, 7 Sep 2009, *Van Devender 2009-1052*! **Mpio Yécora:** Yécora, 1540 m, 7 Sep 1995, common annual in dense herbs, flower light pink, open mid-afternoon, *Van Devender 95-849*!; 4.7 km N of Yécora on road to Agua Blanca, 28°24'44"N, 108°55'29"W, 1570 m, 15 Jul 1997, *Reina-G. 97-7117* (FTG-FAU!); Arroyo Hondo, 4 km W of Chihuahua border, pine-oak forest, flowers light pink, late afternoon, 6 Aug 2000, *Reina-G 2000-365A*!; 2 km NW of Yécora on old road to Santa Rosa, 28°22'45"N, 108°50'45"W, 1560 m, 5 Sep 1996, *Wiens 96-122*!; NW of the cemetary in Yécora, 28°22'40"N, 108°56'W, 1540 m, *Trauba 2 Sep 1997* (FTG-FAU!).

Ipomoea triloba L., Sp. Pl. 161. 1753. TYPE: based on *Convolvulus pentaphyllos minor, flore purpureo* in Sloane, Voy. Jamaica 1:153, t. 97, f. 1, 1707 (LECTOTYPE!).

Herbs, annual, the stems prostrate and twining, 1–3 m long, glabrous or occasionally sparsely pubescent, the indument concentrated on the nodes. **Leaves** 2–8 cm long, 2–7 cm wide, broadly ovate to orbicular, entire, coarsely dentate to deeply 3–7-lobed, basally cordate, the basal lobes rounded to angular or lobed, apically acute to obtuse, both surfaces glabrous or sparsely pilose. **Inflorescences** axillary, cymose. **Flowers** 1–3(–12) with peduncles variable in length from shorter to longer than the petioles, glabrous, angular, minutely verruculose at least toward the apex. Sepals 6–7 mm long, ± equal, the outer sepals oblong to narrowly elliptic-oblong, obtuse to acute, mucronulate-caudate, glabrous or sparsely pubescent without, conspicuously ciliate, mostly glabrous otherwise. Corollas 1–2 cm long, funnelform, lavender, glabrous. **Capsules** 5–6 mm wide, ± globose, brown, bristly pubescent. Seeds 1–4, 2.5–3.2 mm long, globose, dark brown, glabrous. $2n = 30, 60$.

Sonora.—A weed carried, at least partly, as a contaminant in rice and others seeds. Sonoran desert, coastal thornscrub and tropical deciduous forest, often in disturbed sites; 0–950 m. Flowering all year.

General distribution.—California; Campeche, Chiapas, Guerrero, Jalisco, Edo. México, Nayarit, Nuevo León, Oaxaca, Sinaloa, Tabasco, Tamaulipas, Veracruz, Yucatan; Mesoamerica; Argentina, Bolivia, Brasil, Colombia, Ecuador, Paraguay, Peru, Venzuela; Caribbean.

Mpio Álamos: Algodones, 8 Sep 1935, *Gentry 1681*! (mixed with *I. parasitica*); Rancho Esmeralda, N edge of Álamos, 27°00'02"N, 108°56'45"W, 380 m, 21 Nov 1993, *Van Devender 92-895*!; El Ranchería crossing of Río Cuchujaqui, 22.5 km S of Álamos on road to El Chinal, 26°51'N, 108°55'W, 200 m, flowers pink,10 Oct 1992, *Van Devender 92-1146*! **Mpio Etchojoa:** 2 mi E of Bacobampo, 30 m, weedy roadside ditch, flowers purple, 17 Dec 1988, *Sanders 8955*! **Mpio Granados:** Granados, 29.8236°N, 109.2986°W, 550 m, *Meling 23 Sep 1986* (USON!). **Mpio Guaymas:** 1.7 mi on Mex 15 NW of juntion of road to Pitahaya, 27°47'N, 110°26'W, 10 m, coastal plain of thornscrub, marshy, climbing over highway culvert, corollas lavender pink, 11 Oct 1985, *Felger 85-1296*!; 1.3 mi S of Mex 15 on road to Las Guásimas, 27°53'N, 110°34'W, 8 m elev, in shrubs and trees along drainageway, calyx smooth, corollas pink with magenta center, rare, 9 Oct 1985, *Felger 85-1160*! **Mpio Hermosillo:** Km 5, Calle 36, Costa de Hermosillo, Lopez 5 Oct 1984 (USON!). **Mpio Huatabampo:** 9.5 km S on MEX 15 from Las Bocas, 18 Jan 1995, *Friedman 72a-95*!; Bachoco, arroyo 1 km NE of town, 26°44'N, 109°21'W, *Martin & O'Rourke 27 Dec 1986*! **Mpio Navojoa:** 1.5 mi SW of Margarita, 8 km NW of Navojoa, 27°08'N, 109°30'30"W, coastal plain, *Martin & O'Rourke 28 Dec 1985*! **Mpio Ónavas:** La Mula, 28°28'50"N, 109°22'38"W, 790 m, tropical deciduous forest, flowers lavender, drying magenta, opening 7:00–8:00 pm, 30 Aug 2000, *Van Devender 2000-511*! **Mpio San Javier:** Cañón Lo de Campa, 28°32'N, 109°44'33"W, 480 m, 29 Sep 1996, *Varela 96-368* (FTG-FAU!). **Mpio Soyopa:** Arroyo Los Garambullos, 0.5 km SE of Río Yaqui bridge on Mex. 16, 1.5 km E of Tónichi, 28.5694°N, 109.55°W, 180 m, common along river bank, flowers light to dark pink, open at 7:00–8:00 a.m., 29 Sep 2000, *Van Devender 2000-749* (USON!). **Mpio Yécora:** Santa Ana de Yécora, 28.3778°N, 109.15°W, 850 m, very common herbaceous vine, flowers pink, open in the morning, 20 Sep 1998, *Van*

Devender 98-1435 (USON!); Santa Ana, Bermúdez junction, *Martin 10 Oct 1988*!; Santa Ana de Yécora, 28°22'40"N, 109°09'W, 850 m, *Trauba 7 Aug 1997* (FTG-FAU!); 3 km N of Tepoca on MEX 16, 28°27'18"N, 109°15'38"W, 770 m, 10 Sep 1994, *Búrquez-M. 94-145* (FTG-FAU!).

Ipomoea wrightii, see **I. heptaphylla**

JACQUEMONTIA Choisy, Mém. Soc. Phys. Genève 6:476. 1834. [Commemorates Victor Jacquemont, 1801–1832, French botanical explorer.]

Vines, herbs or suffrutescent **shrubs;** stems herbaceous toward tips, procumbent to twining (except sometimes in *J. agrestis*), perennials or occasionally annuals, glabrous or hairy. Leaves chartaceous to herbaceous, mostly cordate, glabrous or hairy usually with stellate trichomes, entire or variously repand, dentate, or lobate, petiolate. **Inflorescences** in scorpioid cymes, head-like cymes, umbelliform, or flowers solitary. **Flowers** on pedicels 5–30 mm long, the bracts small and linear or lanceolate or large and foliose. Sepals equal or unequal, variable in shape, hairy or glabrous. Corollas blue, lilac, or white (red in one West Indian species), subrotate, campanulate, or funnelform, deeply lobed, dentate or almost entire, glabrous or hairy. Stamens and styles included (in our species). Pollen 3-colpate, 12- or 15-rugate. Ovary 2-locular, 4-ovulate, glabrous or hairy; styles 1, filiform; 2 stigmas ellipsoid or oblong and flattened. **Fruits** capsular, 2-celled, with 4 or 8 valves, globose to subglobose. Seeds 1–4, glabrous or pilose, or tuberculate, or winged.

About 80–100 species in the Americas and several in Australia.

Selected references.—Austin (2006), Robertson (1971).

1. Sepals with truncate or cordate bases ____ **J. pringlei**
1. Sepals with rounded to narrowed bases.
  2. Annuals with simple glandular and/or stellate hairs. Outer sepals ovate, narrowly ovate to lanceolate ____ **J. agrestis**
  2. Perennials; hairy or glabrous or nearly so, not glandular. Outer sepals ovate to broadly ovate.
    3. Outer sepals with long attenuate apices ____ **J. abutiloides**
    3. Outer sepals apices obtuse, mucronate, acute or acuminate ____ **J. polyantha**

Jacquemontia abutiloides Benth., Bot. Voy. Sulphur 34–35. 1844. TYPE: MEXICO. BAJA CALIFORNIA [SUR]: Bay of Magdalena, *Hinds s.n.* (HOLOTYPE: K!; photo MO!).

Scrambling and twining **perennial vines,** the stems generally woody near the base and slender above growing into and overtopping shrubs reaching 2 (3) m long; younger stems and herbage with 3-branched stellate hairs, mostly crowded but varying from densly overlapping to sometimes moderately dispersed when vigorously growing following ample rain, the hairs nearly white when young and golden-brown with age. **Leaves** ovate to broadly ovate, to 8 cm long and 4.5 cm wide, usually ½ to ⅔ that size, apically obtuse, acute or rarely retuse, mucronate, acuminate or cuspidate, basally cordate with a deep and wide sinus, pubescent; petiolate. **Inflorescences** axillary, cymose, rarely solitary, the dichasia 1–2 times compound, the peduncles 2.5–8(–13.5) cm long. **Flowers** on pedicels 1–6 mm long, the bracts linear, to 12 mm long. Sepals of different sizes, the outer 2 ovate to narrowly ovate with attenuate apices, 7–11 mm long, 3–6 mm wide, the middle sepal narrowly ovate, attenuate apically, sometimes slightly falcate, the inner 2 sepals ovate or broadly ovate, 5–7 mm long, 2.5–3 mm wide, apically attenuate, the bases narrowed with a stipe ca. 1 mm long; all 5 sepals pubescent on the outer surfaces and to a lesser extent on the inner surfaces, enlarging slightly in fruit. Corollas (1.8–) 2–3.5 cm broad when open, broadly campanulate to rotate, blue. Stamens ± equal or unequal, the anthers 1.5–2.5 mm long. Ovary ovoid, 1.5–2 mm long, the styles 6–7 mm long, longer than the stamens. **Capsules** 5–6 mm long, broadly ovoid, usually opening by 8 segments, partly enclosed by sepals. Seeds 1–4, 2.7–3.5 mm long, 1.8–2.5 mm wide, trigonous, minutely areolate and ruminate.

Sonoran region.—Sonoran desert on Isla Tiburón from near sea level–at least 490 m; widespread in the larger mountain mass (Sierra Kunkaak) and its eastern bajada to the south shore of the island; especially along washes and canyons, and also on desert plains and rocky slopes (Felger et al. 2012). Flowering with sufficient soil moisture at various seasons, flowers recorded October–April. Not known from mainland Sonora, which seems unusual since seemingly similar habitat to that on the island occurs on the adjacent Sonora mainland where Felger et al. (2012) have searched for it.

General distribution.—Endemic to the Sonoran desert in central Baja California (norte) to the Cape Region in Baja California Sur and adjacent islands, and Isla Tiburón.

Jacquemontia abutiloides is closely related to *J. eastwoodiana* and questionably distinct. For example, they have been considered as *J. abutiloides* var. *abutiloides* and *J. abutiloides* var. *eastwoodiana* (I.M. Johnst.) Wiggins. However, Robertson (1971) pointed out that *J. abutiloides* has 3-armed trichomes, peduncles which greatly exceed the leaves, dichasia with several blue flowers, outer sepals with attenuate apices and narrowed bases, and seeds which are usually wingless. By contrast, *J. eastwoodiana* has 4–7-armed trichomes, shorter peduncles, fewer (only 1–3) flowers, less acute sepals, and seeds which are sometimes winged on the outer two margins. *J. eastwoodiana* is endemic to the Baja California Peninsula and adjacent Gulf of California islands. Furthermore, *J. abutiloides* seems closely related to *J. pentanthos* and they can be difficult to distinguish, at least in northwest Mexico, except by their allopatic distributions (*J. pentanthos* is not known from Sonora).

SONORAN ISLANDS. Tiburón: Ensenada de la Cruz, 21 Oct 1963, *Felger 9217*!; Top of Sierra Kunkaak Segundo, 490 m, 25 Nov 2006, *Wilder 06-487*! (See Felger et al. 2012 for additional records).

Jacquemontia agrestis (Choisy) Meisn. in Mart., Fl. Bras. 7:306. 1869. Type: BRAZIL. Bahia: Herbidis campis ad fl. S. Franc[isco], prope Joazeiro, Apr, *Martius* (M!). *Convolvulus agrestis* Choisy in DC, Prodr. 9:405. 1845.

Jacquemontia palmeri S. Watson, Proc. Amer. Acad. Arts 24:63. 1889. Type: MEXICO: Guaymas, Jun 1887, *Palmer 221* (holotype: GH!; isotypes: C!, K!, NY!, UC!, US!).

Jacquemontia pauciflora Brandegee, Univ. Calif. Publ. Bot. 4:384. 1913. Type: MEXICO. Veracruz: *Purpus 6139* (holotype: UC!; isotypes: G!, MO!).

Jacquemontia palmeri var. *varians* Brandegee, Zoë 5:170. 1903. Type: MEXICO: Baja California Sur: Laderas S del Cabo, 1902, *Brandegee s.n.* (holotype: UC!; isotype: US!)

Annual **herbs,** not vining or sometimes small, delicate vines, or rarely perennials, with simple glandular hairs and/or stellate trichomes. **Leaves** 1–6 cm long, 0.5–3.5 cm wide, broadly to narrowly ovate, basally cordate to subtruncate, apically acute to acuminate or rarely obtuse. **Inflorescences** monochasial, few-flowered. **Flowers** (1) 2–6 on peduncles 1–8 cm long, the pedicels 3–15 mm long, erect in fruit; bracts linear, inconspicuous. Sepals 3.5–6.5 mm long, subequal or the inner ones shorter, ovate, narrowly ovate or lanceolate, with long attenuate apices, and with only stellate trichomes or stellate and glandular indumentum. Corollas 6–12 mm long, subrotate to campanulate, blue, glabrous. Stamens 3.5–7 mm long, unequal, included; anthers 1 mm long. Ovary 1 mm long, subglobose, 2-locular, glabrous; styles 3–5.5 mm long. **Capsules** 4–5 mm. wide, subglobose. Seeds 1–4, 2–3 mm long, trigonous, semicircular in longitudinal section, minutely areolate and strongly verrucose, minutely winged on the outer 2 margins.

Sonora.—Sonoran desert, coastal and foothills thornscrub, and tropical deciduous forest, often in disturbed sites including cultivated fields and buffelgrass pasture; near sea level–1555 m. Flowering August–December.

General distribution.—Southern Arizona (Baboquivari and Las Guijas Mountains); Mexico, at least in Baja California Sur, Chiapas, Chihuahua, Durango, Guerrero, Jalisco, Michoacán, Nayarit, Sinaloa, and Veracruz, to Honduras; South America; Cuba.

Easily identified when glandular trichomes are present. Forms without glands are still distinctive from the others in Sonora by the usually annual habitat, few-flowered cymes, and lanceolate sepals.

Mpio Álamos: Parque El Chalatón, Álamos, NE side of the Sierra de Álamos, 27°00'40"N, 108°56'35"W, 500 m, 30 Sep 1992, *Bertelsen 92-123*!; Álamos, 28 Oct 1939, *Gentry 4759*!; [Choquincahui] 7 mi N of Güirocoba, *Salmon 27 Dec 1988*! **Mpio Benjamín Hill:** Rancho El Zorro, W of Rancho El Carrizo (16.9 km W of MEX 15 at 20.5 km S of Benjamín Hill), 30.0261°N, 111.2925°W, 771 m, 23 Aug 2007, *Reina-G. 2007-932*!; 11 m S of Noria, between Nogales and Hermosillo, twining among herbs, in shade along small wash, flowers deep blue, 26 Aug 1941, *Wiggins & Rollins 76*! **Mpio Carbó:** 14 mi by Tecolote road (1.2 mi N of El Oasis) W of MEX 15 in buffelgrass pasture, delicate annual, 750 m, 22 Aug 1982, *Reichenbacher 1046*! **Mpio Huatabampo:** Camahuiroa between Agiabampo and Las Bocas on the Gulf of California, 26°31'N, 109°16'W, 15 Mar 1993, *Van Devender 93-305* (FTG-FAU!). **Mpio Moctezuma:** 21 mi S of Moctezuma, 2600 ft., 25 Sep 1934,*Wiggins 7452* (GH!). **Mpio Ures:** Sierra de Mazatán, 26°6'11"N, 110°15'0"W, 860 m, selva baja cauducifolia, 10 Sep 2003, *Sánchez-Escalante 03-91*! **Mpio Santa Cruz:** Rancho los Fresnos, 1555 m, 5 Dec 2005, *Stark 1*! **Mpio Yécora:** 4.3 km SE of Santa Ana de Yécora on road to Nuri, 745 m, 23 Sep 1977, *Goldberg 77-186*!; 1.9 mi W of Tepoca on Mex 15, tropical deciduous forest, occasional perennial vine, 10 Sep 1999, *Reina-G. 99-439*! **Sonoran Islands:** Tiburón, SE side of Agua Dulce Valley, 28°57'20"N, 112°24.5'W, 280 m, 11 Dec 1976, *Felger 76-T24*!

Jacquemontia albida, see **J. polyantha**

Jacquemontia pentanthos (Jacq.) G. Don

This species has not been verified for Sonora. While it is common in eastern Mexico, it is either absent or rare in western Mexico. According to Robertson (1971), *J. pentanthos* is at the center of a group of species that includes *J. abutiloides, J. albida, J. eastwoodiana, J. polyantha, J. pringlei*, and five others. This group of taxa ranges from Arizona to Central America. We tentatively accept the distinctions made by Robertson (1971) in these segregates (except for *J. albida*), although the relationships of these taxa generally remains confused. These taxa are often misidentified or difficult to identify on herbarium specimens, while living plants are often considerably different. Within this alliance *J. polyantha* and *J. pentanthos* are closely related (see *J. polyantha*).

Jacquemontia polyantha (Schltdl. & Cham.) Hallier f., Bot. Jahrb. Syst. 16:543. 1893. TYPE: MEXICO. VERACRUZ: In dumetis ad Hacienda de la Laguna, 28 Sep 1828, *Schiede & Deppe 220* (HOLOTYPE: HAL!; photos F!, MO!, NY!). *Convolvulus polyanthus* Schltdl. & Cham., Linnaea 5:117. 1830.

Jacquemontia albida Wiggins & Rollins, Contr. Dudley Herb. 3:277. 1943. TYPE: MEXICO. SONORA: [Mpio Hermosillo] Along an arroyo 1 mile NE of El Zapo, between Hermosillo and Tastiota, 4 Sep 1941, *Wiggins & Rollins 273* (HOLOTYPE: DS at CAS!; ISOTYPES: ARIZ!, GH!, LL!, MICH!, MO!, NY!, RSA!, US!).

Jacquemontia apiculata House, Muhlenbergia 5:66. 1909. TYPE: MEXICO. TAMAULIPAS: vicinity of Victoria, about 320 m, 1 Feb–9 Apr 1907, *Palmer 117* (HOLOTYPE: NY!, ISOTYPES: F!, GH, not seen, MO!, US!).

PANEYA (GUARIJIO, Gentry 1081)

Perennial vines, sparsely to densely pubescent with 3-armed trichomes. Stems twining to several meters long or procumbent, herbaceous or becoming woody near the base. **Leaves**: Blades 2.5–11.5 cm long, 1.5–6.5 cm wide, ovate, broadly ovate, to almost circular; basally cordate to less often truncate; apically highly variable—attenuate to acuminate, abruptly acuminate, obtuse or blunt, or sometimes mucronate; margins entire, or repand to undulate. Petioles 0.2–6.5 cm long. **Inflorescences** axillary, loosely cymose, of simple or often compound dichasia; peduncles 5–13 cm long and often longer than the leaves. **Flowers** on pedicels 0.5–2 cm long, the bracts linear, often 5–10 mm long. Sepals unequal to more or less equal; the outer two sepals 6–6.5 mm long, 3.5 mm wide, elliptic, broadly elliptic, or ovate to broadly ovate, the bases narrowed, the the apices acute or acuminate, or shortly attenuate; the inner sepals smaller (narrower and shorter), glabrous or sparsely to densely stellate. Corollas 1–2.5 cm long, funnelform to campanulate, white, glabrous. Stamens unequal, 5–12 mm long; anthers 1–2 mm long. Ovary 1.5 mm long, ovoid to cylindrical, glabrous; styles 6–11 mm long. **Capsules** 4–5 mm long, ovoid, partly enclosed by the sepals. Seeds 1–4, 2.7–3 mm long, rotund, brown, minutely areolate and verrucate-striate, glabrous.

Sonora.—From near Hermosillo and the east-central part of the state southward and eastward. Sonoran desert, coastal thornscrub, and tropical deciduous forest; near sea level–770 m. Flowering at least in January, March, September–December.

General distribution.—Widespread in Mexico including the Sierra Madre Occidental and Sierra Madre Oriental, and Sierra Madre del Sur, and at least in Chihuahua, Guerrero, Edo. México, Michoacán, Sinaloa, Tamaulipas, Veracruz; from desert margins to oak and pine-oak zones

Robertson (1971: 133) reported that *J. albida* is closely related to *J. polyantha*, "which has outer sepals that are broadly ovate or ovate and pubescent instead of elliptic and glabrous." He knew *J. albida* only from the vicinity of Hermosillo. Many additional specimens available to us from a wide range indicate that differences between *J. albida* and *J. polyantha* are too few and do not distinguish them. As Robertson suspected, we conclude that they are best treated as a single species.

Robertson (1971: 168–169) also pointed out that, "Both *J. polyantha* and *J. pentanthos* are very closely related." Primary differences between *J. polyantha* and *J. pentanthos* are in inflorescences, sepals, and flower color. *Jacquemontia pentanthos* has compact cymes and usually rhomboidal outer sepals with long attenuate apices; *J. polyantha* tends to have open cymes and elliptic to ovate outer sepals and acute or acuminate to short-attenuate apices. Moreover, *J. pentanthos* has blue flowers and those of *J. polyantha* are usually white.

Mpio Álamos: Canyon Sapopa, tropical Sonoran, vine on canyon slopes, wirote, Mex., paneya, W [Guarijio], 19 Oct 1934, *Gentry 1081!*; Near Álamos, abandoned milpa, ground vine with short leafy branches and bright white flowers, 28 Oct 1939, *Gentry 4761* (ARIZ!, MO!); Near Taymuco, roadside, [flowers], *Martin 15 Mar 1992!*; Arroyo el Mentidero at Chinal road, 11.3 km S of Álamos, 26°54'45"N, 108°55'05"W, 240 m, canyon bottom in tropical deciduous forest, flowers white, 20 Sep 1993, *Meyer 11!*; Districto Álamos, cañon Estrella, 10 Oct 1933, *Gentry 354!*; Chorijoa, tropical Sonoran, forest, pale bluish flowers, 22 Aug 1935, *Gentry 1596!*; Río Mayo Raft Trip, confluence of San Ignacio and Río Mayo, 27°55'N, 108°47'W, *Jenkins & Rondeau 26 Sep 1991*! **Mpio Cajeme:** 9 mi SE of Ciudad Obregón, dry level plain, columnar cacti and small thorny trees, corolla white, 12 Sep 1973, *Stevens & Fairhurst 2049* (DUKE!); Ciudad Obregón, valley arroyo, 29 Sep 1933, *Gentry 264*! **Mpio Guaymas:** 15 mi SE of Guaymas, arroyo, 26 Sep 1933, *Gentry 263* (F!). **Mpio Hermosillo:** 15 mi S of Hermosillo, mesquite bottomland, flowers white, 6 Sep 1939, *Gentry 4565*! **Mpio Huatabampo:** 1.5 km N-NW of Camahuiroa, coastal Sinaloan thornscrub, 26°33'25"N, 109°17'25"W, ca. 5 m, 23 Nov 1993, *Van Devender 93-1259!*; 2 km W of Tierra y Libertad on northern road to Camahuiroa, dense coastal Sinaloan thornscrub, 26°33'50"N, 109°12'50"W, flowers white, 24 Nov 1993, *Van Devender 93-1285*! **Mpio Sahuaripa:** 5 km W of Sahuaripa, carretera Sahuaripa–Bacanora, 29°01'30"N, 109°16'28"W, 720 m, bosque tropical caudicifolia, 28 Sep 1996, *Flores-M. 4780*! **Mpio Yécora:** 3 km N of Tepoca on MEX 16, 28°27'18"N, 109°15'38"W, 770 m, 10 Sep 1994, *Búrquez 94-147* (FTG-FAU!); Just S of Arroyo Palo Pinta bridge on Mex 16, tropical deciduous forest, 580 m, flowers white, 19 Sep 1998, *Reina-G. 98-1410*!

Jacquemontia pringlei A. Gray, Proc. Amer. Acad. Arts 17:228. 1882. Type: U.S.A. Arizona: Santa Catalina Mountains, 15 May 1881, *Pringle 295* (holotype: GH!, photo MO!).

Jacquemontia pringlei var. *glabrescens* A. Gray, Amer. Acad. Arts 21:402. 1886. Type: MEXICO. Chihuahua: near Batopiles, Aug–Nov 1885, *Palmer 107* (lectotype designated here by K.R. Robertson and D.F. Austin: GH!, photo MO!; isolectotypes: K, not seen, (2) NY!, PH!); Chihuahua: near Batopiles, Aug–Nov 1885, *Palmer 248* (syntype: GH!). ARIZONA. Pima Co: Santa Catalina Mountains, 1882, *Lemmon 3038 & 3038bis* (paratypes: GH!, K, not seen).

Perennial **vines,** the stems twining, with 4–6-armed stellate trichomes, rarely glabrate. **Leaves** broadly ovate to ovate, 2–6.5 cm long, 1.5–4.8 cm wide, basally shallowly cordate to truncate, apically acute or less often retuse to obtuse, sometimes mucronate. **Inflorescences** axillary, loosely cymose or solitary. **Flowers** 1–7 on peduncles 1–11 cm long, the pedicels 2–10 mm long, erect to nodding in fruit; bracts linear, to 6 mm long. Sepals subequal, the outer ovate to broadly ovate, the middle sepal falcate, the inner narrowly ovate, 5.5–9 mm long, the apices acute, pubescent without and to a lesser degree within. Corollas 1.4–2.7 cm long, funnelform, lavender to white, glabrous. Stamens 5–10 mm long, included, anthers 1.5–2 mm long. Ovary 1–1.5 mm long, ovoid, 2-locular, glabrous; styles 7–9 mm long. **Capsules** 5–6 mm long broadly ovoid, enclosed by accrescent sepals. Seeds 1–4, 2–2.5(–3) mm long, trigonous, brown, minutely areolate and ruminate.

Sonora.—Widespread except the northwestern corner of the state; Chihuahuan and Sonoran deserts, coastal and foothills thornscrub, and tropical deciduous forest. Near sea level–1000+ m. Flowering (March) August–December.

General distribution.—Pima, Yuma and Cochise Cos, Arizona; southwestern Chihuahua to northwestern Sinaloa.

Mpio Álamos: Río Mayo Raft Trip, confluence of Rio Moris and Rio Agua Caliente, 28°02.5'N, 108°29'W, *Rondeau & Jenkins 23 Sep 1991!*; Arroyo Verde, 27.1167°N, 108.7083°W, twining vine, flowers white, in shaded canyon, 1100 m, 15 May 1990, *Jenkins 90-58!*; Sierra Saguaribo, *Martin 20 Mar 1992!*; Sugar cane mill and ranch at Jurinabo along Río El Taymuco, 27°15.5'N, 108°46.4'W, 450 m, *Yetman 20 Mar 1992!*; El Guayabo crossing of Río Cuchujaqui, 2.6 km NE of Sabinito Sur, 14 km (by air) E-SE of Álamos, 27.0014°N, 108.7855°W, flowers white, 350 m, 5 Feb 1992, *Van Devender 92-244!*; 2.5 km (by air) N of Álamos, along road to Rincon Viejo, 27°03'25"N, 108°56'35"W, 420 m, common vine to 3 m on steep bank, flowers white, 20 Sept 1993, *Van Devender 93-856* (FTG-FAU!); Near Rancho La Junta at junction of Río Mayo and Arroyo Guajaray, 27.5917° N, 108.8917°W, heavily grazed pasture, vine on shrub, flowers white, 250 m, 18 Mar 1993, *Van Devender 93-400*! **Mpio Altar:** Base of Sierra El Humo, SSW of Sasabe, rocky cliff wall, 900 m, 2 Mar 2004, *Flesch 04-63*! **Mpio Cucurpe:** 6 mi NE of Cucurpe on road to Agua Fria (= R. Santo Domingo, = Saracachi), isolared Sinoloan thornscrub, on roadcut, scattered, flowers white with purplish tint, 2 Sep 1990, *Van Devender 90-481*! **Mpio Fronteras:** Fronteras, 4550 [ft.], 25 Sep 1890, *Hartman 9* (GH!). **Mpio Guaymas:** Hills near Guaymas, *Palmer 294 in 1887* (ARIZ!, GH!, NY!); Guaymas, hills W of town, small clambering vines with lutescent lavender flowers, open mornings, shady exposures in basaltic cerros among rocks, 22 Oct 1939, *Gentry 4679!*; 15 mi S of La Palma, between La Palma and Guaymas, 2 Sep 1941, *Wiggins & Rollins 222* (ARIZ!, MO!); Ensenada Chica, 23 km N, 39 km W of Guaymas, 28°8'N, 111°18'W, 15 m, 1 Oct 1979, *Burgess 5693!*; Bahía San Pedro, 10 m elev, 28.1°N, 111.2°W, low scandent shrub, 1 Oct 1979, *Turner 79-274!*; 17 mi by road (MEX Hwy 15) N of junction of MEX 15 and road to Bahía San Carlos, 7 Sep 1980, *Felger 80-61!*; 5.8 mi N of turnoff to Bahía San Carlos, flowers white, 12 Mar 1983, *Starr 296!*; Microondas Avispas, Sierra Baviso, 11 km by road (Mex 15) S of La Pintada and 6 km by road eastward from highway, flowers white, rhyolite mountain with desert–subtropical scrub ecotone, 28.4833°N, 111.0333°W, 600 m, 11 Aug 1985, *Felger 85-831!*; N end of Miramar, N end Bahía Bacochiabampo, rocky hills adjacent to sea, common, vining in shrubs, corollas white, open in morning, 13 Aug 1985, *Felger 85-898!*; 4 mi (airline) NW of San Carlos Bay, gentle alluvial slope and beach dunes above the large cove just N of Isla Venado, 27.9667°N, 111.1167°W, coastal desert scrub, uncommon perennial vine, flowers light pink, 5 m, 2 Sep 1989, *Sanders 9150*!; Cañon las Barajitas, Sierra el Aguaje, ca. 1 km from shore, 28.0422°N, 111.2111°W, 20 m, corollas pale pink-white with a darker center, 20 Feb 1995, *Felger 95-242*!; Cañón La Balandrona, N side of Sierra El Aguaje, 220 m, canyon bottom, sandy soil beneath shrubs at margin of watercourse, 19 Dec 2001, *Felger 01-638*! **Mpio Hermosillo:** 22 mi by road E of Mex Hwy 15 on road to Ures, rocky hillside on N bank of Río Sonora, blue flowers, 1700 m, 21 Aug 1960, *Felger 3945*!; Cañada El Tetabejo, Sierra Libre, foothills thornscrub on slopes, tropical riparian in canyon bottom, 28°32'30"N, 110°58'45"W, 300 m, solitary perennial vine, flowers white, 26 Sep 1995, *Van Devender 95-1039* (FTG-FAU!). **Mpio Huásibas:** 6.3 mi by road E of Río Bavispe on road from Guasabas to El Coyote (& Bacadehuachi), S rim of Cañón Cruz de Peñasco, steep rocky slope, lower oaks and upper edge of subtropical scrub, flowers pale blue, 1080 m, 24 Jul 1960, *Felger 3639*! **Mpio Huatabampo:** Ejido 10 de April, 3.6 mi W of Mexico 15 on dirt road to Agiabampo and Camahuiroa, elev ca 5 m, coastal Sinaloan thornscrub, very common on shrubs, flowers white, 8 Oct 1992, *Van Devender 92-1106*! **Mpio Navojoa:** Las Guásimas, 12 mi E Navajoa [sic], thorn forest, 27 Oct 1939, *Gentry 4757*! **Mpio Soyopa:** 6.7 km E of Rio Yaqui on Mex. 16, 28.5536°N, 109.6105°W, 260 m, 20 Aug 2000, *Reina-G. 2000-464*! **Mpio Nacozari de García:** 9 mi W of Angustura, 2900 ft, 19 Aug 1941, *White 4038* (ARIZ!, GH!).

MERREMIA Dennst. ex Endl., Gen. Pl. Suppl. 11:1403. 1841, nom. cons.; amend. Hallier f., Bot. Jahrb. Syst. 16:581. 1893. [Commemorates Blasius Merrem, 1761–1824, German professor.]

Lianas or herbaceous annual or perennial **vines** (also flowering in first season or perhaps annuals), the stems twining or prostrate. Leaves simple or palmately compound, ovate, hastate, sagittate, variably palmately or pinnately divided, the segments 3–9, ovate-linear, the margins entire or sinuate-serrulate, sessile or if present the petiole slender, cylindrical, occasionally sulcate, or rarely scale-like. **Inflorescences** axillary, in dichasia or monochasia, sometime umbellate. **Flowers** 1–40, mostly diurnal. Peduncles usually similar to the stems and petioles or reduced or absent, the pedicels usually shorter than the peduncle, smooth, striate, or notably five-angled, slender, stout to distinctly clavate. Bracts glabrous or pilose, usually two, prominent and foliaceous to reduced or scale-like or absent, usually caducous or fugaceous, rarely persisting in fruit, the bracteoles, when present, similar to the bracts. Sepals 5, persistent, imbricate, ovate-lanceolate, herbaceous, membranaceous-coriaceous, glabrous, pilose-appressed, or hirsute, the margins entire, the apex acute to obtuse, attenuate, or rarely emarginate. Corollas campanulate to funnelform, the tube widening gradually or abruptly, the limb more or less entire, the lobes 5–10, white, yellow, or rose-purple, usually glabrous. Stamens 5, included, inserted at the base of the corolla tube, erect, glabrous or pubescent with glandular trichomes; anthers helicoid-contorted; pollen 3-colpate, or polycoplate (Austin et al. 2008; Ferguson et al. 1977). Style 1, white, glabrous, the stigma 2-globose or superficially 4-globose. **Fruits** capsular, globose to more or less conical, brown to straw-colored or gray or transparent when dry, entire or 4-lobed, the locules 2–4, the valves usually 4, glabrous; dehiscence valvular or irregular. Seeds 1–4, brown or black (straw-colored in *M. aegyptia*), rounded or 1–3-angled, glabrous, puberulent, or tomentose.

About 100 species, largely in tropical zones; 27 species known from the Americas.

Selected references.—Austin (1979, 1995), Gunn (1977), O'Donell (1941). Ana Rita Simões (at BM, working on the Merremieae, pers. comm. 2011).

1. Leaves highly variable, usually palmately lobed, cleft or parted, sometimes compound. Corollas white with a purple to purple-red center ____ **M. dissecta**
1. Leaves palmately compound. Corollas white, cream to yellowish.
  2. Plants glabrous. Leaflets entire or nearly so. Larger sepals more than 2 cm long ____ **M. palmeri**
  2. Plants with strigose or hirsute, trichomes. Leaflet margins entire or serrate. Larger sepals to 1.5 cm long.
    3. Sepals 1–1.5 cm long, acuminate-attenuate ____ **M. cissoides**
    3. Sepals 3–7 mm long, obtuse to subtruncate ____ **M. quinquefolia**

Merremia cissoides (Griseb.) Hallier f., Bot. Jahrb. Syst. 16:552. 1893. TYPE: GUAYANA FRANCESA: *Le Blond s.n.* (HOLOTYPE: P-LAM!). *Convolvulus cissoides* Lam., Tab. Encycl. 1:462. 1791 [1793]. *Ipomoea cissoides* (Lam.) Griseb., Fl. Brit. W.I. 473. 1864 [1862].

Twining herbs, usually **perennial,** the Sonora specimens **annuals** (perhaps flowering in the first season?) Stems to 6 m long, herbaceous at least above, with appressed trichomes. **Leaves** palmately compound, the leaflets 5, 1.5–6 cm long, 0.7–1.4 cm wide, ovate, the base decurrent, the margins entire, undulate, dentate or dentate-sinuate, the apex acuminate, membranaceous, glabrous or appressed-pubescent, strigose or hirsute on both surfaces. Petioles 3–5 cm long, hirsute-pilose to glabrous and/or glandular. **Inflorescences** of monocasia or dichasia. **Flowers** 3–7, diurnal. Sepals 1–1.5 cm long, ± equal, subrhomboid to lanceolates, membranaceous, puberulente to pubescent or somewhat hirsute, the apex acuminate-caudate. Corollas 1.5–3 cm long, campanulate, white, sometimes rose or yellowish, the limb almost entire, glabrous. Capsules 6–8 mm long, more or less globose to ovate, light brown when dry, 4-valved, chartaceous, glabrous. Seeds 1–4, 5–7 mm long, rounded, black to gray, puberulent.

Sonora.—Known from a single record from east-central part of the state in tropical deciduous forest at 680 m. Flowering September.

General distribution.—México (Chiapas, Guerrero, Oaxaca, San Luis Potosí, Sinaloa, Tamaulipas, Yucatan), Mesoamérica; Argentina, Bolivia, Bolivia, Brasil, Colombia, Guayanas, Paraguay, Peru, Venezuela; Caribbean. Old World tropics.

Mpio Yécora: 6 km E of Tepoca, 3 km W of the junction with road to Sahuaripa, disturbed tropical deciduous forest, 28°26'15"N, 109°13'05"W, 680 m, occasional on roadside, flowers light yellow, open in the afternoon on a cloudy day, 10 Sep 1999, *Van Devender 99-427*!

***Merremia dissecta** (Jacq.) Hallier f., Bot. Jahrb. Syst. 16:552. 1893. TYPE: E seminibus in America a me collectis Viennamque adlatis laete germinavit in caldariis Caesareis haec planta floruitque jam saepius, Nec occurrit certus collectionis locus, *Jacquin s.n.* (HOLOTYPE: W, plate seen!). *Convolvulus dissectus* Jacq., Obser. Bot. 2:4, pl. 28. 1767. *Ipomoea dissecta* (Jacq.) Pursh, Fl. Amer. Sept. 1:145. 1814 [1813], not Willd. (1794). *Operculina dissecta* (Jacq.) House, Bull. Torrey Bot. Club 33:500. 1906.

Convolvulus palmatus Mill., Gard. Dict., ed. 8, n. 8. 1768. TYPE: MEXICO. VERACRUZ: 1730, *Houstoun* s.n. (LECTOTYPE designated here: barcode BM 000953227!; ISOLECTOTYPES: BM barcodes 000953228!, BM 000953229!)

NOYAU VINE; *MIKALA*, *MIKAILITA* (Pima Bajo, fide Amadeo Rea)

Large, robust **perennial vines.** Stems perennial if not frost- or drought-killed, twining or prostrate, becoming woody below, reaching 8 m long, sparsely to densely hirsute, the trichomes yellowish. **Leaves** 6–10 cm long, 2.5–12 cm wide, the blades dark green, membranaceous, palmately parted, divided, or sometimes compound, with (5) 7 (9) segments or leaflets, these highly variable in shape, from lanceolate-elliptic with entire margins and acute-attenuate apices to ovate or obovate with incised-serrate or pinnate margins and acute to attenuate apices, glabrous or hirsutulous to hispid and the pubescence especially prominent on the veins; petioles cylindrical, slender, hirsutulous to hirsute. **Inflorescences** axillary, dichasial, even compound dichasial, composed of numerous buds, flowers, and fruits developing at different times, but of the dichasia only 1 or 2 flowers open at any one time (day). Peduncles 3.5–15 cm long, greatly exceeding the subtending petioles, hirsutulous to hirsute. **Flowers** diurnal. Sepals 1.2–1.8 cm long, more or less equal or the outer somewhat larger than the interior ones, accrescent and reflexed in fruit, broadly ovate, elliptic, coriaceous, glabrous, margins often scarious, the apex acute to obtuse. Corollas 3–5 cm long, white, with a purple to purple-red throat, campanulate, expanding gradually, the limb more or less entire, glabrous. **Capsules** 1–1.5 cm long and wide, globose to conic, brown and transparent, membranaceous, glabrous. Seeds 1–4, 6–8 mm long, ovoid to rounded, black, glabrous.

Sonora.—Cultivated and sometimes weakly established in tropical deciduous forest near habitations; 200–1300 m. Probably flowering with warm weather at any season.

General distribution.—Florida, Texas, cultivated in Arizona; Baja California Sur, Coahuila, Colima, Guerrero, Hidalgo, Jalisco, Edo. México, Michoacán, Morelos, Nayarit, Nuevo León, Oaxaca, Queretaro, San Luis Potosí, Sinaloa, Tamaulipas, Veracruz; Mesoamerica; Colombia, Venezuela, Guayanas, Ecuador, Perú, Brasil, Bolivia, Paraguay; Antilles; Old World tropics.

This Caribbean species has been introduced into many parts of the Americas as well as widely dispersed in the Old World shortly after European arrival in the Americas, at least partly because of the medicinal seeds and as an ornamental garden plant. In parts of the West Indies and northern South America it is called *almendro, almendrillo, aguinaldo de almendra* or *noyau* because of the almond fragrance of the seeds (Austin 2007).

Mpio Álamos: San Bernardo, locally common herbaceous vine on fence near house, flowers white, 16 Apr 1994, *Van Devender 94-319*!; Aduana, ex short-tree forest, riparian, vine along streambed, 14 Jan 1961, *Felger 5074*! **Mpio Banamichi:** Banamichi along Son. 89, Río Sonora, 30.01833°N, 110.21639°W, cultivated in town, flowers white with purple inside tube, open at 1:05 p.m., 16 Sep 2000, *Reina-G. 2000-721*

(USON!). **Mpio Baviáccora:** Suaqui along SON 89, 29°41'46"N, 110°09'18"W, 680 m, solitary vine to 3 m in tree away from houses, flowers white with purple inside throat, open at 2:40 p.m., 16 Sep 2000, *Van Devender 2000-720*! **Mpio Gen. Plutarco Elías:** Quitovac, climbing up house and up pomegranate in orchard, Papgo name: pl:pe(k), 20 Aug 1981, *Nabhan 259*! **Mpio Soyopa:** Tónichi, 28°35'55"N, 109°33'50"W, 200 m, cultivated vine, flowers white with purple center, open midday, 29 Aug 2000, *Reina-G. 2000-465A*! **U.S.A. ARIZONA. Maricopa Co.:** Mesa, grown from seeds originally collected by Wendy Hodgson and Amadeo Rea, 9 October 1999, from home of Petra Estrella Grijalva, growing on and covering a shade structure, Ónavas, Sonora, called '*rama para adorno*,' '*mikala – mikailita*,' robust twining herbaceous perennial vine on S side of house, leaves dark green, flowers white-cream with purplish center, 14 Jul 2004, *Hodgson 18255* (DES!).

Merremia palmeri (S. Watson) Hallier f., Jahrb. Hamburg. Wiss. Anst. Beih. 3:38. 1899. Type: MEXICO. Sonora: Guaymas, on dry creek bed, Jun 1887, *Palmer 75* (holotype: GH!; isotypes: C!, K!, (2) NY!, (2) US!). *Ipomoea palmeri* S. Watson, Proc. Amer. Acad. Arts 24:63. 1889. *Operculina palmeri* (S. Watson) House, Bull. Torrey Bot. Club 33:502. 1906.

Trompillo, huirote (these are general names; *trompillo* for any morning glory and *huirote* in Mexico for vine)

Large, robust perennial **vines,** glabrous, with milky sap, the stems to 8 m long; growing and flowering during hot weather, often covering trees and shrubs, and leafless and dying back severely in dry seasons. **Leaves** broadly ovate to circular in outline, palmately compound; leaflets 5, lanceolate 5–14 cm long, 0.6–2.5 mm wide (the median one largest), basally attenuate, apically truncate and mucronate, the margins entire or nearly so; petioles 1.5–2.5 cm long. **Inflorescences** solitary, axillary. **Flowers** nocturnal (opening around dusk and quickly wilting with the early-morning heat), on peduncles greatly exceeding the petioles, the pedicles 2.2–4 cm long, the bracts deltoid-ovate and apically caudate, 4–5 mm long, 1–1.5 mm wide. Sepals 2.6–3.5 cm long, 1.2–1.5 cm wide, unequal (the outer ones larger), elliptic-ovate, the margins membranaceous; sepals enlarging in fruit and becoming pock-marked with glands on the inner surfaces. Corollas 5.5–7.3 cm long, 4–6(–8) cm wide, white, salverform to funnelform-salverform, glabrous. **Capsules** brown, globose to ovoid, 1.5 cm long and wide, subtended and partly enclosed by the accrescent sepals. Seeds 2–4, 9–11 mm long, 6–9 mm wide, black, wedge-shaped, puberulent when fresh, glabrescent.

Endemic to Sonora and Sinaloa: Sonoran desert, coastal and foothills thornscrub, and tropical deciduous forest. Northern Sonora from the vicinity of Trincheras, Benjamín Hill, and Presa Angostura southward to Sinaloa; 10–800 m. Flowering recorded (January) March, May–October.

This species is self-incompatible. The nocturnal flowers are pollinated by hawk moths, but excess pollinator visits can lead to a decline in female reproductive success as a result of flower damage or pollen interference (Willmott & Búrquez 1996). Alberto Búrquez (personal communication 6 October 2001) writes that "the flowers emit a faint, sweet fragrance after opening that lasts through the night. Hawkmonths use it as a long-distance cue. When close, they use eyesight and proboscis." In contrast, pollination ecologist Robert A. Raguso described the fragrance of flowers remaining open in the morning as being disagreeable (specimen label for *Raguso RAR 98-162*).

The closely related species *M. platyphylla* (Fernald) O'Donell appears to have bat-pollinated flowers. *M. palmeri* is also related to the Mexican *M. tuberosa* (L.) Rendle and *M. discoidesperma* (Donn. Sm.) O'Donell (Austin 1998c).

Mpio Álamos: Río Mayo Region, Rancho Las Uvalamas, 26°57.7'N, 108°55–56'W, 300-400 m, *Martin & McWhorter 25 Aug 1990* (FTG-FAU!); Álamos, large vine with white flowers, often on *Acacia cochliacantha* or *Haematoxylon brasiletto*, 16 Oct 1936, *Gentry 2919*!; 8 km W of Masiaca, 26°46'30"N, 109°08'56"W 120 m, solitary liana to 6 m in tree, flowers white, opening in the morning, 26 Feb 1995, *Van Devender 95-112*!; 4 km S Álamos on El Chital road, 26°59'05"N, 108°55'10"W 310 m, flowers white, 8 May 1992, *Van Devender 92-596*! **Mpio Benjamín Hill:** 5.6 mi S of Benjamín Hill, 740 m, 30°04'N, 111°05'W, 740 m, corolla white, open 8 a.m., beginnning to close by 8:30 a.m., root woody, knotted, thickened, not tuberous, 8 Oct 1985, *Felger 85-1065*! **Mpio Guaymas:** San Carlos, canyon bottom and lower E-facing slopes, 21 Oct 1984, *Felger 84-182*!; Guaymas, wash margin in open valley of mesquite-grassland, large tough-stemmed vine climbing over shrubs and trees, 23 Oct 1939, *Gentry 4683*!; 4 mi NE of La Misa (not by road), 750 ft, 13 Aug 1969, *Turner 69-60*! **Mpio Hermosillo:** 22 mi NE of MEX 15 on rd to Ures, ca. 1700 ft, common rank growing vine, white nocturnal flowers, 21 Aug 1960, *Felger 3940*!; Centro Ecológico de Sonora, 3 km S of Hermosillo, *Molino-Freaner 15 Sep 1994* (FTG-FAU!); N of Hwy 16 ca. 15 km E of Hermosillo, ca. 1000 ft, *Martin & Jenkins 6 Nov 1987* (FTG-FAU!); 4 mi E of Willard between Hermosillo and Colorado, climbing vine to 5–8 m, corolla pure white, very fragile and open only at night, juice milky, gentle gravelly slope, 5 Sep 1941, *Wiggins & Rollins 286*! **Mpio Huatabampo:** Rocky hillside 5 km N [of] Agiabampo, 21 Sep 1994, *Friedman 340-94*! **Mpio Navojoa:** 5 km E of Navojoa, beside road in *Ambrosia*, *Martin & Jenkins 9 Jun 1993*!; S of Navojoa at km 1626, 6 Sep 1966, *Barr 66-138*! **Mpio Opodepe:** 6 km W of Opodepe, 29.9511°N, 110.6425°W, 790 m, uncommon perennial vine, flowers white, open late afternoon, 21 Jul 2001, *Reina-G. 2001-579* (USON!). **Mpio Rosario:** Arroyo Hondo, 22 mi N of Tezopaco, 500 m, 6 Nov 1982, *Starr 192*! **Mpio Sahuaripa:** Mountains 6.7 mi W of Sahuaripa, *Gates 9 Sep 1959*! **Mpio Soyopa:** NE side of Río Yaqui bridge on MEX 16, just S of Tónichi, ca. 28°34'15"N, 109°33'09"W, 200 m, occasional vine, flowers white, open late afternoon, 21 Sep 1997, *Reina-G. 97-967*!; Tónichi, arroyo up from river, *Spicer 10 Sep 1941*! **Mpio Soyopa:** El Novillo, 350 m, low mountains, subtropical scrub, rank-growing vine, covering shrubs, 24 Oct 1984, *Felger 84-289*!; Arroyo Los Garambullos, 0.5 km SE of Río Yaqui bridge on Mex 16, 1.5 km east of Tónichi, 28°34'10"N, 109°33'00"W, 180 m, uncommon perennial vine, a few white flowers, open midday, 7 Jan 2001, *Reina-G. 2001-18*! **Mpio Trincheras:** Bajada S of Las Trincheras, 2 Sep 1933, *Shreve 8379*! **Mpio Ures:** 19.4 km NE of Ures on Son 89, foothills thornscrub, 29°28'42"N, 110°12'25"W, 595 m, common perennial vine to 2 m in shrub, flowers white, opening 4:45 pm, 15 Sep 2000, *Reina-G 2000-707*! **U.S.A. ARIZONA. Pima Co.:** From Sonora [the plant], along fence at Arizona Sonora Desert Museum [Tucson], one plant, self incompatible, flowers white, bloom in PM, fade by morning, unpleasant fragrance, naphthalene-like skunky, cultivated, 20 Aug 1998, *Raguso RAR98-162*!

Merremia quinquefolia (L.) Hallier f., Bot. Jahrb. Syst. 16:552. 1893. TYPE: "*Convolvulus quinquefolius glaber Americanus*" in Plukenet, Phytographia, t. 167, f. 6, 1696 (LECTOTYPE!). *Ipomoea quinquefolia* L., Sp. Pl. 162. 1753. *Convolvulus quinquefolius* (L.) L., Syst. Nat., ed. 10, 2:923. 1759. *Batatas quinquefolia* (L.) Choisy, Convolv. Orient 127. 1834. *Pharbitis quinquefolia* (L.) Raf., Fl. Tellur. 4:81. 1838.

Perennial or sometimes **annual herbs,** twining or prostrate, glabrous or sparsely hirsute, the stems herbaceous toward the apex, woody toward the base, to 5 m long. **Leaves** 1.5–5 cm long, 2.5–7 cm wide, palmately compound, circular in outline, the leaflets 5, elliptic or lanceolate to oblanceolate, the margins sinuate-serrulate, the segments more or less sessile, apically and basally acute to acuminate, glabrous. Petioles 2–9 cm long, glabrous or with a few scattered patent trichomes. **Inflorescences** of monochasia or dichasia. **Flowers** 1–10, diurnal. Sepals unequal, the outer ones 3–5 mm long, the inner ones 4–7 mm long, oblong, ovate to elliptic, coriaceous to chartaceous, the margins scarious or not, obtuse, mucronulate, glabrous. Corollas 1.5–2.5 cm long, campanulate, cream to white, glabrous. **Capsules** 5–8 mm long, more or less globose, straw-colored to brown, glabrous, the sepals partly surrounding and covering the fruit. Seeds 1–4, 3–5 mm long, straw-colored or black, pubescent with short, brown trichomes.

Sonora.—Southeast and east-central part of the state in tropical deciduous forest, often in disturbed sites and riparian habitats near rivers and along arroyos; 120–460 m. Flowering March–May and September–October.

General distribution.—Florida; Baja California Sur, Chiapas, SW Chihuahua, Colima, Guerrero, Jalisco, Edo. México, Michoacán, Nayarit, Oaxaca, San Luis Potosí, Sinaloa, Tamaulipas, Veracruz; Mesoamerica; Colombia, Venezuela, Ecuador, Perú, Guayanas, Brasil; Antilles.

Mpio Álamos: Near Guajaráy, 120 m, vine growing on *Pisonia capitata* and *Baccharis salicifolia* with yellowish-cream corollas, uncommon 14 Mar 1994, *Fishbein 1551*!; Macúzari (Adolfo Ruiz Cortinez) Dam, 120 m, 16 Oct 1992, locally common herbaceous vine to 3 m high in shrubs, flowers white, *Van Devender 92-1391*!; Below the village of Guajaráy on Arroyo Guajaráy, 27°36'N, 108°55'45"W, 270 m, 19 Mar 1993, tropical deciduous forest in rocky stream canyon, common vine on shrubs, flowers white, *Van Devender 93-454*!; Güirocoba crossing of Río Cuchujaqui, 260 m, locally dense herb on dense *Perityle microglossa* near river, flowers white, 5 May 1992, *Van Devender 92-522*! **Mpio Yécora:** 1.5 km NW of Curea, 460 m, riparian forest in stream canyon, tropical deciduous forest on slope, locally common herbaceous vine in shady arroyo bottom, 17 Sep 1998, *Reina-G. 98-1220* (USON!).

OPERCULINA Silva Manso, Enum. Subst. Braz. 16. 1836. [From Latin *operculum*, a lid or cover, and -*inus*, pertaining to, referring to the covering of the capsule.]

Lianas or small twining **herbs,** the stems prostrate or climbing, to 6 m long, smooth or striate, glabrous. **Leaves** ovate, broadly ovate, pinnatly or palmately lobed or compound, the segments 5 or 7 or entire, glabrous; petioles and pedicels sometimes winged, mostly glabrous. **Inflorescences** in axillary monocasia. **Flowers** few or solitary, often with foliose bracts. Sepals equal or unequal, enlarging in the fruit and becoming coriaceous, sometimes irregularly dentate on the margins, glabrous. Corollas broadly campanulate, funnelform or salverform, white, yellow, or reddish to salmon, the interplicae pilose, the plicae glabrous. Stamens included (exserted in *O. pteripes*); anthers twisted when fully mature; pollen 3-colpate. Ovary glabrous, bilocular, each locule 2-lobed; style included (exserted in *O. pteripes*), filiform; stigma of 2 globose lobes. **Fruits** dehiscent, the upper part separating by a circumscissile epicarp, the upper part more or less fleshy and separating from the lower segment and from the endocarp, 2-locular. Seeds 1–4, ovoid to ovate, glabrous or pubescent.

Species about 15; 10 known from only the Old World.

Selected reference.—Staples and Austin (1981).

1. Leaves pinnatisect to palmately compound. Flowers white, campanulate ____ **O. pinnatifida**
1. Leaves simple, entire. Flowers reddish, red-orange to salmon, tubular ____ **O. pteripes**

Operculina pinnatifida (Kunth) O'Donell, Lilloa 23:432, t. 4–5, 1950. TYPE: CUBA: *Humboldt & Bonpland s.n.* (holotype: P, microfiche!). Although this specimen is labeled as originally from Cuba, no subsequent collections have been found there. We believe that the plants actually were from Mexico, and that there was a confusion in labels. *Convolvulus pinnatifidus* Kunth, Nov. Gen. Sp. (quarto ed.) 3:108. 1818 [1819]. *Ipomoea pinnatifida* (Kunth) G. Don, Gen. Hist. 4:280. 1838. *Merremia pinnatifida* (Kunth) Hallier f., Bot. Jahrb. Syst. 16(4–5):552. 1893.

Ipomoea ornithopoda B.L. Rob., Proc. Amer. Arts 27:183. 1893. Type: MEXICO. San Luis Potosí: Las Canoas, Jul 1890, *Pringle 3553* (holotype: GH!; isotype: F!). *Operculina ornithopoda* (B.L. Rob.) House, Bot. Gaz. 43(6):414. 1907.

Ipomoea megacarpa Brandegee, Zoë 5(10):218. 1905. Type: MEXICO. Sinaloa: Culiacan, 6 Sep 1904, *Brandegee s.n.* (lectotype designated here: barcode UC 105130!; isolectotypes: UC 105129! US US00008200!).

Operculina roseana House, Bull. Torrey Bot. Club 33:500. 1906. Type: MEXICO. Sonora: Agiabampo, 1890, *Palmer 781* (lectotype designated here: US 00111355!; isolectotypes: NY!, US 00111356!).

Operculina angustiloba House, Bull. Torrey Bot. Club 33:501. 1906. Type: MEXICO. San Luis Potosí: San Dieguito, 13–16 Jun 1904, *Palmer 112* (holotype: US!; isotype: GH!).

Operculina pectinata House, Muhlenbergia 5(5):69. 1909. Type: MEXICO. Oaxaca: about Lagunas, 5 Jun 1895, *E.W. Nelson 2646* (holotype: US!; isotypes: GH!, NY!). San Luis Potosí: near Tancanhuitz, 1 Jun 1898, *E.W. Nelson 4369* (paratype: US!).

Gallinita, pata de gallo (Friedman 1996); TANSY-LEAF LID-POD (USDA).

Perennial herbs, the stems twining or prostrate, to 6 m long, sometimes angular, glabrous. **Leaves** 2–12 cm long, 2–11 cm wide, ovate in outline, pinnatisect to palmately compound, the segments 5–9, linear, lanceolate to elliptic-obovate, apically obtuse-acuminate, basally truncate or auriculate, with few trichomes on upper and lower surfaces, the margins entire. Inflorescences of monocasia. **Flowers** 1–3, on winged peduncles (at least in the upper part), glabrous. Sepals 1.1–1.6 cm long, equal, straw-colored to slightly rosy during anthesis, ovate to obovate, accrescent in fruit, membranaceous, glabrous. Corollas 3.4–5.3 cm long, campanulate, white, the limb more or less entire, widening gradually, the interplicae sericeous. **Capsules** 1.2–2 cm long, transparent, brown, glabrous. Seeds 1–4, 5–7 mm long, ellipsoidal, black, glabrous.

Sonora.—Arroyos in coastal thornscrub in the far southwestern part of the state and foothills thornscrub in the central part of the state; 10–730 m. Probably flowering May–October

General distribution.—Texas; Guerrero, Edo. México, Michoacán, Morelos, Nuevo León, Oaxaca, San Luis Potosí, Sinaloa, Tamaulipas, Veracruz; Mesoamerica.

Through much of its range this species is known as *queibra-platos* and is considered such a drastic laxative that even handling the plants will cause dishes to break at home (Alcorn 1984). In some areas it is an important medicinal plant.

Mpio Hutabampo: Jepopaco vicinity, 6.8 km S of Camahuiroa, 26°29'N, 109°15'W, 10 m elev., uncommon perennial vine in *Erythrina flabelliformis* up to 6 m, 20 Oct 1994, *Friedman 435-94* (ASU!). **Mpio Moctezuma:** 13.7 km N-NW of Tepache on road to Moctezuma (SON 117), 29.6239°N, 109.5294°W, 730 m, sparse scrub on basalt cobble plain, uncommon perennial vine on shrub, flowers white open 10:00 a.m., 17 Aug 2003, *Reina-G. 2003-941* (USON!).

Operculina pteripes (G. Don) O'Donell, Lilloa 23:435, t. 6, 1950. Type: ECUADOR: Guayaquil, *Ruiz & Pavon* [8/21]. 1778–88 (printed label), 1800 (typed label) (holotype: MA!; isotype: F!). *Calonyction pteripes* G. Don, Gen. Hist. 4:264. 1838.

Ipomoea pterodes sensu Seem., Bot. Voy. Herald 171. 1854, not Choisy (1845). Type: PANAMA: Rio de Santamaria, *Seemann* (not seen).

Ipomoea alata sensu Rose, Contr. U.S. Natl. Herb. 1:108. 1891. [Not *I. alata* R. Br. (1810) or G. Don (1838), not *Operculina alata* Urb. (1902).] Type: MEXICO. Sonora: Álamos, 16–30 Sep 1890, *Palmer 706* (lectotype designated here: US 00111358!; isolectotypes: US 00930939!, US 00930940!).

Ipomoea alatipes Hook. f., Bot. Mag. 88:t. 5330. 1862. Type: PANAMA: Dec 1861, *Hayes 543* (lectotype designated here: BM 000953206!); Veraguas: *Seemann s.n.* (syntype: not seen). VENEZUELA: *Fendler 2084* (syntype: GH!).

Operculina alatipes (Hooker f.) House, Bull. Torrey Bot. Club 33:499. 1906. *Operculina rubicunda* House, Bull. Torrey Bot. Club 33: 498 (1906). A new name for *I. alata* Rose. *Ipomoea rhodocalyx* A. Gray, Proc. Amer. Acad. Arts 22:439–440. 1887. Type: MEXICO. Jalisco: Tequila, Aug–Sep 1886, *Palmer 421* (holotype: GH!; isotypes: K!, MO!, NY!, US!).

Operculina lancifolia House, Muhlenbergia 5(5):68. 1909. Type: MEXICO. Chiapas: valley of Jiquipilas, 2200–2800 ft alt., 16–18 Aug 1895, *Nelson 2923* (holotype: US!).

CAMPANILLA CHOCOLATE

Perennial herbs or lianas, glabrous, the stems twining, pendulous, or prostrate, reaching 5 m long, becoming woody toward the base, striate to angular, glabrous. **Leaves** 3–17 cm long, 2–8 cm wide, simple, entire, ovate to broadly-ovate, apically acute to acuminate, attenuate, mucronate, basally cordate to almost truncate; petioles to about half as long as the blades. Inflorescences monocasial to dicasial. **Flowers** (1)2–12, on peduncles with 3 wings in the central part 0.6–3.5 mm wide, becoming attenuate toward both ends. Sepals more or less equal, the outer ones 2.2–2.6 mm long, ovate to ovate-elliptic, the apex acute to obutse, the inner ones 2.3–2.5 cm long, ovate, obtuse, glabrous or more often pubescent near the base, surrounding the base of the corolla. Corollas 4–7 cm long, salverform, the limb more or less entire, broadening abruptly, reddish or red-orange to salmon, tomentulose on the tube and the interpliae. **Capsules** 1.5–2 cm long, transparrent, brown, glabrous. Seeds 1–4, 7–9 mm long, ovoid to ellipsoid, black, glabrous.

Sonora.—Foothills thornscrub, tropical deciduous forest, and oak woodland in the southeastern and east-central part of the state; 240–1250 m. Flowering July–October.

General distribution.—Chiapas, southwestern Chihuahua, Colima, Distrito Federal, Edo. México, Guerrero, Jalisco, Michoacán, Morelos, Nayarit, Oaxaca, Sinaloa; Mesoamerica; Colombia, Venezuela, Ecuador, Peru.

The flowers of this vine have the shape and color of bird flowers and are visited by hummingbirds. There is an incredible variation in colors of the flowers even within the limited range available. No study of pollination or color variation has been made beyond casual observations. However, the various names given to it, and the many illustrations from the 1800s onward show the fascination that Europeans had with the flowers.

Mpio Álamos: Arroyo el Mentidero at El Chinal road, 11.3 km S of Álamos, 26°54'45"N, 108°55'05"W, 240 m, 20 Sep 1993, flowers red, *Van Devender 93-843*!; Río Mayo Raft trip, 2 km beyond Palmarito on bank of Río Mayo, 27°53'N, 108°48'W, 26 Sep 1991, *Rondeau & Jenkins 91-180* (FTG-FAU!); 1.3 km S of Güirocoba Road, 3.3 km S of Álamos on road to El Chinal, Sinaloa, 26°59'30"N, 108°55'25"W, 340 m, 11 Oct 1992, *Van Devender 92-1201*!; Rancho Santa Bárbara, 27°07'N, 108°43'W, 1200 m, *Smith 18 Jul 1990*!; Tepopa, N-NW of Chiribo, 27°19'N, 108°43'W, 1250 m, upper dry tropical forest, *Pinus oocarpa, Quercus pennivenia, Martin 22 Aug 1992*!; San Bernardo, infrequent with bright orange-red flowers, 6 Sep 1935, *Gentry 1668*!; 1.7 km S of Álamos, flowers red, 20 Sep 1993, *Van Devender 93-866A*!; 1 mi above El Guayabo crossing of Río Cuchujaqui, 14 km (air) E-SE Álamos, tropical deciduous forest on slopes and *Taxodium-Salix* gallery forest along stream, 27.00138°N, 108.785°W, 350 m, 24 Aug 1993, *Steinmann 93-291*! **Mpio Ónavas:** Rancho La Mula, 28 km SE of Río Yaqui on Mex 16, 28°28'50"N, 109°22'W, 790 m, tropical deciduous forest, very common herbaceous perennial, flowers salmon, 30 Aug 2000, *Van Devender 2000-507*! **Mpio Villa Pesqueira:** 3 mi NE of Mátape, 8 Sep 1941, *Wiggins & Rollins 398*! **Mpio Yécora:** 2.7 km W-NW of Tepoca on Mex. 16, tropical desciduous forest, 28.46°N, 109.263°W, 750 m, uncommon perennial vine, flowers salmon, 1 Sep 2001, *Reina-G. 2001-763* (USON!); La Concepción, 29°19'25"N, 109°02'20"W, 650 m, *Trauba 18 Jul 1997* (FTG-FAU!); 1.5 mi W of Santa Rosa, between mine and town, ca. 2890 ft, 10 Aug 1976, *Goldberg 76-257*!

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BOOK REVIEW

Emily Monosson. 2012. **Evolution in a Toxic World: How Life Responds to Chemical Threats.** (ISBN-13: 978-1-59726-976-6, hbk.). Island Press, 1718 Connecticut Ave., NW, Suite 300, Washington, DC 20009, U.S.A. (**Orders:** http://islandpress.org/index.html). \$35.00 hbk., \$29.95 pbk., 240 pp., 10 figures, notes, index, 6" × 9".

"The best way to envisage the situation is as follows: the environment presents challenges to living species, to which the latter may respond by adaptive genetic changes."—*Theodosius Dobzhansky.*

… And this is exactly what Emily Monosson discusses throughout the ten chapters of *Evolution in a Toxic World: How Life Responds to Chemical Threats.* This 222-page book is a thought-provoking summary of an important but often ignored subject matter, environmental toxicology. The introduction (Chapter 1) is a fascinating overview of the subject matter. Monosson opens her introduction with two powerful sentences: "All of life is chemical. But not all chemicals are compatible with life." Think about that contrast! The author gives an overview of the four sections of the book: 1) Nature's Toxicants (everything is a poison in the right dose), 2) Evolutionary History of Toxicology, 3) Toxic Evolution in Action, and 4) Looking Forward by Looking Back.

Chapter 2—Shining a Light on Earth's Oldest Toxic Threat, looks at UVR, a highly energetic and destructive force to be reckoned with. We all know metals like arsenic and the secondary plant metabolite strychnine are poisonous, but Monosson throws at the reader chemical toxicants that most of us don't think about, like oxygen. Monosoon points out, "we cannot live without it, yet every day we struggle to coexist with this highly reactive and potentially toxic chemical." Oxygen is discussed in detail in Chapter 3—When Life Gives you Oxygen, Respire. Chapter 5 looks at the many toxic metals that life deals with. Chapter 6 discusses chemical warfare … the battle to protect and to survive. The combatants? Plants and animals. Sounds like a sci-fi movie, and it very well could be. Maybe people would watch and then take notice of the thousands of chemicals in our environment. If you like war, then Chapter 6 is a captivating account of this historical battle and challenge to stay alive; it's my favorite chapter in the book. This is not to say that the rest of the book is not interesting. Quite the contrary, Chapter 7—Sensing Chemicals is enticing, Chapter 8—Coordinated Defense is inviting, Chapter 9—Toxic Evolution is captivating, and Chapter 10 is all about toxic overload: "How will life's toxic defense mechanisms respond to industrial age chemicals?" And yes, there are many. "In 2009, the Chemical Abstracts Service, which catalogs and tracks all known chemicals, announced the registration of its fifty-millionth 'novel' chemical—the last ten million chemicals having been registered over the preceding nine months. There are plenty more novel chemicals to be found." In the conclusion, Monosson writes that this toxic world we live in is challenging to each and every human. We do live in a sea of toxic chemicals. "Life on Earth is now subject to a virtual onslaught of chemicals associated in one way or another with human activity. We are a society built on chemicals, and there is no turning back." Monosson says that we must strive to better understand how chemicals affect wildlife and human health. "We have to do so. There is no higher ground, no corner on earth where life can escape the influence of toxic chemicals. The choice must not be to 'evolve or die.'"—*Barney Lipscomb, Botanical Research Institute of Texas, 1700 University Dr., Fort Worth, Texas 76107-3400, U.S.A.*

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CONVOLVULACEAE OF SONORA, MEXICO. II: *CUSCUTA*

Mihai Costea

Department of Biology
Wilfrid Laurier University
75 University Avenue W
Waterloo, ON, N2L 3C5, CANADA
mcostea@wlu.ca

Richard S. Felger

Herbarium, University of Arizona
P.O. Box 210036, Tucson, Arizona 85721, U.S.A.
and Sky Island Alliance, P.O. Box 41165
Tucson, Arizona 85717, U.S.A.
rfelger@ag.arizona.edu

Daniel F. Austin

Arizona-Sonora Desert Museum
2021 N. Kinney Road, Tucson, Arizona 85743, U.S.A.
and Herbarium, University of Arizona
P.O. Box 210036, Tucson, Arizona 85721, U.S.A.
dr_ipomoea@yahoo.com

Thomas R. Van Devender

Sky Island Alliance, P.O. Box 41165
Tucson, Arizona 85717 and Herbarium
University of Arizona
P.O. Box 210036, Tucson, Arizona 85721, U.S.A.
VanDevender@skyislandalliance.org

J. Jesús Sánchez-Escalante

Universidad de Sonora
Dept. de Investigaciones Científicas y Tecnológicas
Rosales y Niños Héroes, Centro
Hermosillo, Son, 83000, MÉXICO
jsanchez@guayacan.uson.mx

ABSTRACT

This article is the second part of a comprehensive floristic and taxonomic study of the Convolvulaceae occurring in the state of Sonora, Mexico in which we examine the parasitic genus *Cuscuta* (dodder). We document for the first time 21 species belonging to subgenus *Grammica*, the largest and most complicated taxonomically infrageneric group of *Cuscuta*. Sonoran dodders represent about a third of the total number of species found in Mexico, and the diversity of species is most similar to that of the Baja California Peninsula and Arizona (12 and 11, respectively species in common), followed by New Mexico (nine species in common). The best represented in Sonora is the *C. umbellata* clade, with seven of the nine North American species growing in this geographical area. Two species, *C. campestris* and *C. indecora*, are invasive agricultural pests that have likely been introduced in Sonora with contaminated alfalfa seeds. We revise the nomenclature and typification of all the taxa. Dichotomous identification keys, detailed descriptions, phenology, host range, local and global geographic distribution data are provided.

RESUMEN

Este artículo es la segunda parte de un estudio florístico y taxonómico detallado de la familia Convolvulaceae del Estado de Sonora, México en el cual examinamos el género parasítico *Cuscuta* (fideo). Documentamos por primera vez 21 especies pertenecientes al subgénero *Grammica*, el grupo infragenérico de *Cuscuta* taxonómicamente más grande y complicado. Las especies sonorenses representan alrededor de un tercio del total de especies encontradas en México, y la diversidad de especies es mas similar a la de la Peninsula Baja California y Arizona (12 y 11 especies en común, respectivamente), seguida por Nuevo México (nueve especies en común). La mejor representada en Sonora es el clado *C. umbellata*, con siete de las nueve especies norteamericanas creciendo en esta área geográfica. Dos especies, *C. campestris* y *C. indecora*, son plagas agrícolas invasoras que han sido introducidas a Sonora a través de semillas de alfalfa contaminadas. Revisamos la nomenclatura y tipificación de todos los taxones. Se proporcionan claves de identificación dicotómicas, así como descripciones detalladas, y datos de fenología, distribución de hospederos y distribución geográfica tanto local como mundial.

Key Words: *Cuscuta*, floristic diversity, ecology, geographic distribution, Mexico, Sonora, vegetation, typification

INTRODUCTION

This is the second part of a comprehensive study regarding the Convolvulaceae of Sonora (Felger et al. 2012). In the first part, we included a general introduction, information about the growth forms, cases of endemism/rare species, species diversity, and types of vegetation for all the genera/species. The first part also provided identification keys, and extensive taxonomic and floristic data for all the Convolvulaceae genera except Cus-

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cuta (dodder). Since the diversity of dodder species and their association with certain vegetation types were presented together with the other Convolvulaceae (Felger et al. 2012), this article concludes the monographic study of this botanical family in Sonora with a taxonomic and floristic account of the genus *Cuscuta*.

Cuscuta is nearly cosmopolitan and comprises over 200 species (Costea 2007–onwards). Although some dodders are agricultural pests (Costea & Tardif 2006), more numerous *Cuscuta* species require conservation measures (Costea & Stefanović 2009). Roughly 75% of species are native to the Americas and about 30% to Mexico and southern USA (Stefanović et al. 2007). We have documented 21 species of *Cuscuta* in the flora of Sonora, a number that is higher or comparable to that of the neighboring areas to the north and west (Arizona, the two Baja California states, California, and New Mexico; see table 1, Felger et al. 2012). Interestingly, while the species diversity of the other Convolvulaceae genera increases towards southern Mexico and Central America, dodder species richness declines sharply in these geographical areas (Felger et al. 2012). The 21 species that occur in Sonora belong to nine of the 15 clades of subgenus *Grammica*, the most complex infrageneric taxon of *Cuscuta* (Stefanović et al. 2007). The best represented in Sonora is the *C. umbellata* clade (clade "L") with seven of the nine North American species growing in Sonora (*C. desmouliniana*, *C. legitima*, *C. leptantha*, *C. odontolepis*, *C. polyanthemos*, *C. tuberculata*, and *C. umbellata*). This strongly suggests that Sonora is part of the genetic center of origin for this clade, which has a complicated evolutionary history shaped by reticulate evolution (Costea & Stefanović 2010). The other eight clades of subg. *Grammica* are represented in Sonora by one species (*C. salina*, clade "A"; C. *tinctoria*, clade "G"; *C. corymbosa* var. *grandiflora*, clade "J", *C. indecora*, clade "M"; *C. campestris*, clade "B"; *C. vandevenderi*, clade "N"), two species (*C. azteca* and *C. chinensis* var. *applanata*, Clade "H"; *C. americana* and *C. macrocephala*, clade "I"), or three species (*C. boldinghii*, *C. costaricensis*, and *C. erosa*, clade "K").

CUSCUTA L., Sp. Pl. 124. 1753. [Based on the Aramaic and Hebrew triradical root of the verb K-S-Y (כ,ך Kaph, ש Shin, י Yodh), כשי, which means "to cover" (Costea & Tardif 2004)].

Common names.—Dodder; fideo

Herbaceous **vines.** Stems filiform, yellow or orange, trailing or dextrorsely twining and attached to the host by numerous small haustoria, glabrous. **Leaves** reduced to minute, alternate scales. **Inflorescences** monochazial clusters further grouped in cymose inflorescences that are often confluent. **Flowers** 4–5-merous, small, always ± fleshy when fresh, thick or membranous-thin when dry, white, white-cream, sometimes yellowish or reddish. Conic-cylindrical papillae present or absent on the pedicels, perianth and ovary/capsule; laticifers visible or not in the calyx, corolla, ovary/capsules, translucent, white, yellow or orange, isolated or arranged in rows especially in the midveins of the calyx and corolla lobes, round, ovoid or elongated. Calyx gamosepalous; lobes basally overlapping or not, sometimes with multicellular projections (*C. chinensis* var. *applanata*, *C. boldinghii*). Corolla gamopetalous with lobes imbricate in bud, sometimes with a subapical cusp or horn-like multicellular appendage (*C. boldinghii*, *C. costaricensis*, *C. erosa*). Stamens alternating with the corolla lobes. Pollen 3-colpate (sometimes 4- or 5-colpate in the same anther), tectum imperforate to reticulate. Infrastaminal scales commonly present, scale-like appendages dentate or fringed, bridged and adnate to the corolla tube base, forming a corona alternating with the corolla lobes. Ovary superior, 2-locular, each locule with 2 anatropous ovules. Styles 2, terminal, distinct or united, equal or unequal. Stigmas spherical to linear (only distinct unequal styles with spherical stigma in the species from Sonora). **Fruits** capsules, indehiscent (sometimes opening irregularly between the styles) or circumscissile by a ± regular line near the base. **Seeds** 1–4 per capsule, 3-angled or dorsoventrally compressed; endosperm nuclear; embryo uniformly slender, 1–3-coiled, without cotyledons, consisting mostly from the hypocotyl; seed coat alveolate when dry and papillate when hydrated (rarely not alveolate/papillate with cells ± rectangular, puzzle-like arranged).

Cuscuta campestris and *C. indecora* are weeds, the former subcosmopolitan, the latter widespread in North and South America. Both species have been likely introduced to Sonora with contaminated legume seeds (e.g., alfalfa; Costea & Tardif 2006). Another species, *C. tinctoria*, may also have been introduced to Sonora on the cultivated tree *Schinus terebinthifolia*. Although none of the *Cuscuta* spp. are endemic to Sonora, many occur only here and in adjacent geographical areas (Table 1, Felger et al. 2012). The diversity of *Cuscuta* species in Sonora is most similar to that of the Baja California Peninsula and Arizona (12 and 11, respectively common species), followed by New Mexico (9 common species), while only three of the Sonoran species occur in California (Table 1, Felger et al. 2012).

Selected references.—Stefanović et al. (2007), Welsh et al. (2010), Wright et al. (2011, 2012), Yuncker (1932, 1965).

Identification of most *Cuscuta* spp. is a lengthy process because rehydration of flowers, dissection, and examination under a microscope are usually necessary. Measurements of floral parts were done on rehydrated herbarium material. Length of flowers was measured from the base of calyx to the tip of straightened corolla lobes. The texture of flowers and the color of calyx were noted on dry herbarium material. Observation of papillae and laticifers requires magnifications of at least 100 ×. Examination of seed surface requires magnifications of at least 150 ×. In describing the stem, the following categories based on stem diameter were used (Yuncker 1921): "slender" with the diameter of 0.35–0.4 mm, "medium" with the diameter of 0.4–0.6 mm, and "coarse" when diameter is greater than 0.6 mm. The geographical distribution, both in Sonora and Mexico, is based on herbarium specimens.

The host range is also based on herbarium labels as well as observations by Richard Felger; hosts observed in other geographical areas are included when they are present in Sonora.

SEM images of the flowers for some species are provided to help identification. The vouchers are indicated ("SEM") in the lists of typical collections examined. Pictures were taken with the scanning electron microscopes Hitachi S-570 and LEO 1530 FE-SEM at 15 KV. Samples were coated with 30 nm gold using an Emitech K 550 sputter coater. Numerous images for all the species, including the types, with details of dissected flowers are available from Digital Atlas of *Cuscuta* (Costea 2007–onwards). All specimens cited have been seen by Costea and are at ARIZ unless otherwise indicated. For citation of herbarium specimens see Felger et al. (2012). Plants not native to flora area are marked with an asterisk (*).

1. Capsules indehiscent.
2. Corolla lobes with inflexed apices. Often weeds in alfalfa and other crops.
3. Perianth membranous; calyx yellow, shiny-reticulate when dry, with obtuse to rounded apices. Capsules globose-depressed to depressed, 1.3–2.8 × 1.9–3.8 mm; not thickened or risen around the large interstylar aperture **C. campestris**
3. Perianth fleshy; calyx brownish not shiny reticulate when dry, with acute lobes. Capsules globose to subglobose, thickened and risen around the medium interstylar aperture **C. indecora**
2. Corolla lobes straight. Not weeds.
4. Stamens equaling to longer than corolla lobes. Capsules globose-depressed to globose-obovoid with 3–4 seeds **C. vandevenderi**
4. Stamens shorter than corolla lobes. Capsules elliptical-ovoid with 1 seed **C. salina** var. **salina**
1. Capsules circumscissile near the base (the line of dehiscence is readily detectable even at the base of young ovaries; at this stage, the carpellary wall will tear along the dehiscence line when light pressure is applied).
5. Corolla lobes with a subapical horn-like projection.
6. Bracts broadly triangular, 3–3.5 mm long. Flowers 4.2–5.5 mm long; calyx lobes acuminate, without a subapical dome- or horn-like protuberance **C. costaricensis**
6. Bracts ovate to lanceolate, 0.75–2 mm long. Flowers 2.5–4.5 mm long; calyx lobes obtuse, truncate to acute with a subapical, dome- or horn-like protuberance.
7. Calyx lobes orbicular to oblong-obovate, apex nearly truncate not exceeded by the subapiacal dome-like appendage. Seeds 0.94–1.45 × 0.8–1.38 mm **C. erosa**
7. Calyx lobes ovate, oblong to slightly spathulate, apex obtuse to acute, exceeded by the apical horn-like appendage. Seeds 0.75–1.1 × 0.7–0.9 mm **C. boldinghii**
5. Corolla lobes without subapical projections.
8. Calyx lobes round to wider than long, with obtuse or rounded apex.
9. Flowers 2.5–4.2 mm long. Capsules globose-ovoid to ovoid. Seeds 1 per capsule **C. americana**
9. Flowers 4.5–6.5(–7) mm long. Capsules globose to globose-depressed. Seeds usually more than 1 per capsule.
10. Calyx lobes not or barely overlapping **C. corymbosa** var. **grandiflora**
10. Calyx lobes broadly overlapping.
11. Flowers 5–6.5 mm long; corolla lobes mostly erect ca. ¼ of the corolla tube; stamens included, filaments 0.1–0.3 mm long; infrastaminal scales ca. ⅔ as long as the corolla tube **C. macrocephala**
11. Flowers 4–5.2 mm long; corolla lobes initially erect, later reflexed, ± equaling the tube; stamens exerted, filaments 0.8–1.2 mm long; infrastaminal scales equaling corolla tube **C. tinctoria**
8. Calyx lobes triangular-ovate to lanceolate, longer than wide with obtuse, acute to acuminate apex.

12. Calyx ¼–¾ of the corolla tube.

13. Inflorescences dense, paniculiform-glomerulate; pedicels to 1 mm long. Calyx lobes basally overlapping **C. odontolepis**

13. Inflorescences loose, umbelliform or racemiform; pedicels 2–15 mm long. Calyx lobes not basally overlapping.

14. Flowers 5–7.5 mm long; corolla lobes ca. ½ the tube **C. polyanthemos**

14. Flowers 2.5–4.5(–5) mm long; corolla lobes equaling the tube.

15. Flowers 5-merous; calyx lobes carinate and/or with multicellular protuberances on the midveins; corolla lobes erect **C. tuberculata**

15. Flowers 4-merous; calyx lobes not carinate, without multicellular protuberances on the midveins; corolla lobes spreading to reflexed **C. leptantha**

12. Calyx equaling or somewhat longer than corolla tube.

16. Inflorescences umbellate.

17. Papillae present on the pedicels, calyx and corolla lobes; infrastaminal scales ca. ¾ of the corolla tube **C. desmouliniana**

17. Papillae absent on the pedicels and calyx (sometimes present of the adaxial face of corolla lobes); infrastaminal scales equaling or slightly longer than the corolla tube.

18. Flowers 4.0–5.5(–6.0) mm long; calyx lobes acuminate **C. legitima**

18. Flowers 2–3 mm long; calyx lobes obtuse to acute **C. umbellata** var. **umbellata**

16. Inflorescences glomerulate or dense paniculiform.

19. Flowers thick, brown-reddish when dry; infrastaminal scales oblong, distally truncate and superficially denticulate, bifid or irregularly fringed with a few fimbria **C. dentatasquamata**

19. Flowers membranous, creamy-yellow upon drying; infrastaminal scales distally rounded and uniformly fringed.

20. Calyx lobes not carinate or weakly so (carina not visible without a microscope), with acute lobes; styles 0.4–0.7 mm long **C. azteca**

20. Calyx lobes carinate, with obtuse to rounded lobes; styles 0.8–1.8 mm long **C. chinensis** var. **applanata**

Cuscuta americana L., Sp. Pl. 1:124. 1753. TYPE: U.S.A.: "Habitat in Virginia," *Kalm s.n.* (conserved, 170.5, photos S-LINN!, Reveal et al. 1990).

Stems medium, yellow-orange. **Inflorescences** glomerulate or dense paniculiform, often confluent. Pedicels 0.2–1 mm long, bracts 1 at bases of clusters, 0–1 at the base pedicels, 1.2–2.2 mm long, ovate to lanceolate, margins entire, apex acute. **Flowers** 5-merous (Fig. 1d), 2.5–4.2 mm long, thick, white when fresh, brownish upon drying. Papillae absent. Laticifers not visible or barely visible in the calyx and corolla lobes, isolated, elongated. Calyx 2.4–3.3 mm long, brownish, cylindric, ¾ to equaling corolla tube, divided ca. ¼ the length, tube 1.5–2.4 mm long, lobes 0.5–0.9 mm long, basally overlapping, broadly ovate, not carinate, margins entire, apex rounded to obtuse. Corolla 2–3.3 mm long, tube 1.7–2.5 mm long, cylindric, lobes 0.5–0.8 mm long, usually erect, sometimes slightly spreading, ⅓–¼ of the corolla tube, broadly ovate, margins entire, apex obtuse, ± cucullate to straight. Stamens included, shorter than the lobes; anthers 0.25–0.4 × 0.25–0.4 mm, broadly ovate to subround, filaments 0.1–0.3 mm long. Infrastaminal scales 1.4–1.8 mm long, ¾–⅘ the length of corolla tube, bridged at 0.7–0.8 mm, triangular to oblong, short-fringed, fimbriae 0.05–0.15 mm. Styles 1.5–2.2 mm long, equal to longer than the ovary, uniformly filiform. **Capsules** circumscissile, 1.8–3 × 0.8–2 mm, globose-ovoid to elliptic, not thickened or risen around the small interstylar aperture, not translucent, capped by the withered corolla. Seeds 1 per capsule, 1.42–1.57 × 1–1.19 mm, subglobose to ellipsoid, seed coat cells obscurely alveolate/papillate.

Sonora.— Relatively common and widespread; Sonoran Desert except the more arid regions, coastal and foothills thornscrub, tropical deciduous forest, oak woodland, and occasionally a weed in *Citrus* groves; ca. 10–1050 m. Flowering throughout the year but especially September–December. Parasitizes a wide variety of woody and herbaceous genera in Sonora including *Acalypha californica*, *Aloysia sonorensis*, *Bursera* including *B. microphylla*, *Celtis pallida*, *Citharexylum flabellifolium*, *Colubrina viridis*, *Cottsia* (*Janusia*) including *C. gracilis*, *Coursetia glandulosa*, *Haematoxylum brasilleto*, *Haplophyton cimicidum*, *Havardia mexicana*, *Jatropha cardiophylla*, *Karwinskia humboldtiana*, *Krameria bicolor* (*K. grayi*), *Lantana velutina*, *Lysiloma divaricatum*, *Marsdenia edulis*, *Melochia tomentosa*, *Mimosa*, *Prosopis glandulosa*, *Sebastiania biloculare*, *Senna* including *S. pallida*, *Solanum hindsianum*, *Vachellia constricta*, and *Vallesia laciniata*.

General distribution.—Florida; most of Mexico: Baja California (norte) and Sur, Chiapas, Colima, Guer-

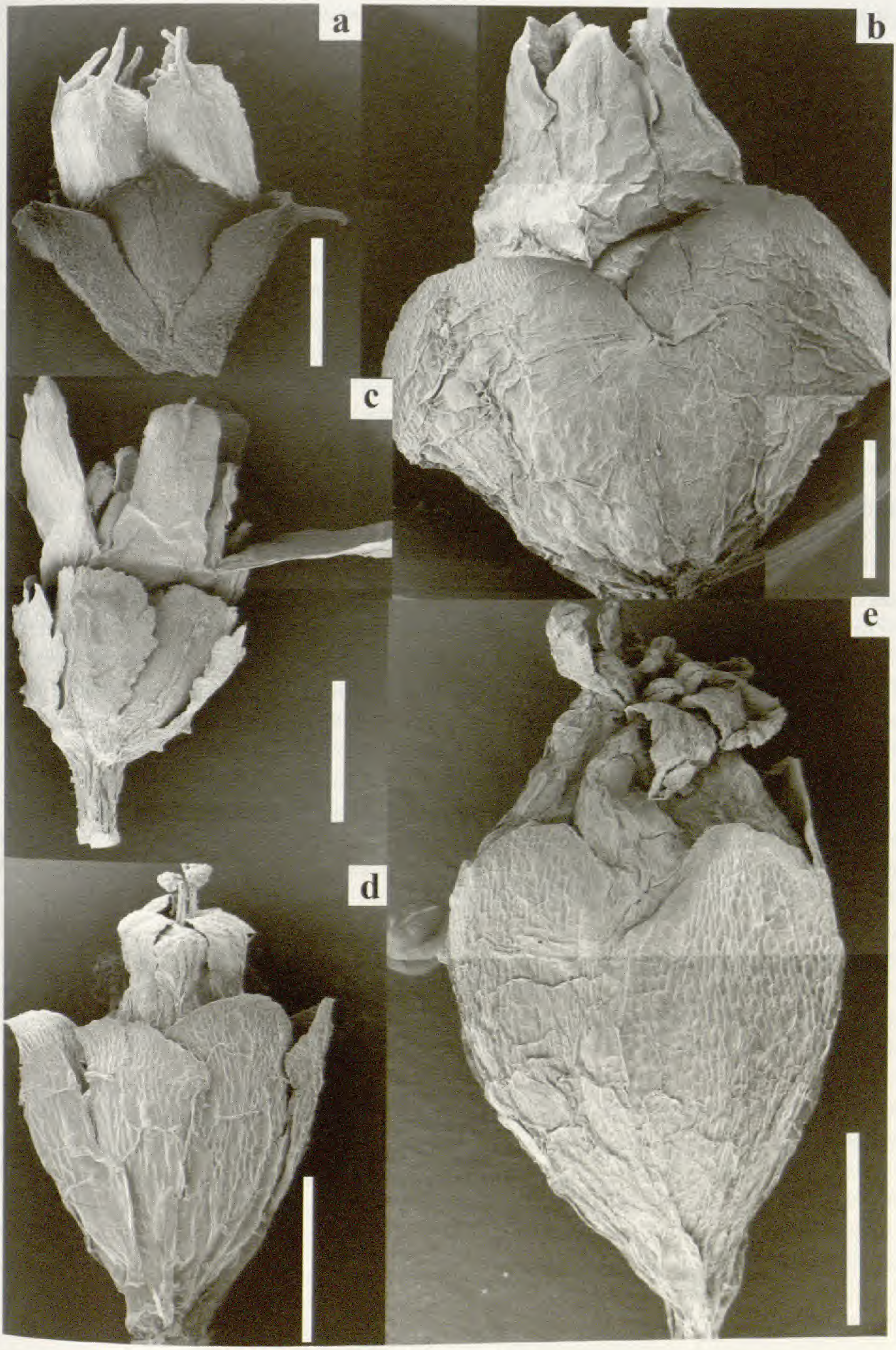

Fig. 1. Morphology of flower, **a.** *Cuscuta boldinghii* (scale bar = 0.75 mm); **b.** *Cuscuta macrocephala* (composite image resulted from the stiching of 4 photos; scale bar 1.3 mm); **c.** *Cuscuta erosa* (scale bar = 1.2 mm); **d.** *Cuscuta americana* (scale bar = 0.9 mm); **e.** *Cuscuta corymbosa* var. *grandiflora* (composite image resulted from the stiching of 2 photos; scale bar = 1.3 mm).

rero, Edo. México, Jalisco, Michoacán, Nayarit, Oaxaca, Puebla, Sinaloa, Veracruz, Yucatán; West Indies; Central and South America.

Selected reference.—Austin (1982).

Mpio Álamos: Álamos, 27°01'N, 108°56'W, 400 m, 20 Sep 1993, *Van Devender 93-823A* (ARIZ, UC, UCR, ARIZ, UC); Álamos, 27°01'N, 108°50'W, 400 m, 11 Mar 1994, *Van Devender 94-59* (ARIZ, UC); Arroyo el Mentidero at El Chinal Rd, 11.3 km S of Álamos, 26°54'45"N, 108°55'05"W, 240 m, 15 Mar 1994, *Van Devender 93-1321*; 15 Mar 1994, *Van Devender 94-176* (ARIZ, ASU, UC; ARIZ, MEXU, UC, UCR). **Mpio Altar:** 10 mi N of Dátil, on *Acacia paucispina* [= *A. constricta*], 2 Nov 1935, *Shreve 492-G*. **Mpio Cucurpe:** Palm Canyon, 17.7 mi SE of Magdalena, Cerro Cinta de Plata, *Van Devender 2 Oct 1976*. **Mpio Guaymas:** Cerro Vigía, 305 m, 9 Jan 1965, *Felger 11803*; 2 km by road W from Puente el Tigre at Mex Hwy 15, 70 m, 30 Dec 1985, *Felger 85-1538*; SE of mouth of Nacapule Canyon, 13 Jan 1965, *Felger 11963*; 5 mi N of Algodones, 10 Nov 1964, *Felger 11362*; near San Carlos Bay, 24 Oct 1939, *Gentry 4723*. **Mpio Hermosillo:** half way between Punta Chueca and town of Bahia Kino, on *Krameria grayi*, *Moser & Moser*, 2 Jan 1972. **Mpio Huatabampo:** 1.6 km N Cerrillos at rocky hills at turnoff to Manuel Caudillo, 9 km SE Melchor Ocampo, 26.4667°N, 109.125°W, thornscrub, 19 Oct 1994, *Friedman 413-94* (ASU). **Mpio Soyopa:** Arroyo Los Garambullos, 0.5 km SE of Río Yaqui bridge on MEX 16, 3.3 km S, 1.5 km E of Tónichi, 28°34'10"N, 109°33'00"W, 180 m, 29 Sep 2000, *Van Devender 2000-745* (ARIZ, HCIB, MEXU, USON, WLU) [SEM]; 0.6 km N of MEX 16 on road to Tónichi, just E of Río Yaqui, foothills thornscrub, 28°34'33"N, 109°33'02"W, 270 m, 7 Jan 2001, *Van Devender 2001-16* (ARIZ, USON, WLU). **Mpio Villa Pesqueira:** S foot of Sierra Pinta, ca. 33 mi S of Moctezuma, ca. 29°35'N, 110°01'W, 730 m, 15 Sep 1996, *Shortman 96-71*. **SONORAN ISLANDS. Tiburón:** N base of Sierra Kunkaak, 23 Oct 2007, *Felger 07-98*; Canyon at NE base of Sierra Kunkaak, 24 Nov 2006, *Wilder 06-428*; Top of Sierra Kunkaak Segundo, E peak of Sierra Kunkaak, 25 Nov 2006, *Wilder 06-495*.

Cuscuta azteca Costea & Stefanov., Org. Divers. Evol. 11:381. 2011. Type: MEXICO. San Luis Potosí: 1877, *Schaffner 780* (holotype: GH!; isotypes: CAS, F!, K!, NY!). *Cuscuta potosina* W. Schaffn. ex S. Watson var. *globifera* W. Schaffn. ex Yunck., Illinois Biol. Monogr. 6(2–3):40. 1921.

Stems slender, orange-yellow. **Inflorescences** glomerulate, often confluent. Pedicels 0.4–1.3 mm long. Bracts 1 at the base of clusters and 0–1 at the base of pedicels, ovate to lanceolate, 1.2–1.8 mm long, margins entire, apex acute. **Flowers** (Fig. 3c) 5-merous, 2–2.6 mm long, membranous, white when fresh, creamy-brownish when dried, papillae absent. Laticifers visible in the corolla and ovary/capsule, isolated, elongated. Calyx 1.4–1.7 mm long, straw-yellow, membranous, finely reticulate and shiny, cupulate, equaling corolla tube, divided ca. ⅔ the length, tube 0.3–0.5 mm long; lobes 0.8–1.3 mm long, not basally overlapping or only slightly so, ovate, not carinate but occasionally with a few multicellular protuberances along midveins, margins entire, apex acute. Corolla 1.5–2.1 mm long, the tube 0.8–1.2 mm long, campanulate but becoming globose in fruit; lobes 0.8–1.2 mm long, erect to spreading, shorter to equaling the tube, ovate-triangular, margins entire or with a few irregular teeth, apex acute, straight to slightly incurved. Stamens exserted, shorter than corolla lobes; anthers 0.25–0.3 × 0.25–0.3 mm, ovate to subround, filaments 0.3–0.6 mm long. Infrastaminal scales 0.9–1.3 mm long, equaling to longer than corolla tube, bridged at 0.1–0.25 mm, oblong, fringed in the distal ½, fimbriae 0.15–0.3 mm long. Styles 0.4–0.7 mm long, shorter than the ovary, evenly filiform. **Capsules** circumscissile, 1.2–2.5 × 1–1.8 mm, depressed-globose, not thickened or risen around the small interstylar aperture, translucent, loosely surrounded or capped by the withered corolla. **Seeds** 3–4 per capsule, 0.8–1 × 0.7–0.9 mm, angled, broadly elliptic to sub-round; seed coat cells alveolate/papillate.

Sonora.—Infrequent in east-central and southeastern Sonora in tropical deciduous forest and pine-oak forest; 370–1920 m. Flowering September–November. Potential herbaceous hosts include *Ayenia*, *Cosmos*, *Dalea*, *Evolvulus*, and *Heterosperma*.

General distribution.—Arizona, New Mexico; Chihuahua, Coahuila, Distrito Federal, Durango, Guanajuato, Edo. México, Hidalgo, Morelos, Oaxaca, Puebla, Querétaro, San Luis Potosí.

Selected reference.—Costea et al. (2011a).

Mpio Álamos: El Guayabo crossing of Río Cuchujaqui, 2.6 km NE of Sabinito Sur, 14 km (by air) E-SE Álamos, tropical deciduous forest on slopes, *Taxodium-Salix* gallery forest along stream, 27°00'05"N, 108°47'08"W, 370 m, 21 Nov 1993, *Steinmann 93-349* (ARIZ, ASU, UC, UCR). **Mpio Yécora:** Restaurant Puerto de la Cruz, 14 km W of Yécora on MEX 16, NE base of Mesa del Campanero (El Enmedio). 28°22'30"N 109°01'42"W, 1920 m, 6 Sep 1996, *Van Devender 96-451* (ARIZ, USON, WLU) [SEM].

Cuscuta boldinghii Urb., Repert. Spec. Nov. 16:38. 1919. Type: NETHERLANDS ANTILLES: Bonaire, *Boldingh 7379* (holotype: at B was apparently destroyed during the Second World War; isotypes: K!, NY!, U (photo!, flowers not dissected)).

Cuscuta ceratophora Yunck., Illinois Biol. Monogr. 6(2–3):28. 1921. Type: MEXICO. Guerrero/Michoacán: 8 Oct 1898, *Langlassé 438* (holotype: US!; isotypes: F!, GH!, K!, NY!, P (not seen)).

Stems slender, yellow-orange. **Inflorescences,** glomerulate or dense-paniculiform, globose-isolated or confluent. Pedicels 0.2–0.6 mm long. Bracts 1 at the base of clusters, 0–2 at the base of pedicels, 0.75–1.8 mm long, ovate to lanceolate resembling sepals, margins entire, apex acuminate to attenuate. **Flowers** 5-merous (Fig. 1a), 2.5–4 mm long, membranous, creamy when fresh, brown when dried. Papillae absent. Laticifers not visible. Calyx 2.3–2.8 mm long, brownish, not reticulate, shiny, campanulate, ca. as long as the corolla tube, divided ½–⅔ the length; tube 0.6–1.1 mm long; lobes 1.3–1.8 mm long, overlapping, ovate, oblong to obovate, not carinate, margins entire or finely serrulate-denticulate, apex acute or obtuse with a subapical horn-like projection, 0.3–0.6 mm long, prolonging beyond the apex. Corollas 2.2–3.2 mm long, tube 1.2–1.6 mm long, campanulate; lobes 1.2–1.8 mm long, ca. as long as the tube, spreading to reflexed, ovate to lanceolate, margins entire to irregular denticulate, apex obtuse but with a subapical horn-like straight projection 0.3–0.7 mm long (like the calyx lobes). Stamens exserted, shorter than corolla lobes, 0.4–0.5 × 0.2–0.3 mm; filaments 0.5–0.9 mm long; anthers ovate to elliptic. Infrastaminal scales 1.2–1.6 mm long, equaling corolla tube, bridged at 0.5–0.7 mm, oblong to broadly ovate, rounded, sparsely short-fringed, fimbriae 0.04–0.15 mm long. Styles 0.9–2 mm long, longer than the ovary, stout and subulate, wider at the base and tapering toward the stigma. **Capsules** circumscissile, 1.8–2.3 × 1.8–2.3 mm, globose, not thickened or risen around the small interstylar aperture, not translucent, capped by the withered corolla. **Seeds** 1–4 per capsule, 0.75–1.1 × 0.55–0.65 mm, angled, subround, ovate to broadly elliptic, seed coat cells ± polygonal [not alveolate/papillate] and puzzle-like arranged.

Sonora.—Southern parts in coastal thornscrub and tropical deciduous forest; 20–260 m. Flowering September–January. In Sonora recorded on *Dicliptera resupinata* and *Euphorbia albomarginata*. Potential hosts from elsewhere in Mexico include *Acalypha, Aeschynomene, Bouchea, Dalea, Desmodium, Euphorbia, Hamelia, Phyllanthus, Salvia, Tephrosia,* and *Wedelia*.

General distribution.—Baja California Sur, Chiapas, Edo. México, Jalisco, Guerrero, Michoacán, Sinaloa, Tabasco, Tamaulipas, Veracruz, Yucatán; West Indies; Guatemala, Honduras, Costa Rica; Venezuela.

Selected reference.—Costea et al. (2011b).

Mpio Álamos: Güirocoba crossing of Río Cuchujaqui, 12.3 km (by air) S-SE of Álamos, 26°56'15"N, 108°53'W, 260 m, on *Dicliptera resupinata*, 28 Jan 1992, *Van Devender 92-31* (ARIZ, UC). **Mpio Huatabampo:** 2.3 km NE of Las Bocas, ca. 50 km (by air) S of Navojoa, dense coastal thornscrub, 26°37'53"N, 109°19'36"W, 20 m, on *Euphorbia albomarginata*, 22 Sep 1994, *Van Devender 94-692* (ARIZ, ASU, UC, UCR) [SEM].

*__Cuscuta campestris__ Yunck., Mem. Torr. Bot. Club 18:138. 1932. Type: U.S.A. Texas: wet prairies, [no date], *Lindheimer 126* (holotype: MO!; isotype: MO!).

Cuscuta pentagona Engelm. var. *calycina* Engelm., Amer. J. Sci. 45:76. 1843 [1845]. Type: *Lindheimer 126* (lectotype: Yuncker 1921) MO!; isolectotype: MO!). *Cuscuta arvensis* Beyr. ex Engelm. var. *calycina* (Engelm.) Engelm., Trans. Acad. Sci. St. Louis 1:495. 1859.

Stems medium, yellow to orange. **Inflorescences** dense, corymbiform-glomerulate. Bracts 1 at the base of clusters, 0–1 at the base of pedicels, 0.9–1.5 mm long, membranous, ovate, ovate-triangular to lanceolate, margins entire, apex acute. Pedicels 0.3–2.5(–3.5) mm long. **Flowers** (4–) 5-merous, 2–3.6 mm, membranous. Papillae absent. Laticifers evident in the calyx, corolla, and ovary/capsule, isolated or arranged in rows, round, ovoid or elongated. Calyx 1.6–2.1 mm long, yellow, reticulate, shiny, cupulate, ca. as long as corolla tube, divided ⅖–⅗ the length, the tube 0.5–0.9 mm long; lobes 1–1.4 mm long, overlapping, ovate triangular, not carinate, margins entire, apex obtuse to rounded. Corolla 2–3.5 mm long, white-creamy when fresh, creamy or golden-yellow when dried, the tube (1.1–)1.5–1.9 mm, campanulate, not saccate; lobes 1.4–1.8 mm long, spreading, triangular to triangular-lanceolate, ca. as long as the tube, margins entire, apex acute to acuminate, inflexed. Stamens exserted, shorter than corolla lobes; anthers broadly elliptic to subround, (0.3–)0.4–0.5 × 0.3–0.4 mm, filaments 0.4–0.8 mm long. Infrastaminal scales 1.5–2 mm long, equaling or exceeding corolla tube, bridged at 0.3–0.5 mm, oblong-ovate to spatulate, rounded, uniformly dense fimbriate, fimbriae 0.3–

0.4(–0.5) mm long. Styles evenly filiform, 0.5–1.6 mm long, shorter to ca. as long as the ovary. **Capsules** indehiscent, globose-depressed to depressed, 1.3–2.8 × 1.9–3.8 mm, not thickened or risen around the large interstylar aperture, sometimes translucent; persistent corolla enveloping ⅓ or less of the capsule base. **Seeds** 4 per capsule, angled, subrotund to broadly elliptic, 1.12–1.54 × 0.9–1.1 mm, seed coat cells alveolate/papillate, hilum region subterminal. $2n = 56$.

Sonora.—Collected from a relatively undisturbed area in Arizona close to the border with Sonora, in oak-grassland at ca. 1040 m, and from agricultural fields in coastal thornscrub in southern Sonora at ca. 10 m. Flowering June–September. Host species in Arizona and Sonora include *Artemisia, Bidens laevis, Brassica nigra, Lotus, Polygonum, Rumex, Senna, Thelesperma*, and *Xanthium*. *Cuscuta campestris* may be more common both in Sonora and elsewhere in Mexico than the scarce herbarium vouchers suggest. Weeds are less collected compared to native plants in Mexico.

General distribution.—Subcosmopolitan; widespread in Canada and USA; Chihuahua, Durango, Guanajuato, Jalisco, Michoacán, Morelos, San Luis Potosí; Central and S America; Europe, Asia, Africa, Australia. This species is perhaps the most widespread and successful weed of the genus worldwide (Costea & Tardif 2006).

Selected references.—Costea et al. (2006a), Costea and Tardif (2006).

Mpio Etchojoa: Los Tejabanes, Etchojoa, weed in a crop of *Carthamus tinctorius*, *Sainz 12 Jun 2010* (WLU). **ARIZONA. Santa Cruz Co.:** Sycamore Canyon, Pajarito Mountains, *Van Devender 13 Aug 1977.*

Cuscuta chinensis Lam. var. **applanata** (Engelm.) Costea & Stefanov., Org., Divers. Evol. 11:383. 2011. TYPE: U.S.A. ARIZONA: 1851–1852, *Wright 1623* (LECTOTYPE: MO!; ISOLECTOTYPES: K!, NY!, US!). *Cuscuta applanata* Engelm., Trans. Acad. Sci. St. Louis 1:479. 1859.

Stems slender, yellow to creamy. **Inflorescences** glomerulate to dense paniculiform, often confluent. Pedicels 0.4–3 mm long. Bracts 1 at the base of clusters, 0–1 at the base of pedicels, 0.9–2.5 mm long, ovate to subround, carinate, margins entire, apex obtuse to rounded. **Flowers** 5-merous (Fig. 3a), 2.5–3.5 mm long, membranous, white-creamy when fresh, creamy-yellow upon drying. Papillae absent. Laticifers evident in the bracts, calyx, corolla, anthers, and ovary, isolated or in rows, ovoid to elongated. Calyx 1.5–2 mm long, straw-yellow, reticulate and shiny, shallowly cupulate, ca. as long as the corolla tube, divided ca. ½ to the base; tube 0.6–0.8 mm long; lobes 0.8–1 mm long, basally overlapping, broadly triangular-ovate, carinate (Fig. 3b) and with irregular multicellular protuberances along midveins, margins entire, apex obtuse to rounded. Corolla 2–3.3 mm long, tube 1–1.5 mm long, campanulate but becoming globose in fruit; lobes 0.9–1.3 mm long, spreading, ca. as long as the tube, ovate-lanceolate, margins entire, apex obtuse to rounded, ± incurved (but not inflexed). Stamens ± exserted, shorter than the lobes; filaments 0.4–0.8 mm long; anthers 0.4–0.6 × 0.4–0.5 mm, broadly ovate to surround. Infrastaminal scales 1.2–1.8 mm long, equal or longer than corolla tube, bridged at 0.2–0.4 mm, obovate, long fringed, fimbriae 0.2–0.4 mm. Styles 0.8–1.8 mm, equal or longer than the ovary, evenly filiform. **Capsules** circumscissile, 1.2–2.5 × 0.8–1.6 mm, depressed-globose and slightly angular, not thickened or risen around the small interstylar aperture, translucent, surrounded by the withered corolla. **Seeds** (1–) 3–4 per capsule, 0.85–1.2 × 0.8–1.1 mm, angled, broadly-elliptic, seed coat cells alveolate/papillate.

Sonora.—Apparently uncommon, with three records from the northern and central part of the state; desert grassland, Sonoran Desert, and tropical deciduous forest; 700–1350 m. Flowering August–September. Potential hosts, mostly herbaceous, include *Amaranthus, Ambrosia, Anisacanthus, Bahia, Bahiopsis, Baileya, Boerhavia, Chamaecrista, Chamaesaracha, Croton, Dalea, Ipomoea, Parthenium, Sanvitalia, Solanum, Tiquilia, Tragia, Viguiera*, and probably others.

General distribution.—Arizona, New Mexico, Texas, Utah; Aguascalientes, Chihuahua, Coahuila, Durango, Guanajuato, Hidalgo, Oaxaca, Querétaro, Puebla, San Luis Potosí, Zacatecas.

Selected reference.—Costea et al. (2011a).

Mpio Ónavas: Rancho La Mula, 28.2 km SE of Río Yaqui on MEX 16 (KM 195 E of Hermosillo), 28°28'50"N, 109°22'W, 790 m, tropical deciduous forest, on *Chamaecrista nicitans*, 30 Aug 2000, *Van Devender 2000-506* (ARIZ, WLU). **Mpio Santa Ana** [probably]: flats 2.5 mi S of Llano [probably Estación Llano], 15 Sep 1934, *Wiggins 7221* (CAS, US). **Mpio Santa Cruz:** 0.8 km S of Santa Cruz on road to San Lázaro, desert grassland, 31°11'23"N, 110°36'22"W, 1340 m, on *Ambrosia confertiflora*, 17 Aug 2001, *Van Devender 2001-710* (ARIZ, USON, WLU) [SEM].

Cuscuta corymbosa Ruiz & Pav. var. **grandiflora** Engelm., Trans. Acad. Sci. St. Louis 1:483. 1859; Syst. Arrang. Sp. Cuscuta 33. 1859. (Engelmann published the same name in both publications, the same year). Type: COLOMBIA, [from Popayán?]: *Humboldt 2002*, ex herb *Willdenow 3157* (lectotype here designated: B!; fragment at MO!). Engelmann (1859) did not mention any herbarium collection for var. *grandiflora*, but he indicated as synonyms for this variety two species, *C. popayanensis* Kunth and *C. cymosa* Willd., and he further stated that both were "founded on the same specimen" collected by Humbold "New Granada, Humboldt." In the Willdenow herbarium exists only the specimen mentioned above. A "New Granada" collection of Humboldt could not be located. *Cuscuta popayanensis* Kunth, Nov. Gen. Sp. [H.B.K.] 3:123. 1818. *Cuscuta cymosa* Willd. ex Roem. & Schult., Syst. Veg., ed. 15 bis [Roemer & Schultes] 6:205. 1820.

Cuscuta inclusa Choisy, Mém. Soc. Phys. Genéve 9:275, pl. 2, f. 2, 1842. Type: MEXICO. Toluca: 1827, *Berlandier 1103* (lectotype: G!; isolectotype: F!).

Cuscuta patens Benth., Bot. Voy. Sulphur 35. 1844. Type: MEXICO. Baja California Sur: Magdalena Bay, *Bentham s.n.* (K!).

Cuscuta laxiflora Benth., Bot. Voy. Sulphur 138. 1844. Type: MEXICO. Guerrero: Acapulco, *Bentham s.n.* (K!).

Stems medium, orange. **Inflorescences** dense, corymbiform or umbellate, often confluent. Pedicels 2–6 mm long. Bracts 1 at the base of clusters, absent at the base of pedicels, 0.5–1 mm long, ovate lanceolate, margins entire, apex acute. **Flowers** 5-merous (Fig. 1e), 4.5–6.5(–7) mm long, membranous, white when fresh, creamy brownish when dried, papillae absent. Laticifers barely visible in the calyx and corolla lobes, isolated, ovoid to elongate. Calyx 2–2.5 mm long, straw-yellow to brownish, membranous, finely reticulate, not shiny, cylindric campanulate, ½–¾ as long as the corolla tube, divided ca. ¼ its length; tube 1.1–2 mm long; lobes 0.4–0.75 mm long, not overlapping or only slightly so, rounded, not carinate, margins entire. Corolla 4–6 mm long; tube 3–5 mm long, cylindric, becoming dilated in the lower ½; lobes 1–1.5 mm long, initially erect, later spreading, ⅓–¼ of the corolla length, ovate, margins entire, apex obtuse to rounded, ± incurved. Stamens included, shorter than the corolla lobes; filaments 0.1–0.3 mm long; anthers 0.5–0.6 × 0.3–0.4 mm, subround to elliptic. Infrastaminal scales 1.5–2 mm long, ½–¾ as long as the corolla tube, bridged at 0.2–0.35 mm, forming oblong ridges with fringed margins, fimbriae 0.4–0.15 mm long. Styles 2.4–4.2 mm long, much longer than the ovary, evenly filiform. **Capsules** circumscissile, 2–2.9 × 2.2–2.6 mm, globose to slightly depressed, not thickened or risen around the small interstylar aperture, translucent, surrounded by the withered corolla. **Seeds** 2–4 per capsule, 1.1–1.3 × 0.7–0.9 mm, slightly angled, broadly elliptic, sometimes with a longitudinal groove on the ventral face; seed coat cells alveolate/papillate.

Sonora.—Locally in Gulf Coast of the Sonoran Desert in a large, ecologically pristine canyon in the Guaymas region opposite Isla San Pedro Nolasco and in foothills thornscrub in east-central Sonora; also on Islas San Pedro Nolasco and San Esteban; ca. 5–450 m. Flowering December–April. Probably more widespread in the state. Parasitic especially on *Colubrina viridis* and *Vaseyanthus insularis* (Felger et al. 2011); also on *Abutilon californicum*, *Acalypha californica*, *Cottsia linearis* (*Janusia linearis*), *Mirabilis laevis* var. *villosa*, *Perityle californica*, and Poaceae.

General distribution.—One of the most common species in Mexico, where it is sometimes weedy. Baja California Sur, Chiapas, Colima, Durango, Edo. México, Guerrero, Guanajuato, Hidalgo, Jalisco, Michoacán, Morelos, Nayarit, Sinaloa, Tamaulipas, Veracruz; also in Central and South America.

Selected references.—Felger and Wilder (2011, 2012), Yuncker (1932).

Mpio Guaymas: Cañón las Barajitas, Sierra el Aguaje, 28°03'27"N, 111°09'27"W, 90 m, 19 Feb 1995, *Felger 95-208*. **Mpio Soyopa:** 0.6 km N of MEX 16 on road to Tónichi just E of Río Yaqui, 28.5758°N, 109.5505°W, 270 m, foothills thornscrub, on *Janusia linearis*, 7 Jan 2001, *Van Devender 2001-16*. **SONORAN ISLANDS. San Esteban:** N side of island, on *Vaseyanthus insularis*, 21 & 22 Dec 1966, *Felger 15405*; 10 Apr 1968, *Felger 17550*; Steep N slope of NE peak, 28°42'N, 112°35'W, 450 m, on *Mirabilis laevis* var. *crassifolia*, 26 Apr 1966, *Moran 13052*. **San Pedro Nolasco:** NE side of Island, 18 Jan 1965, *Felger 12082* [SEM]; NE side of island, N-facing slope, on shrubs and herbs, many on *Perityle californica*, also on *Vaseyanthus insularis*, 18 Jan 1965, *Felger 12082*; NE side, halfway to summit, 150 m, abundant at all elevations, mostly on *Vaseyanthus insularis*, also on grasses and many shrubs, 28 Nov 2006, *Felger 06-91*; Steep granitic slope, 16 Dec 1951, *Gentry 11354*.

Cuscuta costaricensis Yunck., Mem. Torrey Bot. Club 18:227. 1932. Type: MEXICO. Durango: Santiago Papasquiaro, Aug 1896, *Palmer 412* (holotype: US!; isotypes: B!, GH!, K!, MO!).

Cuscuta odontolepis Engelm. var. *fimbriata* Yunck., Illinois Biol. Monogr. 6(2–3):38–39. 1921.

Stems slender to medium, yellow or orange. **Inflorescences** dense, glomerulate, often confluent. Pedicels 0–1.5 mm long. Bracts 1 at the base of clusters, 0–1 at the base of pedicels, 3–3.5 mm long, broadly triangular (broader than long), margins entire, apex cuspidate. **Flowers** 5-merous (Fig. 2c), 4.2–5.5 mm long, membranous, white when fresh, creamy-white when dried. Papillae present on the calyx and corolla lobes. Laticifers visible in the corolla lobes, anthers and infrastaminal scales. Calyx 3.2–3.5 mm long, straw-yellow, reticulate, not shiny, campanulate, equaling the corolla tube, divided ⅔–¾; tube 1–1.5 mm long; lobes 1.5–2.1 mm long, basally overlapping, broadly ovate-triangular, not carinate, margins entire, apex cuspidate. Corolla 3.5–4.5 mm long; tube 2–3 mm long, campanulate; lobes 1.5–2 mm long, erect to reflexed, ½–⅓ the tube, ovate, overlapping at base, margins entire, apex rounded or obtuse but appearing cuspidate because of a subterminal dorsal cusp, 0.1–0.3 mm long, prolonging beyond the apex. Stamens barely exserted, shorter than corolla lobes; filaments 0.3–0.6 mm long; anthers 0.5–7 × 0.45–0.55 mm, elliptic. Infrastaminal scales 2–2.8 mm long, reaching filament bases, bridged at 0.4–0.6 mm, oblong-obovate, dense and long fringed, fimbriae 0.2–0.4 mm long. Styles 3–3.5 mm long, longer than the ovary, evenly filiform. **Capsules** circumscissile, 2.5–4 × 2–3.1 mm, depressed globose, thickened at the apex and with a large interstylar aperture, translucent or not, loosely surrounded and capped by the withered corolla. **Seeds** 3–4 per capsule, 1–1.2 × 0.6–0.8 mm, angled, broadly elliptic; seed coat cells alveolate/papillate.

Sonora.—East-central and southeast parts of the state in oak woodland and pine-oak forest; 1250–2100 m. Flowering August–October. Parasitic on herbaceous hosts; documented in Sonora on *Anoda*, *Cologania*, *Desmodium*, *Jaltomata procumbens*, and *Tagetes micrantha*; elsewhere in Mexico on *Heterosperma*, *Melampodium*, *Milleria*, *Salvia*, *Simsia*, and *Xanthocephalum*.

General distribution.—Chihuahua, Durango, Edo. México, Guanajuato, Jalisco, Michoacán; Guatemala, Costa Rica.

Selected reference.—Costea et al. (2011b).

Mpio Álamos: Rancho Santa Bárbara, 42.3 km E-NE of Álamos, 27°07'08"N, 108'43'18"W, 1250 m, oak woodland, on *Tagetes micrantha* and *Desmodium*, 2 Oct 2006, *Reina–G. 2006-1049* (ARIZ, WLU). **Mpio Yécora:** ca. 2 km NW of Yécora on old road to Santa Rosa, 28°22'33'N, 108°56'24"W, 1560 m, 5 Sep 1996, *Wiens 96-125* (WLU [SEM]); 8.5 km W of Restaurant Puerto de La Cruz on MEX 16 (km 257 E of Ciudad Obregón), N side of Mesa del Campanero, pine-oak forest, 28°22'15"N, 109°03'59"W, 1460 m, 22 Sep 1997, *Van Devender 97-990* (WLU); Rio Yepachic near junction with Arroyo Hondo, ca. 2 km (by air) W of Chihuahua border, oak woodland with canyon riparian forest, 28°27'10"N, 108°32'15"W, 1380 m, 27 Sep 1998, on *Cologania*, *Van Devender 98-1789* (ARIZ, WLU); Yécora, 28°21'48"N, 108°55'56"W, 1556 m, 16 Sep 2006, locally common on *Salvia* and *Jaltomata procumbens*, *Reina-G. 2006-888* (ARIZ, USON, WLU).

Cuscuta dentatasquamata Yunck., Bull. Torrey Bot. Club 49:107. 1922. TYPE: MEXICO. SONORA: Los Pinitos, [27.4°N, 110.2°W, 6100 ft], 12 Oct 1890. *Hartman 119* (HOLOTYPE: GH!; ISOTYPE: US!).

Stems medium to slender. **Inflorescences** dense, glomerulate or compact-paniculiform, often confluent, pedicels 0.4–2 mm long. Bracts 1 at the base of clusters, 0–1 at the base of pedicels, 1.2–1.75 mm long, ovate-triangular to lanceolate, margins entire, apex acute to acuminate. **Flowers** 5-merous, 2.6–3.8 mm long, thick, yellowish when fresh, reddish-brown when dried. Papillae absent. Laticifers not visible. Calyx 2.3–2.6 mm long, reddish-brown, not reticulate or shiny, thick, campanulate, somewhat longer than corolla tube, divided ca. ½ the length; tube 1–1.4 mm long; lobes 1–1.4 mm long, not basally overlapping or only slightly so, triangular, carinate or with irregular multicellular protuberances along mid-veins, margins entire or irregular, apex acute. Corolla 2.5–3.4 mm long; tube 1.2–1.6 mm long, campanulate, latter ± globose; lobes 0.7–1.2 mm long, erect or spreading, ca. ⅓ as long as the tube, triangular, margins entire, apex acute straight or incurved. Stamens exerted, shorter than corolla lobes; filaments 0.3–0.4 mm long; anthers 0.25–0.4 × 0.25–0.35 mm, broadly elliptic to sub-round. Infrastaminal scales 1.2–1.5 mm long, reaching filament bases, bridged at ca. 0.5 mm, oblong, distally truncate and scarcely denticulate, bifid or irregularly fringed, fimbriae, 0.05–0.2 mm long. Styles 0.6–1.4 mm long, equaling or longer than the ovary, uniformly slender to slightly subulate. **Capsules** circumscissile, 3–4 × 1.8–2.9 mm, depressed-globose, moderately thickened but not risen around the small interstylar aperture, usually translucent, surrounded by the withered corolla at the base. **Seeds** 2–4 per capsule, 1.3–1.4 × 0.8–1.4 mm, angled, subround; seed coat alveolate/papillate.

Sonora.—This species is known in Sonora only from the type collection and flowers at least in October.

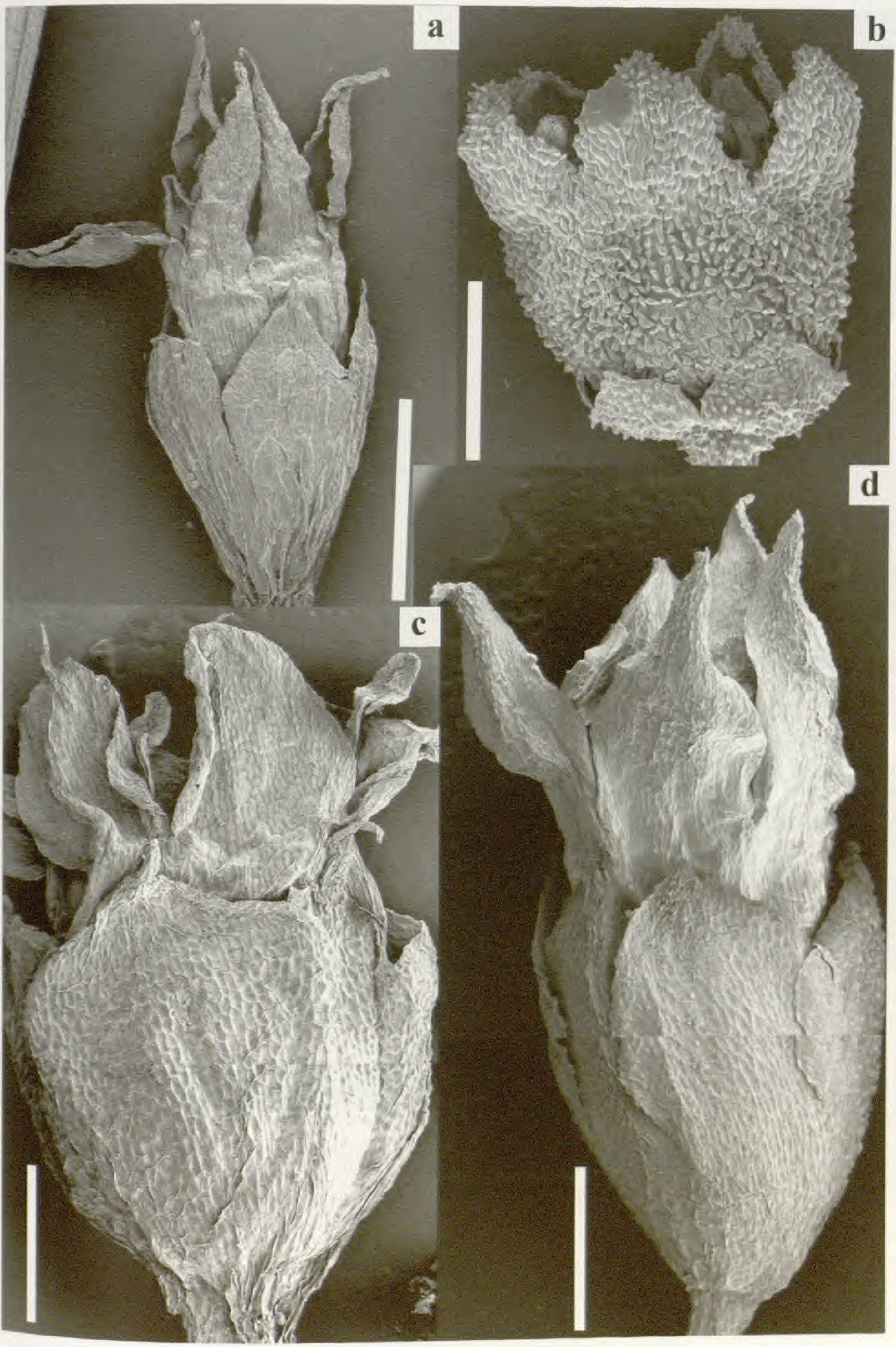

Fig. 2. Morphology of flower, **a.** *Cuscuta salina* var. *salina* (scale bar = 1.36 mm); **b.** *Cuscuta indecora* var. *indecora* (scale bar = 1 mm); **c.** *Cuscuta costaricensis* (scale bar = 1.15 mm); **d.** *Cuscuta odontolepis* (composite image resulted from the stiching of 2 photos; scale bar = 1.15 mm).

The type locality is in pine-oak forest and the host plant is *Bouvardia ternifolia*. In addition to the type collection, *C. dentatasquamata* is recorded from a canyon in southern Arizona mountains in oak woodland and should be sought elsewhere with *Bouvardia* in southern Arizona and northern Sonora mountains.

General distribution.—Arizona; Chihuahua, and Sonora; apparently very rare.

Selected reference.—Yuncker (1932).

ARIZONA. Pima Co: Florida Canyon, Santa Rita Experimental Range, Santa Rita Mountains, 7 Oct 1934, *Kearney 10580!*

Cuscuta desmouliniana Yunck., Illinois Biol. Monogr. 6(2–3):40–41. 1931. Type: MEXICO. SONORA: hills near Altar, 26 Aug 1884, *Pringle 105* (holotype: NY!; isotypes: ARIZ!, ASU!, G!, GH!, IND, MEXU!, MO!, NY!, US!).

Cuscuta desmouliniana var. *attenuiloba* Yunck., Illinois Biol. Monogr. 6(2–3):41. 1921. Regarding *Pringle 105*, Yuncker (1921, p 41) mentioned: "this specimen seems to be a mixture of the following two distinguishable varieties ("typical" and "attenuiloba").

Cuscuta umbellata var. *dubia* Yunck., Illinois. Biol. Monogr. 6(2–3):43. 1921. Type: MEXICO. Sonora: Guaymas, 22 Feb 1904, *Palmer 1209* (holotype: US!).

Stems slender, yellow-orange. **Inflorescences** loose, umbellate, often confluent. Pedicels 1–5 mm long. Bracts 1 at the base of clusters and 0–1 at the base of pedicels, 0.6–1 mm long, ovate-lanceolate, margins entire, apex acute. **Flowers** 5-merous (Fig. 3d), 2–3 mm long, membranous, white when fresh, creamy-white when dried. Papillae usually present on the pedicels, calyx, abaxial and adaxial epidermis of corolla lobes, and sometimes on the ovary/capsule. Laticifers not visible or hardly so in the midveins of corolla lobes, elongate. Calyx 0.6–1.2 mm long, brownish-yellow, ± reticulate or shiny, campanulate, equaling or somewhat longer than the corolla tube, divided ⅓–½ the length; tube 0.25–0.5 mm long; lobes 0.5–0.76 mm long, not overlapping, triangular-ovate to lanceolate, weakly to distinctly carinate, with small dome-like multicellular projections on the midveins, margins irregular, ± revolute at the base and forming angled sinuses (especially when lobes are triangular ovate), apex acute to acuminate. Corolla 1.5–2.9 mm long; tube narrow-campanulate, 0.8–1.5 mm long; lobes 1–1.5 mm long, initially erect, later spreading or reflexed, slightly longer than the tube, lanceolate, margins entire sometimes involute upon drying and appearing very narrow, apex acute, ± incurved. Stamens short-exserted, shorter than corolla lobes; filaments 0.4–0.7 mm long; anthers 0.4–0.6 × 0.2–0.3 mm, ovate to oblong. Infrastaminal scales 0.6–1 mm long, ca. ¾ of the corolla tube, bridged at 0.1–0.2 mm, oblong to spathulate, short-fringed, fimbriae 0.05–0.15 mm long. Styles 1.2–2.1 mm long, longer than the ovary, evenly filiform. **Capsules** circumscissile, 1.5–2 × 0.9–1.7 mm, globose, to globose-depressed, slightly thickened and risen, or with a few protuberances around the inconspicuous interstylar aperture, translucent, capped by the withered corolla (Fig. 3e). **Seeds** 2–4 per capsule, 0.75–0.9 × 0.7–0.8 mm, angled, subrotund to broadly elliptic; seed coat cells alveolate/papillate.

Sonora.—Common in the Sonoran Desert, especially on sandy flats, valley floors, and bajadas, and in coastal and foothills thornscrub; near sea level–300 m. Recorded on herbaceous hosts including *Amaranthus watsonii*, *Boerhavia* (including *B. coccinea*, *B. triquetra*), *Euphorbia* subgenus *Chamaesyce* (especially *E. polycarpa*), *Pectis* (including *P. coulteri*, *P. papposa*), and occasionally on *Tumamoca macdougalii*.

General distribution.—Baja California (norte) and Sur, Sinaloa.

Selected reference.—Costea and Stefanović (2010).

Mpio Caborca: 35.2 km W of Caborca on road to Desemboque, desertscrub on sandy flats with *Larrea* and *Olneya*, 30°44'35"N, 112°26'32"W, 63 m, 16 Jan 2002, *Van Devender 2002-23* (WLU). **Mpio Guaymas:** 6 mi NW of Guaymas, 28 Feb 1933, *Shreve 6134*; Old road to Algodones, San Carlos, 27°57'42"N, 111°03'43"W, ca. 35 m, 26 Dec 2000, *Reina-G. 2000-917* (CAS, US, WLU). **Mpio Hermosillo:** 5 mi by road E of Bahia Kino, 19 Oct 1963, *Felger 9046*. **Mpio Huatabampo:** 6.25 km E of Camahuiroa, 1.9 km W of Tierra y Libertad, 26°33'00"N, 109°12'45"W, 25 m, 20 Jan 1995, *Friedman 213-95*. **Mpio Pitiquito:** at coast on N side of headland ca. 10 mi S of Desemboque [San Ignacio], 22 March 1978, *Spellenberg 4943* (NMC). **Mpio Soyopa:** Arroyo Los Garambullos, 1.5 km E of Tónichi, 28°34'10"N, 109°33'00"W, 180 m, 15 Sep 1998, *Van Devender 98-1120* (ARIZ, WLU); 4 Sep1996, *Van Devender 96-360* (ARIZ, NMC, WLU) [SEM]. **SONORAN ISLANDS. Dátil:** NW side of island, 20 Dec 1966, *Felger 15313A*. **Tiburón:** SE side of Agua Dulce Valley, ca. 12 mi S from Tecomate, 28°57'20"N, 112°24.5'W, ca. 280 m, 8 Sep 1974, *Felger 76-T14*; Zozni Cmiipla, bajada to 1 km inland, on *Euphorbia polycarpa*, *Boerhavia triquetra*, and a few *Tumamoca macdougalii*, 26 Sep 2008, *Felger 08-120*.

Cuscuta erosa Yunck., Illinois Biol. Monogr. 6(2–3):26. 1921. Type: MEXICO. Sonora: 1869, *Palmer s.n.* (holotype: US!)

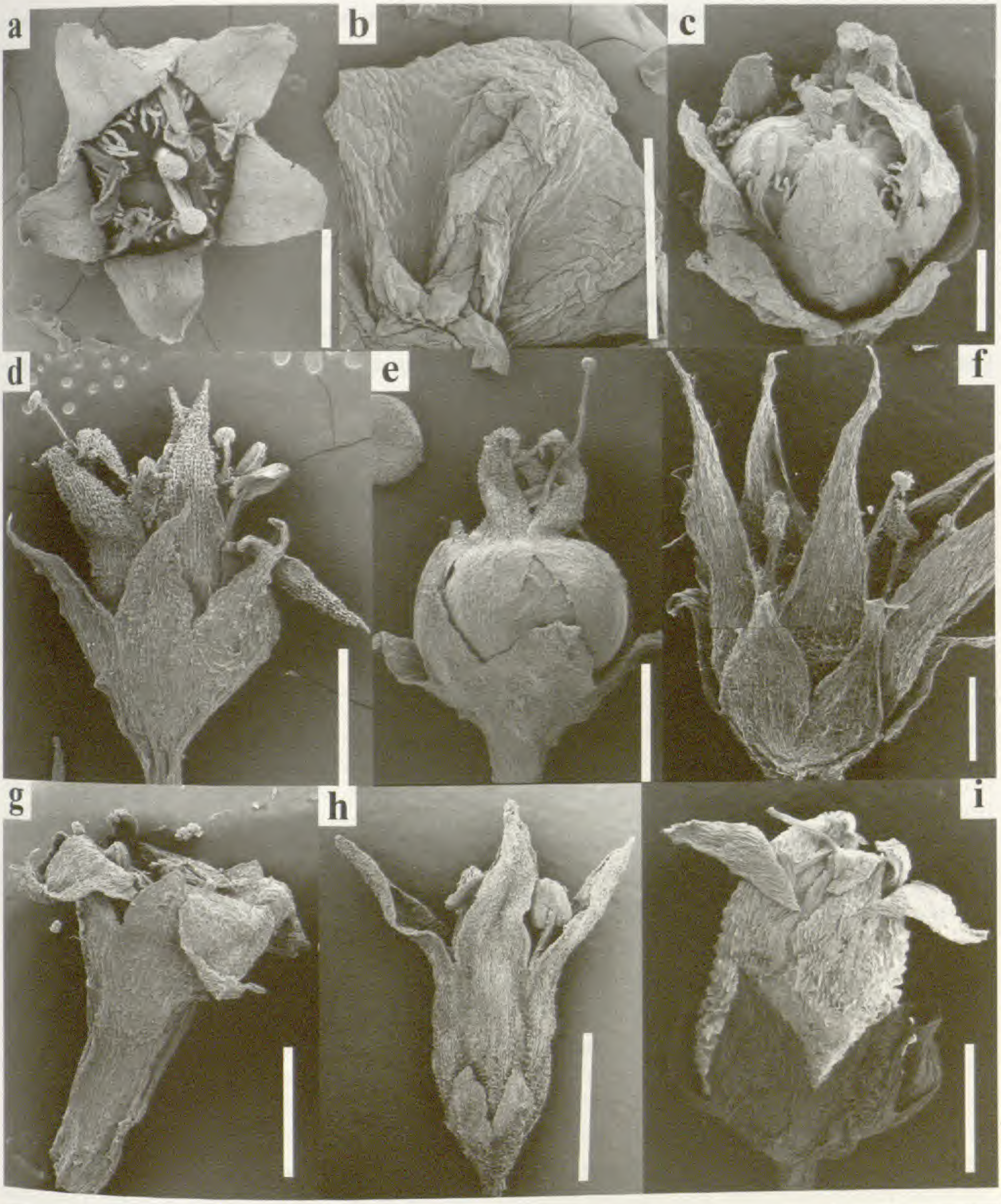

Fig. 3. a–b. *Cuscuta chinensis* var. *applanata* (scale bar = 1 mm), **a.** flower, **b.** calyx lobe; **c.** *C. azteca*, flower (scale bar = 1 mm); **d–e.** *Cuscuta desmouliniana*, **d.** flower, **e.** capsule capped by corolla (scale bars = 1 mm); **f.** *Cuscuta legitima* (scale bar = 1.3 mm); **g.** *Cuscuta umbellata* var. *umbellata* (scale bar 1 mm); **h.** *Cuscuta leptantha* (scale bar = 1.3 mm); **i.** *Cuscuta tuberculata* (scale bar = 1.25 mm).

Stems medium, yellow-creamy to purple. **Inflorescences** loose to moderately dense, paniculiform or corymbiform. Pedicels 1.5–6 mm long. Bracts 1 at the base of clusters and 0–1 at the base of pedicels, 0.8–1.9 mm long, ovate-triangular to lanceolate, margins entire to serrulate-denticulate, apex obtuse to acute, sometimes with a subapical horn-like projection. **Flowers** 5-merous (Fig. 1c), 3.5–4.5 mm long, membranous, creamy to reddish-brown both when fresh and dried. Papillae absent. Laticifers not visible. Calyx 1.5–2.2 mm long, yellow, finely reticulate, shiny, cupulate, ¾ to almost equaling corolla tube, divided ½–⅔ of the length; tube 0.5–0.8 mm long; lobes 1.2–1.6 mm long, basally overlapping, oblong-obovate to orbicular, unevenly carinate, margins membranous and minutely erose or denticulate, apex nearly truncate with a dorsal subapiacal dome-like projection, not exceeding the apex. Corolla 3–4 mm long; tube 1.5–2.2 mm long, campanulate, sometimes with horizontal ridges between stamen attachments; lobes 1.2–1.6 mm long, erect to spreading or reflexed, ovate-oblong, margins denticulate, apex obtuse, cucullate, often with a dorsal subapical horn-like appendage, 0.1–0.2 mm long. Stamens exserted, shorter than the corolla lobes; filaments 0.4–1 mm long; anthers 0.7–1 × 0.4–0.5 mm, ovate to oblong. Infrastaminal scales 1.5–2 mm long, ¾ to almost equaling corolla tube, bridged at 0.4–0.6 mm, oblong to almost truncate, dense and long fringed, fimbriae 0.2–0.4 mm long. Styles 1.8–3.2 mm long, longer than the ovary, thick and ± subulate, wider at the base and tapering toward the stigma. **Capsules** circumscissile, 2–2.5 × 2.2–2.5 mm, globose, thickened but not risen around the inconspicuous interstylar aperture, not translucent, carrying the withered corolla about the middle or at the top. **Seeds** 1–4 per capsule, 0.94–1.45 × 0.8–1.38 mm, angled, subround to ovate; seed coat cells alveolate/papillate.

Sonora.—Relatively common in Chihuahuan Desert, foothills thornscrub, and the lower margins of tropical deciduous forest; 450–1250 m. Flowering August–October. Parasitizing herbaceous plants, small shrub, and vining hosts: *Abutilon californicum*, *Amaranthus palmeri*, *Ambrosia confertiflora*, *Anisacanthus thurberi*, *Bidens*, *Boerhavia*, *Carlowrightia*, *Euphorbia*, *Gomphrena sonorae*, *Hymenoclea*, *Ipomoea ternifolia*, *Jatropha cardiophylla*, *Justicia longii*, *Kallstroemia*, *Merremia palmeri*, *Mimosa*, *Portulaca*, *Rhynchosia minima*, *Ruella*, *Husselia*, *Sphinctospermum*, *Talinum paniculatum*, *Tephrosia vicioidies*, and *Tetramerium*.

General distribution.—Arizona; Baja California Sur, Sinaloa.

Selected reference.—Costea et al. (2011b).

Mpio Agua Prieta: ca. 7.5 km (by air) SW of Agua Prieta, ca. 4.5 km NE of Rancho La Calera, Sierra Anibácachi, Rancho La Calera, Chihuahuan desertscrub on limestone, 31°15'34"N, 109°36'34"W, 1233 m, 3 Oct 2004, *Van Devender 2004-1199* (WLU). **Mpio Arizpe:** Puente Agua Caliente, Rancho Agua Caliente, ca. 3 km S-SW of Arizpe on SON 89, foothills thornscrub, 30°19'37"N, 110°11'33"W, ca. 920 m, 18 Aug 2001, *Sánchez NF-172* (WLU). **Mpio Baviácora:** SW edge of Mazocahui on SON 117 to Ures, 29°47'56"N, 109°40'36"W, 620 m, 14 Aug 2006, *Reina-G. 2006-475* (ARIZ, ASU, MO, USON, WLU). **Mpio Cucurpe:** Cucurpe, 30°19'46"N, 110°42'18"W, 880 m, 22 Aug 2001, *Reina-G. 2001-748* (ARIZ, HCIB, WLU). **Mpio Cumpas:** Cumpas, 29°59'47"N, 109°46'33"W, 13 Aug 2006, *Van Devender 2006-462* (WLU). **Mpio La Colorada:** 4 mi E of Willard, between Hermosillo and Colorada, 5 Sep 1941, *Wiggins & Rollins 288* (ARIZ, CAS, DS); 11.5 km, SE of la Colorada on MEX16, 28°46'24"N, 110°30'18"W, 444 m, 15 Aug 2006, *Van Devender 2006-553* (HCIB, TEX, WLU), *Van Devender 2006-555* (ARIZ, USON, WLU). **Mpio Moctezuma:** 18.9 km S-SE of junction with Moctezuma-Huásabas Hwy on road to Tepache, basalt cobble plain with sparse open foothills thornscrub, 29°39'44"N, 109°37'13"W, 635 m, 14 Sep 2006, *Reina-G. 2006-856* (WLU). **Mpio Yécora:** Curea, foothills thornscrub on conglomerate, 28°18'42"N, 109°16'42"W, 490 m, 17 Sep 1998, *Reina-G. 98-1251* (WLU); 2.7 km W-NW of Tepoca on MEX 16, base of steep N-facing cliffs in tropical deciduous forest, 28°27'36"N, 109°15'48"W, 750 m, 30 Aug 2000, *Van Devender 2000-526* (ARIZ, WLU) [SEM].

***Cuscuta indecora** Choisy var. **indecora,** Mém. Soc. Phys. Genéve 9:278. 1842. Type: MEXICO [Tamaulipas]: Mexicum ad Matamoros, Oct 1830, *Berlandier 2285-865* (holotype: G-DC!; isotypes: MO!, P!). *Cuscuta decora* Choisy ex Engelm. var. *indecora* (Choisy) Engelm., Trans. Acad. Sci. St. Louis 1:502. 1859. *Grammica indecora* (Choisy) W.A. Weber, Southw. Naturalist 18:319. 1973. *Epithymum indecorum* (Choisy) Nieuwl. & Lunell, Amer. Midl. Naturalist 4:511. 1916. For more synonymy see Costea et al. 2006b.

Stems slender to medium, yellow to orange. **Inflorescences** loose to dense, paniculiform or corymbiform, confluent. Pedicels 0.5–6 mm long. Bracts 1 at bases of clusters and 0–1 at the base of pedicels, 0.6–1.5 mm long, ovate to lanceolate, margins entire, apex acute. **Flowers** 5-merous (Fig. 2b), 3–5.3 mm long, membranous to thick, translucent-white when fresh, creamy-yellow to dark brown when dried. Dome-like papillae usually present on the pedicels, perianth and ovary. Laticifers visible in the perianth along the midveins and in ovary/capsules, isolated or in longitudinal rows, ovoid to elongated. Calyx 1.2–2 mm long, creamy-yellow to brownish, not reticulate or shiny, cupulate, ca. ½ of the corolla tube, divided ⅓–½ of the length, tube 0.5–1 mm long, lobes 0.5–1.2 mm long, overlapping at the base, triangular-ovate, not carinate, margins entire, apex acute. Corolla 2.5–4.5 mm long, tube 2–3.2 mm long, campanulate, campanulate-cylindric, sub-globose or sub-urceolate, lobes 0.7–1.5 mm long, suberect to erect, ⅓ to equaling the tube, triangular-ovate, margins entire, apex acute, inflexed. Stamens barely exserted or enclosed, shorter than corolla lobes, anthers 0.5–1 × 0.3–0.5 mm, ovate-elliptic to oblong, filaments 0.3–0.7 mm long. Infrastaminal scales 1.5–2.8 mm long, reaching the filament bases, bridged at 0.5–0.7 mm, obovate to spathulate, rounded, uniformly dense, long fringed, fimbriae 0.2–0.4 mm long. Styles 1–2.5 mm long, ca. as long as the ovary, evenly filiform. **Capsules** indehiscent, 1.9–4(–5) × 2–3.5 mm, globose to subglobose, thickened and risen around the medium large interstylar aperture, semi-translucent, surrounded or capped by the withered corolla. Seeds 2–4 per capsule, 1.42–1.86 × 1.25–1.6 mm, shape heterogeneous on the same plant: dorsoventrally compressed to weakly angled, broadly elliptic to transversely oblique, seed coat cells variable: alveolate/papillate, polygonal (not alveolate/papillose), and puzzle-like arranged, or both kinds present on the same seed. $2n = 30$.

Sonora.—Sonoran Desert and coastal thornscrub; ca. 10–100 m. Flowering August–November(–March). Apparently spreading as a weed of alfalfa (with contaminated seeds); other hosts include *Baccharis*, *Chenopodium*, *Helianthus*, *Heterotheca*, *Ipomoea*, *Pluchea*, *Polygonum*, *Rhynchosia*, and *Tephrosia*.

General distribution.—throughout most of the USA; Aguascalientes, Chihuahua, Coahuila, Edo. México, Jalisco, Michoacán, Nuevo León, Puebla, Querétaro, Sinaloa, Tabasco, Tamaulipas, Veracruz, Zacatecas, Yucatán; West Indies; Central America; South America. As in the case of *C. campestris*, *C. indecora* may be more widely distributed in Mexico than current herbarium data suggest.

Selected reference.—Costea et al. (2006b).

Mpio Bácum: Bácum, weed in alfalfa, *Salazar García 9 Aug 2010* ("muestra 2010–01574," WLU). **Mpio Huatabampo:** 5.7 km SW of Ejido 10 de Abril at MEX 15, 1.4 km W of Tierra Y Libertad, ca. 7.4 km (by air) E-NE Camahuiroa, coastal Sinaloan thornscrub, ca. 35 m, 8 Oct 1992, *Van Devender 92-1103*, and 15 Mar 1993, *Van Devender 93-322* (ARIZ, UC, UCR; ARIZ, UC); 2 km W of Tierra y Libertad on N road to Camahuiroa, 26°33'50"N, 109°12'50"W, 24 Nov 1993, *Van Devender 93-1283* (ARIZ, ASU, CAS, TEX, UC, UCR, USON). **Mpio Etchojoa:** Etchojoa, weed in alfalfa, *Sainz 24 Apr 2010* (WLU). **Mpio Fronteras:** Fronteras, ca. 1356 m, 25 Sep 1890, *Hartman 52* (US). **Mpio Navojoa:** Ejido 8 de Febrero, weed in alfalfa, *Ley 21 Aug 2010* ("muestra 2010-01980," WLU). **Mpio San Ingnacio:** Ejido San Ignacio Río Muerto, weed in alfalfa, *Salazar-García 9 Aug 2010* ("muestra 2010-01573," WLU).

Cuscuta legitima Costea & Stefanov., Taxon 59:1795. 2010. Type: MEXICO. Sonora: NW side of Río Yaqui at MEX 15 near Esperanza, ca. 9 km N of Ciudad Obregón, 27°35'45"N 109°56'W, ca. 40 m, locally common parasite on *Boerhavia coccinea* (Nyctaginaceae), flowers white, stems yellow, 10 Sep 1994, *Van Devender 94-458* (holotype: ARIZ; isotypes: ASU!, MEXU!, UC!, UCR!, WLU!).

Cuscuta californica var. *reflexa* J.M. Coult., Contr. U.S. Natl. Herb. 1:45. 1890; 2:295. 1892; *Cuscuta umbellata* var. *reflexa* (J.M. Coult.) Yunck., Illinois Biol. Monogr. 6(2–3):42. 1921. Type: U.S.A. Texas: Roma, 1889, *Nealley 338* (holotype: US!; isotype: GH!).

Stems slender, yellow-orange. **Inflorescences** dense to loose, umbelliform, confluent. Pedicels 2–10 mm long. bracts 1 at the base of clusters and 0–1 at the base of pedicels, 2.0–3.6 mm long, broadly triangular-ovate, margins entire, apex acuminate. **Flowers** 5-merous (Fig. 3f), 4.0–5.5(–6.0) mm long, membranous, white when fresh, creamy-white when dried. Papillae absent. Laticifers evident in the bracts, calyx, corolla, tips of infrastaminal scale fimbriae, and ovary, isolated, ovoid. Calyx 2.5–3.2 mm long, straw-yellow, finely reticulate, slightly shiny, campanulate, longer than corolla tube, divided ca. ⅔ the length, tube 0.6–1.0 mm long, lobes 1.5–2.2 mm long, not basally overlapping, ovate-lanceolate, not carinate, margins entire, apex acuminate. Corolla 3.8–5.2(–5.6) mm long, tube 1.6–2.1 mm long, campanulate, lobes 1.8–3.0 mm long, initially erect, later reflexed, longer than the tube, linear-lanceolate, margins entire, apex acuminate, straight. Stamens exserted, shorter than the lobes, anthers 0.50–0.70 × 0.24–0.36 mm, elliptic to oblong, filaments 0.6–1.0 mm long. Infrastaminal scales 1.8–2.2 mm long, equaling or slightly longer than the tube, bridged at 0.2–0.4 mm, spathulate to obovate, uniformly dense-fringed, fimbriae 0.2–0.5 mm long. Styles 0.9–2.5 mm, longer than the ovary, evenly filiform. **Capsules** circumscissile, 2–3 × 1–2 mm, depressed, irregularly thickened and slightly risen around the inconspicuous interstylar aperture, translucent, surrounded or capped by the withered corolla. **Seeds** 2–4 per capsule, 0.9–1.2 × 0.8–0.9 mm, broadly elliptic to subround.

Sonora.—Chihuahuan and Sonoran Deserts, coastal and foothills thornscrub, tropical deciduous forest; 40–1200 m. Flowering August–November. Common but not weedy; hosts herbaceous, including *Allionia incarnata*, *Amaranthus*, *Boerhavia*, *Chamaesaracha*, *Evolvulus*, *Kallstroemia*, *Salsola*, *Solanum*, *Tidestromia lanuginosa*, *Trianthema portulacastrum*, and *Tribulus terrestris*.

General distribution.—Arizona, Kansas, New Mexico, Texas; Baja California (norte), Chihuahua, Coahuila, Tamaulipas.

Selected reference.—Costea and Stefanović (2010).

Mpio Agua Prieta: S edge of Agua Prieta on Mex 17, Chihuahuan desertscrub, 31°18'21"N, 109°34'55"W, 1204 m, 13 Sep 2006, *Van Devender 2006-757* (HCIB, MO, TEX, WLU). **Mpio Álamos:** Capitahuasa, 26°45'35"N, 108°55'W, 160 m, 25 Sep 1993, *Van Devender 93-1123* (ARIZ, UC, UCR). **Mpio Cajeme:** Ciudad Obregón, 29 Sep 1933, *Gentry 272* (ARIZ, MICH); Cerro La Antena, 1 km N of Microondas La Cabana, 27°27'45"N, 109°46'20"W, 200 m, Sinaloan thornscrub, 19 Sep 1994, *Van Devender 94-603* (ARIZ, ASU, MEXU, UC, USON); NW side of Rio Yaqui at MEX 15 near Esperanza, ca. 9 km N of Ciudad Obregón, 27°35'45"N, 109°56'W, ca. 40 m, 10 Sep 1994, *Van Devender 94-458* (ARIZ, ASU, MEXU, UC, UCR) [SEM]. **Mpio Hermosillo:** New Year's Mine, 20 mi S of Hermosillo, *Jones 28 Oct 1926* (MO); 27 mi W of Hermosillo, on road to Kino Bay, 28 Aug 1941, *Wiggins & Rollins 133* (ARIZ, CAS, DS). **Mpio Navojoa:** San José de Masiaca; 26°45'N, 109°14'30"W, 70 m, 22 Sep 1994, *Van Devender 94-710, 94-711* (ARIZ, MEXU, UC). **Mpio Puerto Peñasco:** Pinacate Region, MacDougal Crater, 8 Sep 1964, *Felger 10488*; 0.5 km E of MacDougal Crater, 8 Sep 1964, *Felger 10432A, 10435, 10436*; W Pinacate, *Equihua 6 Nov 1982*; Sykes Crater, NW of Pinacate Region, 155 m, 8 Dec 1970, *Felger 20035*; 1 km SWW Papago Tanks, 28 Sep 1964, *Felger 10608*; Rancho Grijalva (Rancho Guadalupe Victoria), 32°00'35"N, 113°34'25"W, 225 m, *Ezcurra 9 Nov 1982*. **Mpio Soyopa:** Tónichi, 28°35'55"N, 109°33'50"W, 200 m, 17 Aug 2006, *Van Devender 2006-627* (ARIZ, NMC, WLU); Arroyo Las Tinajas below ruins of Toledo smelter, near Loma Maderista, 3.5 km S of Tónichi, W side of Río Yaqui, foothills thornscrub, ca. 28°34'03"N, 109°33'25"W, 220 m, 17 Aug 2006, *Van Devender 2006-638* (WLU); Arroyo los Conejos, 3.4 km N of MEX16 on road to San Antonio de la Huerta, 215 m, 28°35'39"N, 109°35'33"W, 225 m, 16 Aug 2006, *Reina-G. 2006-586* (MEXU, WLU), *Reina-G. 2006-606* (WLU), *Reina-G. 2006-612* (WLU).

Cuscuta leptantha Engelm., Trans. Acad. Sci. St. Louis 1:489. 1859. Type: U.S.A. Texas: Oct 1849, *Wright 522* (holotype: MO!; isotype: US!).

Cuscuta palmeri S. Watson Proc. Amer. Acad. Arts 24:64. 1889. Type: MEXICO. Baja California: 1887, *Palmer 544* (holotype: NY!; isotypes US!, GH!).

Stems slender, yellow-orange. **Inflorescences** loose, umbellate, confluent. Pedicels (1–)2–7 mm long. Bracts 1 at the base of clusters and 0–1 at the base of pedicels, 0.75–1 mm long, triangular ovate, margins entire, apex acute. **Flowers** 4-merous (Fig. 3h), 3.5–4.5(–5) mm long, membranous, white when fresh, creamy-white when dried, papillae usually present on the pedicels and perianth. Laticifers not visible. Calyx 1.5–1.8 mm long, straw-yellow, not reticulate or shiny, campanulate, ⅓–½ of the corolla tube, divided ca. ½ the length, the tube 0.5–0.8 mm long, lobes 0.8–1 mm long, not basally overlapping, triangular-ovate, not carinate, margins entire, apex acute. Corolla 3–4 mm long, tube cylindric, 1.5–2.5 mm long, lobes 1.5–2 mm long, initially erect, later spreading or reflexed, as long as the tube, lanceolate, margins entire often involute upon drying and corolla lobes appearing narrow, apex acute ± cucullate. Stamens short-exserted, shorter than corolla lobes, anthers 0.4–0.6 × 0.35–0.45 mm, subround to broadly elliptic, filaments 0.3–0.6 mm long. Infrastaminal scales 1.3–2.1 mm long, ca. ½ of the corolla tube, bridged at 0.4–0.8 mm, oblong, uniformly short-fringed, fimbriae 0.05–0.15 mm long. Styles 1.2–2.1 mm long, longer than the ovary, evenly filiform. **Capsules** circumscissile, 1.5–2 × 1.6–1.9 mm, globose, slightly thicken and risen or with a few protuberances around the inconspicuous interstylar aperture, translucent, capped by the withered corolla. Seeds 2–4 per capsule, 0.75–0.9 × 0.7–0.8 mm, angled, subrotund to broadly elliptic, seed coat cells alveolate/papillate.

Sonora.—Sonoran Desert; 5–150 m. Flowering December–May. Parasitic on *Euphorbia* subgenus *Chamaesyce*, especially *E. polycarpa*.

General distribution.—Texas, New Mexico; Baja California (norte) and Sur, and Sinaloa.

Selected reference.—Costea and Stefanović (2010).

Mpio Hermosillo: 1.5 mi E of Santa Rosa, 15 Feb 1965, *Felger 12575*; 4 mi by road NW of Rancho Noche Buena at ca. 0.5 mi E of crest of "Seri Pass," Sierra Seri, 14 May 1966, *Felger 14035*; Roadside 3.7 mi S of Punta Chueca, 13 Apr 1980, *Bowers 1966*; Playa Esthela, just N of Bahia de Kino, 28°52'28"N, 112°01'20"W, 50 m, 31 Dec 2000, *Van Devender 2000-933* (WLU) [SEM]. **Mpio Pitiquito:** 5.9 mi S of Desemboque Rio San Ignacio, 14 Apr 1968, *Felger 17762*; 19.8 mi S of Desemboque Rio San Ignacio, 14 May 1966, *Felger 14080*; ca. 1 mi E of 19 mi by road S of Desemboque, vic. 29°20'N, 112°14'W, 18 Feb 1968, *Felger 17205*. **SONORAN ISLANDS. Tiburón:** SW Central Valley, *Felger 17342*; 1 km inland at Zozni Cmiipla, at base and N side of Punta San Miguel, 23 Nov 2006, *Wilder 06-368*; Canyon at base of Capxölim, 24 Nov 2006, *Wilder 06-381*.

Cuscuta macrocephala W. Schaffn. ex Yunck., Illinois Biol. Monogr. 6(2–3):36. 1921. Type: MEXICO. Sinaloa: [no date], *Schaffner s.n.* (holotype: NY!).

Stems orange, coarse. **Inflorescences** dense, paniculiform-glomerulate. Pedicels 0.3–3.2 mm long. Bracts 1 at the base of clusters and 0–1 at the base of pedicels, 1.5–3 mm long, ovate, margins entire, apex obtuse. **Flowers**

5-merous (Fig. 1b), 5–6.5 mm long, thick, creamy-white when fresh, brownish when dried. Papillae absent. Laticifers visible in the calyx and corolla, isolated, ovoid to elongate. Calyx 3.5–4.2 mm long, dark brownish, thick, with membranous reticulate margins, not shiny, campanulate, about equaling the corolla tube, divided ca. ⅓ of its length, tube 1.3–2 mm long, lobes 1.8–2.2 mm long, broader than long, auriculate at base and broadly overlapping and forming angles at sinuses, margins entire, apex rounded. Corolla 4.5–6 mm long, tube 3.8–4.5 mm long, cylindric-campanulate, lobes 0.7–1 mm long, mostly erect, ca. ¼ of the corolla tube, ovate to oblong, margins entire, overlapping at base, apex obtuse to rounded. Stamens included, shorter than corolla lobes, 0.7–1.1 × 0.4–0.6 mm, anthers ovate to oblong-elliptic, filaments 0.1–0.3 mm long. Infrastaminal scales 3–3.3 mm long, ca. ⅔ as long as the corolla tube, bridged at 0.7–1 mm, oblong, densely fringed, fimbriae 0.15–0.3 mm long. Styles 1.4–4.3 mm long, longer than the ovary, evenly thick, or thicker at the base. **Capsules** circumscissile, 2.5–3.6 × 2.4–3.3 mm, globose, slightly thickened around the small interstylar aperture, not translucent, capped by the withered corolla. **Seeds** 2–4 per capsule, 1.4–1.9 × 1–1.3 mm, angled, broadly elliptic, seed coat cells alveolate/papillate.

Sonora.—East part of the state in grassland, foothills thornscrub, tropical deciduous forest, oak woodland; 500–1030 m. Flowering August–October. Parasitic on woody and herbaceous hosts including *Acacia*, *Amaranthus*, *Anisacanthus*, *Cryptostegia*, *Guazuma ulmifolia*, *Morus microphylla*, *Quercus*, *Platanus*, *Prosopis*, *Sida*, and *Tecoma*.

General distribution.—Baja California Sur, Sinaloa, Jalisco, Querétaro, Tamaulipas.

Selected reference.—Yuncker (1932).

Mpio Álamos: Rancho Santa Bárbara (E-NE of Álamos), 27°06'34"N, 108'42'58"W, 1070 m, tropical deciduous forest-oak woodland transition, 5 Oct 2006, *Van Devender 2006-1240* (ARIZ, WLU). **Mpio Arivechi:** Arroyo Bámori, 5 km S Bámori on road to Valle de Tacupeto, 28°49'15"N, 109°10'24"W, 536 m, riparian area in foothills thornscrub 15 Sep 2006, *Van Devender 2006-872* (ARIZ, NMC, USON, WLU). **Mpio Cucurpe:** Palm Canyon, 25 km SE of Magdalena on road to Cucurpe, Sierra Babiso (Cerro Cinta de Plata), 30°29'N, 111°46'W, 1300 m, *Van Devender 4-5 Sep 1976*, also *Van Devender 2 Oct 1976*; 17.7 mi SE of Magdalena on road to Cucurpe, 3 Oct 1982, *Starr 175*. **Mpio San Javier:** 1.4 km E of La Barranca on MEX 16, tropical deciduous forest, 28°34'48"N, 109°40'15"W, ca. 640 m, 31 Aug 2001, *Van Devender 2001-758* (WLU). **Mpio Yécora:** Arroyo El Reparo, Rancho Arroyo Hondo, rocky stream canyon with *Guazuma ulmifolia*, *Morus microphylla*, and *Platanus*, 28°20'50"N, 109°07'17"W, 780–840 m, *Reina-G. 98-1524* (USON, WLU); Arroyo Los Huérigos, 9.3 km E of Tepoca on MEX 16, 3.5 km (by air) W-NW of San Nicolás, *Populus monticola* riparian gallery forest, 28°25'48"N, 109'11'31"W, 650 m, 1 Sep 2001, *Reina-G. 2001-774* (ARIZ, WLU) [SEM].

Cuscuta odontolepis Engelm., Trans. Acad. Sci. St. Louis 1:486. 1859. Type: U.S.A. Arizona: Santa Rita Mountains, S of Tucson, 1851–1852, *Wright 1624* (holotype: MO!; isotypes: GH!, K!, NY!).

Stems slender, yellowish. **Inflorescences** dense, paniculiform-glomerulate. Pedicels to 1 mm long. Bracts 1 at the base of cymes and 0–1 at the base of pedicels/flowers, membranous, 2–3 mm long, subround to broadly ovate, margins entire, apex acute to short acuminate. **Flowers** (Fig. 2d) 5-merous, 4.5–5 mm long, membranous, white when fresh, creamy-white when dried. Papillae present on the bracts, calyx and corolla lobes. Laticifers not visible. Calyx 2–2.5 mm long, straw-yellow, finely reticulate, not shiny, campanulate, ½–¾ as long as the corolla tube, divided ca. ⅔, tube 0.5–0.9 mm long, lobes 1.3–1.5 mm long, ovate-triangular, outer 2 lobes auriculate, basally overlapping, not carinate, margins entire, apex acute to short acuminate. Corolla 3.5–4.5 mm long, tube 2.2–2.8 mm long, cylindric, lobes 1.6–2 mm long, initially erect, later reflexed, ovate-triangular, margins entire, basally overlapping, apex acute to short acuminate, straight. Stamens barely exserted, shorter than corolla lobes, anthers 0.7–1.1 × 0.25–3 mm long, oblong, filaments 0.3–0.7 mm long. Infrastaminal scales 2–2.5 mm long, ½ to equaling corolla tube, bridged at 0.25–0.5 mm, oblong-spathulate to obovate, rounded, fringed in the distal ½, fimbriae 0.2–0.3 mm long. Styles 2.8–4 mm long, longer than the ovary, evenly filiform. **Capsules** circumscissile, 2.9–4 × 3–3.5 mm, globose to globose-depressed, thickened and raised around the inconspicuous interstylar aperture, translucent, loosely surrounded and capped by the withered corolla. **Seeds** 3–4 per capsule, 1–1.25 × 0.65–0.8 mm, angled, broadly elliptic, seed coat cells alveolate/papillate.

Sonora.—Sonoran Desert, desert grassland, and riparian areas in foothills thornscrub; 500–1300 m. Flowering August–November. Parasitizing on *Amaranthus*.

General distribution.—Arizona and Sonora.

Selected reference.—Costea and Stefanović (2010).

Mpio Arivechi: Arroyo Bámori, 5 km S Bámori on road to Valle de Tacupeto, 28°49'15"N, 109°10'24"W, 536 m, 536 m, riparian area in foothills thornscrub, on *Amaranthus*, 15 Sep 2006, *Van Devender 2006-869* (ARIZ, USON, WLU) [SEM]. **Mpio Cucurpe:** Palm Canyon, 25 km SE of Magdalena on road to Cucurpe, Sierra Babiso (Cerro Cinta de Plata), 30°29'N, 111°46'W, 1300 m, 2 Oct 1976, *Van Devender s.n.* (ARIZ). **Mpio Fronteras:** S edge of Esqueda on SON 17, desert grassland, 30°42'41"N, 109°35'15"W, 1215 m, on *Amaranthus*, 13 Aug 2006, *Van Devender 2006-467* (ARIZ, MEXU, WLU). **Mpio Hermosillo:** vicinity of Hermosillo, Valley of Rio de Sonora, 7 Mar 1910, *Rose 12477* (US).

Cuscuta polyanthemos W. Schaffn. ex Yunck., Illinois Biol. Monogr. 6(2–3):46. 1921. Type: MEXICO. Sinaloa: Culiacán, *Schaffner s.n.* (holotype: NY!).

Stems slender, yellow. **Inflorescences** loose, corymbiform or umbellate, often confluent. Pedicels 4–15(–20 mm) long. Bracts 1 at the base of clusters, 0.8–1.2 mm long, ovate triangular to lanceolate, margins entire apex acute. **Flowers** 5-merous, 5–7.5 mm long, membranous, white both when fresh and dry. Papillae present on the corolla lobes. Laticifers not visible. Calyx 2–2.5 mm long, straw-yellow, not reticulate or shiny, cylindric campanulate, ¼–⅓ of the corolla tube, divided ca. ⅓ the length, the tube 0.4–0.8 mm long, lobes 1.5–2 mm long, not basally overlapping, triangular-ovate to lanceolate, not carinate but with small protuberances in the midveins, margins entire, apex acute. Corolla 5–7 mm long, the tube 4–5 mm long, cylindric, lobes 2–2.5 mm long, initially erect later spreading or reflexed, ½ as long as the tube, triangular lanceolate, margins entire, apex acute to acuminate. Stamens short-exserted, shorter than corolla lobes, anthers 0.6–1 × 0.35–0.45 mm, oblong elliptic, filaments 0.5–0.8 mm long. Infrastaminal scales 2–2.5 mm long, bridged at 0.25–0.4 mm, ½–⅓ of the corolla tube, oblong, sparsely, short-fringed, fimbriae 0.05–0.2 mm long. Styles 4–5 mm long, much longer than the ovary, evenly filiform. **Capsules** circumscissile, 1–2 × 0.8–1.2 mm, globose, thicken and risen around the inconspicuous interstylar aperture, translucent, capped by the withered corolla. **Seeds** 2–3 per capsule, 1–1.2 × 0.7–0.85 mm, angled, subrotund to broadly ovate, seed coat cells alveolate/papillate.

Sonora.—Foothills thornscrub; 635 m. Flowering September and October. Rare; parasitizing *Euphorbia* subgenus *Chamaesyce* spp.

General distribution.—Sonora and Sinaloa.

Selected reference.—Costea and Stefanović (2010).

Mpio Moctezuma: 18.9 km S-SE of junction with Moctezuma-Huásabas Hwy on road to Tepache; basalt cobble plain with sparse open foothills thornscrub, 29°39'N 44"N, 109°37'13"W, 635 m, *Reina-G 2006-809* (WLU).

Cuscuta salina Engelm. var. **salina,** in W.H. Brewer, S. Watson, & A. Gray, Bot. Calif. 1:536. 1876. Type: U.S.A. Utah: Rio Virgen, on *Suaeda*, saline soil, Nov 1885, *Remy s.n.* (lectotype (Yuncker 1932) MO!; isolectotypes: P!, fragment NY!).

Cuscuta californica Hook. & Arn. var. *squamigera* Engelm., Trans. Acad. Sci. St. Louis 1:499. 1859. *Cuscuta squamigera* (Engelm.) Piper, Contrib. U.S. Natl. Herb. 11:455. 1906. *Cuscuta salina* var. *squamigera* (Engelm.) Yunck., Illinois Biol. Monogr. 6(2–3):71. 1921.

Stems slender, orange-yellow. **Inflorescences** dense, corymbiform, often confluent. Pedicels (0.5–) 1–5 mm long. Bracts 1 at the base of clusters and 1(–0) at the base of pedicels, 0.7–1.2 mm long, ovate-lanceolate to lanceolate, margins entire, apex acute to acuminate. **Flowers** 5-merous (Fig. 2a), 2.5–4.5 mm long, membranous, white when fresh, creamy-brownish when dried. Papillae or dome-shaped cells present on corolla lobes. Laticifers conspicuous in the perianth, ovary and the capsule. Calyx 1.5–2.5 mm long, glossy yellow, cylindrical to narrow-campanulate, equaling corolla tube, divided ca. ½ the length, the tube 0.6–1.2 mm long, lobes 0.7–1.5 mm long, ovate-lanceolate to lanceolate, not basally overlapping or slightly so, margins entire, apex acute to acuminate. Corolla 2.2–4 mm long, tube 1.2–2 mm long, cylindric-campanulate to obconical, lobes 1.3–2 mm long, erect to spreading, equaling the corolla tube, ovate-lanceolate to oblong-lanceolate, margins entire, not basally overlapping, apex acute to cuspidate. Stamens exerted when flowers are completely open, shorter than corolla lobes, anthers 0.3–0.7 × 0.3–0.4 mm, broadly oblong to elliptical, filaments 0.3–0.7 mm long. Infrastaminal scales 1–1.8 mm long, nearly equaling corolla length (80–90% of the corolla tube), bridged at 0.2–0.45 mm, oblong to slightly obovate, short-fringed, fimbriae 0.03–0.2 mm long. Styles 0.4–0.9 mm long, shorter than the ovary, uniformly thin. **Capsules** indehiscent, 1.6–2.5 × 1.7–2.2 mm, ovate-elliptic, ± thickened around the intrastylar aperture, surrounded or capped by the withered corolla. **Seeds** 1 per capsule, 1.35–1.55

× 1.25–1.43 mm, ± visible through the pericarp, dorsoventrally compressed, broadly elliptic to subround; surface of seed coat epidermis alveolate when dried and papillate when hydrated.

Sonora.—The species is apparently localized at Sonoyta (400 m) and Quitobaquito (at the Arizona–Sonora border, 335 m). Flowering April–May. Growing on *Suaeda moquinii*.

General distribution.—Arizona, California, Nevada, New Mexico, Utah, Texas; Baja California (norte) on herbaceous hosts (e.g., species of *Frankenia, Salsola, Suaeda, Wislizenia*) from inland salt flats, marshes, and ponds.

Selected references.—Costea et al. (2006c, 2009), Felger (2000).

Mpio de Sonoyta: Sonoyta, 1 km S of international border at Lukeville; disturbed habitat at edge of irrigated fields, 28 Apr 1991, *Felger 91-5* (ARIZ, MEXU).

***Cuscuta tinctoria** Mart. ex Engelm. var. **tinctoria**, Trans. Acad. St. Louis 1:480. 1859. Type: MEXICO. Oaxaca: 1827, *Karwinsky s.n.* (lectotype: MO!; isolectotype: NY!).

Stems medium to rarely coarse. **Inflorescences** dense, corymbiform to sub-glomerulate usually confluent. Pedicels 0.5–2.6 mm long. Bracts 1 at the base of clusters, usually absent at the base of pedicels or flowers, 1.5–3 mm long, oblong to oblong lanceolate, acute to obtuse, margins entire. **Flowers** 5-merous, 4–5.2 mm long, thick, white when fresh, reddish-brownish when dried. Papillae absent. Laticifers visible in the calyx, corolla, isolated or in rows, ovoid to elongated. Calyx 2–3 mm long, reddish-brownish, more or less reticulate, ± glossy, campanulate, equaling corolla tube, divided ⅓–¼ the length, tube 0.5–1 mm long, lobes 1.6–2.2 mm long, broadly overlapping, round to broader than long or occasionally broadly elliptic, not carinate or with multicellular protuberances on the midveins, margins entire, apex rounded. Corolla 3.5–5 mm long, tube 2.3–3 mm long, campanulate, lobes 1.5–2.5 mm long, initially erect, later reflexed, equaling or shorter than the tube, oblong-ovate, overlapping, margin entire, apex rounded, straight. Stamens exerted, shorter than corolla lobes, anthers 0.7–1.1 mm long, oblong-elliptic, filaments 0.8–1.2 mm long. Infrastaminal scales 2.5–3 mm long, equaling corolla tube, bridged at 0.8–1.2 mm, oblong to ovate, uniformly dense-fringed, fimbriae 0.2–0.5 mm long. Styles 1.2–2.1(–3) mm long, longer than the ovary, thick, but uniform. **Capsules** circumscissile, 1.5–3 × 1.8–2.5 mm, globose to depressed-globose, not thickened and/or risen around the small interstylar aperture, translucent, capped by the withered corolla. **Seeds** (2–)4 per capsule, 1.5–2 × 1.2–1.9 mm, angled or slightly dorsoventrally compressed, elliptic-oblong to subround, seed coat cells alveolate/papillate or wrinkled.

Sonora.—This species may be a sporadic introduction. It was collected in northern Sonora in 1994 from a cultivated *Schinus terebinthifolia* tree. On many subsequent visits, however, it was not found again. Ornamental trees and shrubs grown in Sonora are often brought from nurseries in Guadalajara, Jalisco, which points to a potential source for new introductions. Sonoran Desert. Flowering December–January.

General distribution.—Yuncker (1932, 1965) mentioned that *C. tinctoria* is common throughout Mexico to Guatemala. This species is part of the largest and most complicated taxonomically clade in Mexico (clade "G"; Stefanović et al. 2007) and the delimitation of species and their distribution require more study.

Selected reference.—Yuncker (1932).

Mpio Magdalena de Kino: Toll station on MEX 15 bypass at Magdalena, ca. 30°37'N, 110° 57'30"W, 800 m, 29 Dec 1994, *Van Devender 94-1008* (ARIZ, MEXU, USON, WLU) [SEM].

Cuscuta tuberculata Brandegee, Univ. Calif. Publ. Bot. 3:389. 1909. Type: MEXICO. Lower California [Baja California Sur]: Santa Margarita Island, on *Boerhavia*, 6 Mar 1889, *Brandegee 3* (holotype: UC!, isotype: MO!).

Stems filiform, yellow-orange. **Inflorescences** loose, umbelliform or racemiform, confluent. Pedicels 2–3(–5) mm long. Bracts 1 at the base of clusters, usually absent at the base of peduncles, 0.5–0.75 mm long, ovate-lanceolate, margins entire, apex acute. **Flowers** 5-merous (Fig. 3i), 2.5–4 mm long, membranous, white-creamy when fresh, creamy when dried. Papillae present especially at the base of the corolla tube. Laticifers barely visible in the corolla, isolated, ovoid to elongated. Calyx 0.5–1.5 mm long, yellow, not or finely reticulate, ± glossy, cupulate-angular, ⅓–½ as long as the corolla tube, divided almost to the base, tube 0.2–0.5 mm long, lobes 1–1.3 mm long, not basally overlapping, triangular to lanceolate, carinate and/or with multicellular protuberances on the midveins, margins entire, acute to acuminate. Corolla 2–3.5 mm long, tube 1.5–2.2 mm long, cylindric, lobes 1.2–2 mm long, erect, about equaling the tube, triangular lanceolate, margins entire, apex acute, straight. Stamens barely exserted, shorter to almost equaling corolla lobes, anthers 0.5–0.8 × 0.25–0.3 mm, ovate to oblong, filaments 0.4–0.7 mm long. Infrastaminal scales 0.5–1 mm long, ca. ½ the length of the corolla tube, bridged at 0.3–0.5 mm long, ovate, uniformly short-fringed, fimbriae 0.05–0.15 mm long. Styles 1.5–3 mm long, longer than the ovary, evenly filiform. **Capsules** circumscissile, globose, 1.3–2.2 × 1–2.3 mm, slightly thickened and risen around the small interstylar aperture, translucent, capped by the withered corolla. **Seeds** 3–4 per capsule, 0.6–0.9 × 0.3–0.5 mm, angled or slightly dorsoventrally compressed, elliptic-oblong, seed coat cells alveolate/papillate.

Sonora.—Relatively common in the Sonoran Desert and foothills thornscrub; 100–700 m. Flowering August–November. The host is usually *Boerhavia*, sometimes *Amaranthus* or genera of Euphorbiaceae.

General distribution.—Arizona, New Mexico; Baja California Sur.

Selected reference.—Costea and Stefanović (2010).

Mpio Álamos: Mocúzari (Adolfo Ruiz Cortinez) Dam on Río Mayo, W-NW of Álamos, 27°13'10"N 109°06'30"W, 120 m, 16 Oct 1992, *Van Devender 92-1386* (ARIZ, ASU, CAS, UCR). **Mpio Caborca:** Km 15 on Caborca–El Desemboque [road], 200 m, 25 Aug 1975, *Rodriguez 1642* (G, MEXU, MO, SD). **Mpio Hermosillo:** 8 mi W of Hermosillo, ca. 1 mi NW of the road to Kino Bay, 27 Aug 1941, *Wiggins & Rollins 98* (ARIZ, CAS, DS, MO, RSA); ca. 25 km W of Hermosillo on rd. to Bahía de Kino, Escuela de Agricultura, Universidad de Sonora, 29°01'29"N 111°08'33"W, 10 Aug 2001, *Reina-G. 2001-623* (ARIZ, MEXU, USON, WLU) [SEM]. **Mio Cajeme:** ca. 2.2 mi NE of Hwy 15 (toward a microwave tower), ca. 6.9 mi SE of Ciudad Obregón, 12 Sep 1973, *Stevens 2052b* (CAS, MEXU, MICH). **Mpio La Colorada:** 36 Km, SE of Hermosillo on MEX 16, 28°49'54"N 110°39'25"W, 317 m, 15 Aug 2006, *Van Devender 2006-552* (HCIB, USON, WLU); 4.7 Km E of Tecoripa on MEX 16, 28°37'04"N 109°54'25"W, 410 m, 16 Aug 2006, *Reina-G. 2006-559* (ARIZ, CAS, WLU). **Mpio General Plutarco Elías Calles:** 2.7 mi W of Sonoyta on Mex Hwy 2, 14 Sep 1986, *Felger 86-315*. **Mpio Guaymas:** near San Carlos Bay, 24 Oct 1939, *Gentry 4719*. **Mpio Moctezuma:** 14.1 km S-SE of Moctezuma on road to Tepache, 29°40'53"N 109°38'00"W, basalt cobble plain with dwarf foothills thornscrub, 607 m, 14 Aug 2006, *Reina-G. 2006-544* (MO, TEX, WLU). **Mpio Opodepe:** Querobabi, Plains of Sonora desertscrub, 30°03'14"N 111°01'39"W, 680 m, 20 Aug 2001, *Reina-G. 2001-730* (ASU, HCIB, NMC, WLU). **Mpio Soyopa:** Arroyo Los Garambullos, 0.5 km SE of Río Yaqui bridge on MEX 16, 3.3 km S, 1.5 km E of Tónichi, 28°34'10"N 109°33'00"W, 180 m, 15 Sep 1998, *Van Devender 98-1111* (ARIZ, WLU); 17 Aug 2006, *Van Devender 2006-622* (US, WLU); 17 Sep 2006, *Van Devender 2006-932A* (WLU). **Mpio Puerto Peñasco:** Pinacate Region, Sykes Crater, 400 m, 8 Dec 1970, *Felger 19998*.

Cuscuta umbellata Kunth var. **umbellata,** Nov. Gen. Sp. Pl. 3[folio]:95. 1818. Type: [MEXICO]: Crescit in Nova Hispania, inter Querretaro et Salamanca, *Humboldt s.n.* (lectotype: Yuncker 1932: MO!; isolectotype: P!).

Stems slender, yellow-orange. **Inflorescences** dense to loose, umbelliform, confluent. Pedicels 2–10 mm long. Bracts 1 at the base of clusters, usually absent at the base of pedicels, 0.5–2.0 mm long, triangular-ovate, margins entire, apex acute. **Flowers** 5-merous (Fig. 3g), 2–3 mm long, membranous, white when fresh, creamy-white or dark brown when dried. Papillae sometimes present but only on the adaxial face of corolla lobes. Laticifers evident in the bracts, calyx, corolla, tips of infrastaminal scale fimbriae, and ovary, isolated, ovoid. Calyx 0.8–1.4 mm long, straw-yellow, finely reticulate, slightly shiny, campanulate, equaling the corolla tube, divided ca. ⅔ the length, tube 0.25–0.60 mm long, lobes 0.5–0.9 mm long, not basally overlapping, broadly triangular-ovate, not carinate, margins entire, apex obtuse to acute, initially cucullate, later straight. Corolla 2.0–2.5 mm long, tube 0.6–1.2 mm long, campanulate, lobes 0.8–1.5 mm long, initially erect, later reflexed, equaling or slightly longer than the tube, oblong to lanceolate, margins entire, apex obtuse to acute, straight. Stamens exserted, shorter than the lobes, anthers 0.40–0.60 × 0.24–0.30 mm, elliptic to oblong, filaments 0.4–0.7 mm long. Infrastaminal scales 0.8–1.2 mm long, equaling or slightly longer than the tube, bridged at ca. 0.1 mm, subspathulate to obovate, uniformly dense-fringed, fimbriae 0.15–0.32 mm long. Styles 0.8–1.7 mm long, equaling or longer than the ovary, evenly filiform. **Capsules** circumscissile, 1.0–2.5 × 0.5–1.2 mm, depressed, irregularly thickened and slightly risen around the inconspicuous interstylar aperture, translucent, surrounded or capped by the withered corolla. **Seeds** 4 per capsule, 0.80–1.20 × 0.65–0.80 mm, angled, broadly elliptic to surround, seed coat cells alveolate/papillate.

Sonora.—Sonoran Desert in the western part of the state, ca. 10–430 m. Flowering June–December-March. Potential host plants in northwestern Sonora include *Acleisanthes*, *Allionia*, *Amaranthus*, *Atriplex*, *Boerhavia*, *Gilia*, *Kallstroemia*, *Salsola*, *Suaeda*, *Tidestromia*, *Trianthema*, and *Tribulus*.

General distribution.—Arizona, Colorado, New Mexico, Texas; Chihuahua, Coahuila, Durango, Distrito Federal, Guanajuato, Guerrero, Edo. México, Hidalgo, Jalisco, Michoacán, Nuevo Leon, Oaxaca, Puebla, Querétaro, San Luis Potosí, Tamaulipas, Veracruz; West Indies; Central and South America.

Selected reference.—Costea and Stefanović (2010).

Mpio Guaymas: 1 mi N of Suhuoral [Sahuaral], 19 mi W of Arrieros on rd to Tastiota, on *Atriplex barclayana* and *A. polycarpa*, 3 Sep 1941, *Wiggins & Rollins 254* (CAS, UC). **Mpio General Plutarco Elías Calles:** Quitovac, extremely common, 2 Sep 1980, *Nabhan & Rea 167*; NW side of Sonoyta, Calle 16 de Septiembre, ca. 0.5 km E of Río Sonoyta, slight depression, sandy soil, disturbed, weedy habitat, 4 Oct 1985, *Felger 85-940*.

Cuscuta vandevenderi Costea & Stefanov., Botany 86:679. 2008. TYPE: MEXICO. SONORA: Municipio Yécora, 28°22'40"N, 109°09'W', 850 m, common parasite on *Sida rhombifolia* (Malvaceae); flowers starting white, turning yellowish, 20 Sep 1998, *Van Devender 98–1434* (HOLOTYPE: ARIZ!; ISOTYPES: MEXU!, NY!, WLU!).

Cuscuta gracillima var. *esquamata* Yunck., Illinois Biol. Monogr. 6(2–3):43. 1921. TYPE: MEXICO. BAJA CALIFORNIA: El Taste, 16 Sep 1893, *Brandegee s.n.* (HOLOTYPE: UC!).

Stems thin. **Inflorescences** corymbiform cymes arranged in dense globose inflorescences, 1–3 cm in diameter. Pedicels 0.7–6 mm long. Bracts 1 at the base of clusters, 0.5–0.75 mm long, triangular-ovate, margins entire or denticulate, apex acute. **Flowers** (4–) 5-merous, 2–2.6 mm long, membranous, white turning cream yellowish when fresh, creamy–light brown when dried. Papillae absent. Laticifers prominent in the calyx and corolla, articulated or isolated, rectangular, ovoid to elongated. Calyx 0.9–1.6 mm long, yellow-gray, not shiny, campanulate, divided ½–⅓ mm, tube 0.4–0.8 mm long, lobes 0.5–1.2 mm long, not overlapping to overlapping, triangular to triangular-lanceolate, carinate, margins ± entire to serrulate, apex acute, acuminate to obtuse. Corolla 1.5–2.1 mm long, tube campanulate, 0.9–1.3 mm long, lobes 0.6–1.3 mm long, erect to slightly spreading, triangular, margins entire to irregular, apex obtuse to acute. Stamens equaling to longer than corolla lobes, anthers 0.3–0.5 × 0.3–0.4 mm, subround to broadly elliptic, filaments 0.6–1.5 mm long. Infrastaminal scales 1–1.2 mm long, equaling corolla tube, bridged at 0.4–0.5 mm, oblong–ovate to truncate, densely fringed, fimbriae 0.1–0.2 mm long. Styles 0.8–1.2 mm long, longer than the ovary, uniformly filiform. **Capsules** indehiscent, 1.8–2.4 × 0.8–1.2 mm, globose–depressed to globose–obovoid, slightly thickened but not risen around the relatively large interstylar aperture; persistent corolla surrounding the base of capsules. **Seeds** 3–4 per capsule, 0.9–1.1 × 1–1.2 mm, subrotund, seed coat cells alveolate/papillate.

Cuscuta vandevenderi resembles *C. gracillima* from which it differs through the smaller flowers and indehiscent capsules surrounded by persistent corollas, and the often serrate calyx and corolla lobes. From *C. deltoidea*, which is the closest related species, it can be separated by the indehiscent capsules and denser inflorescences (Costea et al. 2008).

Sonora.—Southeast and central part of the state in tropical deciduous forest, oak woodland, and pine-oak forests (sometimes in openings); 350–1550 m. Flowering September–December. Parasitizing various herbs, e.g., *Ayenia*, *Chamaecrista*, *Cosmos*, *Euphorbia*, *Sida*, and *Evolvulus*.

General distribution.—Sonora and Baja California Sur.

Selected reference.—Costea et al. (2008).

Mpio Álamos: Sierra Tecurahui, 1200–1500 m, 26–28 Oct 1961, *Gentry 19423* (US); 3.9 km above Rancho El Palmarito, 23.9 km, E-NE of Álamos, 27°03'04"N, 108°45'51"W, 516 m, 1 Oct 2006, *Van Devender 2006-983* (WLU); El Guayabo Crossing of Río Cuchujaqui, 14 Km (by air) E-SE of Álamos, 27°00'05"N, 108°47'08"'W, 370 m, 21 Nov 1993, *Steinmann 93-349* (ASU). **Mpio Mazatán:** Sierra de Mazatán, Rancho El Flauta, 29°06'N, 110°12'50"W, 1260 m, 9 Oct 2004, *Reina 2004-1224* (USON, WLU). **Mpio Yécora:** Santa Ana de Yécora; 28°22'40"N, 109°09'W, 850 m, 20 Sep 1998, *Van Devender 98-1434* (ARIZ, MEXU, NY, WLU); Cañada La Ventana (Arroyo El Otro Lado), 2.5 km (by air) E-SE of Yécora, 28°21'38"N, 108°53'55"W, 1520 m, 18 Sep 1998, *Van Devender 98-1334* (WLU) [SEM].

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TREPTOSTEMON (LAURACEAE), A NEW GENUS OF FOSSIL FLOWER FROM MID-TERTIARY DOMINICAN AMBER

Kenton L. Chambers
Department of Botany and Plant Pathology
Oregon State University
Corvallis, Oregon 97331, U.S.A.
chamberk@science.oregonstate.edu

George O. Poinar, Jr.
Department of Zoology
Oregon State University
Corvallis, Oregon 97331, U.S.A.

Andre S. Chanderbali
Department of Biology
University of Florida
Gainesville, Florida 32611, U.S.A.

ABSTRACT

A fossil flower of family Lauraceae is described from amber of Late Oligocene-Early Miocene deposits in the Dominican Republic, island of Hispaniola. The flower is staminate and lacks a visible pistillode. It has 6 equal, lanceolate, spreading tepals and at least 6 fertile stamens. The 4 anther pores of the stamens of whorls 1 and 2 are arranged in pairs, one above the other. The pores are open and in some cases have the torn remains of apical valves. The 3 stamens of whorl 3 have at least 2 pores, whose raised valves are visible, but the total number of pores is uncertain. It is not known whether these stamens are functional or staminodial. Whorl 4 staminodes appear to be absent. A distinctive feature of the flower is that all 6 anthers of whorls 1 and 2 stamens are extrorse in dehiscence. Due to this unique characteristic, the flower cannot be assigned to any modern genus, and it is here described as the new genus and species **Treptostemon domingensis**.

RESUMEN

Se describe una flor fósil de la familia Lauraceae procedente de ámbar de depósitos del Oligocenetardío- Miocene temprano en la República Dominicana, isla de la Española. La flor es estaminada y carece de un pistilodio visible. Tiene 6 tépalos iguales, lanceolados extendidos, y al menos 6 estambres fértiles. Los 4 poros de las anteras de los estambres de los verticilo 1 y 2 están colocados en pares, uno encima del otro. Los poros están abiertos y en algunos casos tienen restos de desgarros de las valvas apicales. Los 3 estambres del verticilo 3 tienen al menos 2 poros, cuyas valvas elevadas son visibles, pero el número total de poros es incierto. No se conoce cuantos de estos estambres son funcionales o son estaminodios. El verticilo 4 de estaminodios parece estar ausente. Una característica distintiva de la flor es que las 6 anteras de los verticilos de estambres 1 y 2 tienen dehiscencia extrorsa. Debido a esta característica única, la flor no puede ser asignada ningún género moderno, y se describe aquí como el nuevo género y especie **Treptostemon domingensis.**

INTRODUCTION

Amber deposits of the Cordillera Septentrional, Dominican Republic, continue to yield interesting fossil angiosperm flowers from the low-elevation tropical forests characteristic of Mid-Tertiary Caribbean vegetation (Poinar & Poinar 1999). We have recently described fossils assignable to *Licania* (Chrysobalanaceae) (Poinar et al. 2008a, revised by Chambers & Poinar 2010), *Persea* (Lauraceae) (Chambers et al. 2011a), *Trichilia* (Meliaceae) (Chambers et al. 2011b), *Swietenia* (Meliaceae) (Chambers & Poinar 2012), and *Trochanthera* (possibly Moraceae) (Poinar et al. 2008b). A second flower of Lauraceae is described in the present paper. It has several well-marked features, including 6 fertile stamens in whorls 1 and 2, whose anthers have 2 pairs of pores that open extrorsely. The stamens of whorl 3 display 2 upright valves but are possibly staminodial, since their terminal portion is dissimilar in size and shape from the fertile anthers. The anthers are closely adjacent and are on short filaments. The epidermis of the anthers and staminodes is densely covered with minute trichomes. No pistillode or whorl 4 staminodes are visible. Because of the extrorse dehiscence of the 6 anthers of whorls 1 and 2, the fossil cannot easily be accommodated in any modern genus of Lauraceae. We therefore propose to separate it as the new genus and species *Treptostemon domingensis*.

MATERIALS AND METHODS

All the amber fossils referred to above came from mines in the Cordillera Septentrional, between Puerto Plata and Santiago, Dominican Republic. Dating methods applied to the deposits are thus far equivocal. An age of 45–30 mybp was assigned by Cépek in Schlee (1999) based on fossil coccoliths, and one of 20–15 mybp was determined by Iturralde-Vinent and MacPhee (1996) based on foraminifera. The amber is found in turbiditic

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sandstones of the Upper Eocene to Lower Miocene Mamey Group (Draper et al. 1994). Animals and plants of the forest vegetation present at the time of amber deposition were described by Poinar and Poinar (1999), the original resin having been a product of the arborescent genus *Hymenaea* (Fabaceae). In Poinar and Poinar (op. cit.), the present flower was inadvertently assigned to the genus *Nectandra* (Pg. 21, Fig. 10).

DESCRIPTION

Treptostemon K.L. Chambers, Poinar, & A.S. Chanderbali, gen. nov. Type Species: *Treptostemon domingensis* K.L. Chambers, Poinar, & A.S. Chanderbali, sp. nov. (**Figs. 1–2**).

Diagnosis.—Flower staminate, radially symmetrical (Fig. 1), receptacle flat, pedicel remnant strigose, tepals 6, in 2 whorls of 3, separate, approximately equal, spreading, lightly strigose on both surfaces, margins involute, glabrous (Fig. 2), stamens 9, in whorls of 3, at least the outer 2 whorls fertile, anthers minutely puberulent, those of whorls 1 and 2 with 4 pores arranged as 2 pairs, one above the other, all extrorse, opening by apical valves, stamens of whorl 3 functional or staminodial, their distal portion dissimilar in size and shape from the fertile anthers (Fig. 2), 2 or 4 small pores probably present, the distal pair opening extrorsely by upturned valves, glands of whorl 3 stamens small, whorl 4 staminodes and pistillode not evident. Pistillate flower unknown.

Etymology.—From Greek "treptos," turned, and "stemon," stamen.

Treptostemon domingensis K.L. Chambers, Poinar, & A.S. Chanderbali, sp. nov. Type: HISPANIOLA. Dominican Republic: amber mine in the northern mountain ranges (Cordillera Septentrional), 1995, *unknown amber miner s.n.* (holotype: catalogue number Sd-9-64, deposited in the Poinar amber collection maintained at Oregon State University, Corvallis, Oregon 97331, U.S.A.)

Description.—Tepals lanceolate, acute, laterally spreading, 3.1 to 4.0 mm long, 1.1 to 1.6 mm wide (Fig. 1), anthers of whorls 1 and 2 0.9 to 1.0 mm wide, ca. 1.0 mm long, with short filaments, pores extrorse, circular to oblong, ca. 0.3 mm in diameter, valve remnants visible in a few cases (Fig. 2), connective forming an adaxial ridge, stamens of whorl 3 club-shaped, distal portion cylindrical, 0.7 mm in diameter, pores extrorse, the distal pair defined by small, upturned valves (Fig. 2), otherwise not observable, glands of whorl 3 stamens 0.19 mm wide (only 1 observed).

Etymology.—From source of amber in Dominican Republic.

DISCUSSION

Examination of the fossil is best done from above, as in Figures 1 and 2. In a lateral view, obtained with difficulty, the outer anthers display all 4 extrorse pores, although in apical view, the lower pair may be barely visible (Fig. 2). The filaments of the outer stamens are quite short and curve at the tip, so that the anthers face dorsolaterally. The positioning of the stamens does not allow observation of pores on whorl 3, and their number is uncertain. The upraised valves of the distal pores (Fig. 2) are in an extrorse position. Despite the reduced size and cylindrical shape of these anthers, it is uncertain whether the whorl 3 stamens are fertile or staminodial. A staminodial condition is possible, considering the report by Kubitzki and Kurz (1984) that in staminate flowers of 3 dioecious species of *Ocotea* they studied, "[t]he staminodes often possess valves that open after the wilting of the stigma" (i.e., stigma of the pistillode). Only one gland of the whorl 3 stamens is in view (Fig. 2). On some anthers, small, black air bubbles that have settled among the surface trichomes may be confused for pores, but these are artifacts. The extrorse dehiscence in all androecial whorls of *Treptostemon* is unique in Lauraceae, although in *Pleurothyrium* there are 9 tetrasporangiate, latrorse anthers which may look almost extrorse (J. Rohwer, pers. comm.).

The shortness of the stamens of *Treptostemon* and their close positioning in the flower are features similar to *Aniba* and *Aiouea* (Kubitzki and Renner 1982), among other genera, although a close relationship to these 2 taxa, which are hermaphrodite, with upright tepals and only 2 pores per anther, is not likely. Furthermore, the usual laurad introrse dehiscence of whorls 1 and 2 anthers occurs in the 2 genera. Stamens with short filaments also occur in the New World dioecious genera *Rhodostemonodaphne* (Madriñán 2004) and *Ocotea* (the latter

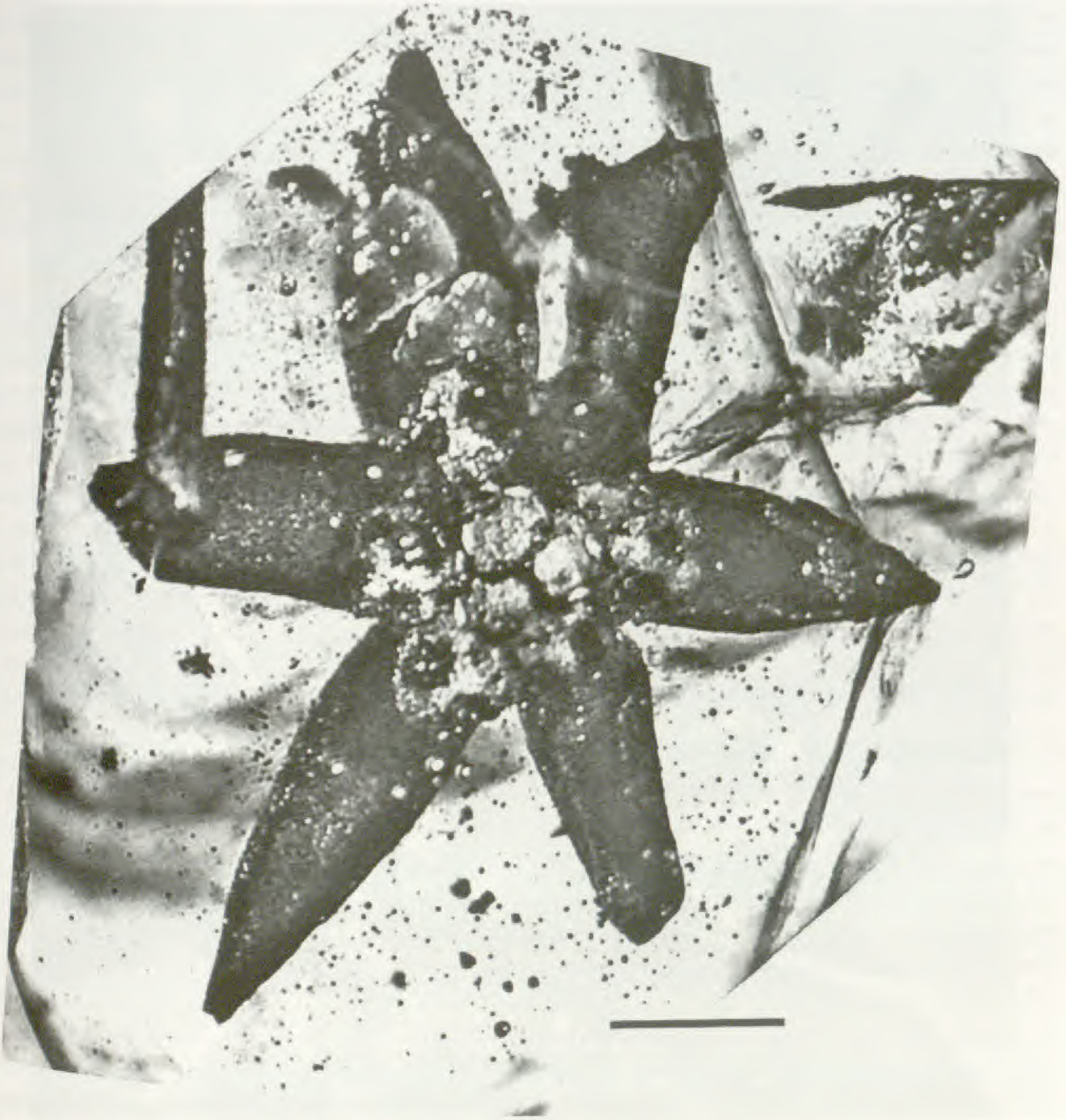

Fig. 1. ***Treptostemon domingensis,*** **apical view of complete flower. Scale bar = 1.4 mm.**

with bisexual or unisexual flowers). Both have 4-pored, introrse anthers, but in *Rhodostemonodaphne* the pores form a more or less horizontal row (Rohwer 1993; van der Werff 1991, Fig. 2E), unlike the pores of *Treptostemon* anthers. The latter two genera are similar in lacking staminodes of whorl 4 but differ in their receptacle, which is narrowly tubular in *Rhodostemonodaphne* (Rohwer op. cit.). The closest relative among genera with 4-pored anthers is probably *Ocotea*, a species-rich and variable taxon characterized by Rohwer (1993, p. 382) as "the dustbin of the Perseae." Dioecious species such as *O. pyramidata* (Allen 1945) may have anthers 1.0 mm long, with the filament only 0.5 mm. (As an aside, although pollen is shed inwards by these anthers, it is also released outwards from the 2.15 mm-long stamens of whorl 3). According to Rohwer (op. cit.) the whorl 4 staminodes of *Ocotea* are absent in unisexual flowers, the receptacle varies from flat to deeply tubular, and the pistillode in male flowers may be present or absent. The principal difference between *Ocotea* and *Treptostemon*, therefore, is that the former has anthers of whorls 1 and 2 dehiscing introrsely.

Pollen had recently been discharged from the *Treptostemon* flower before it became immersed in tree res-

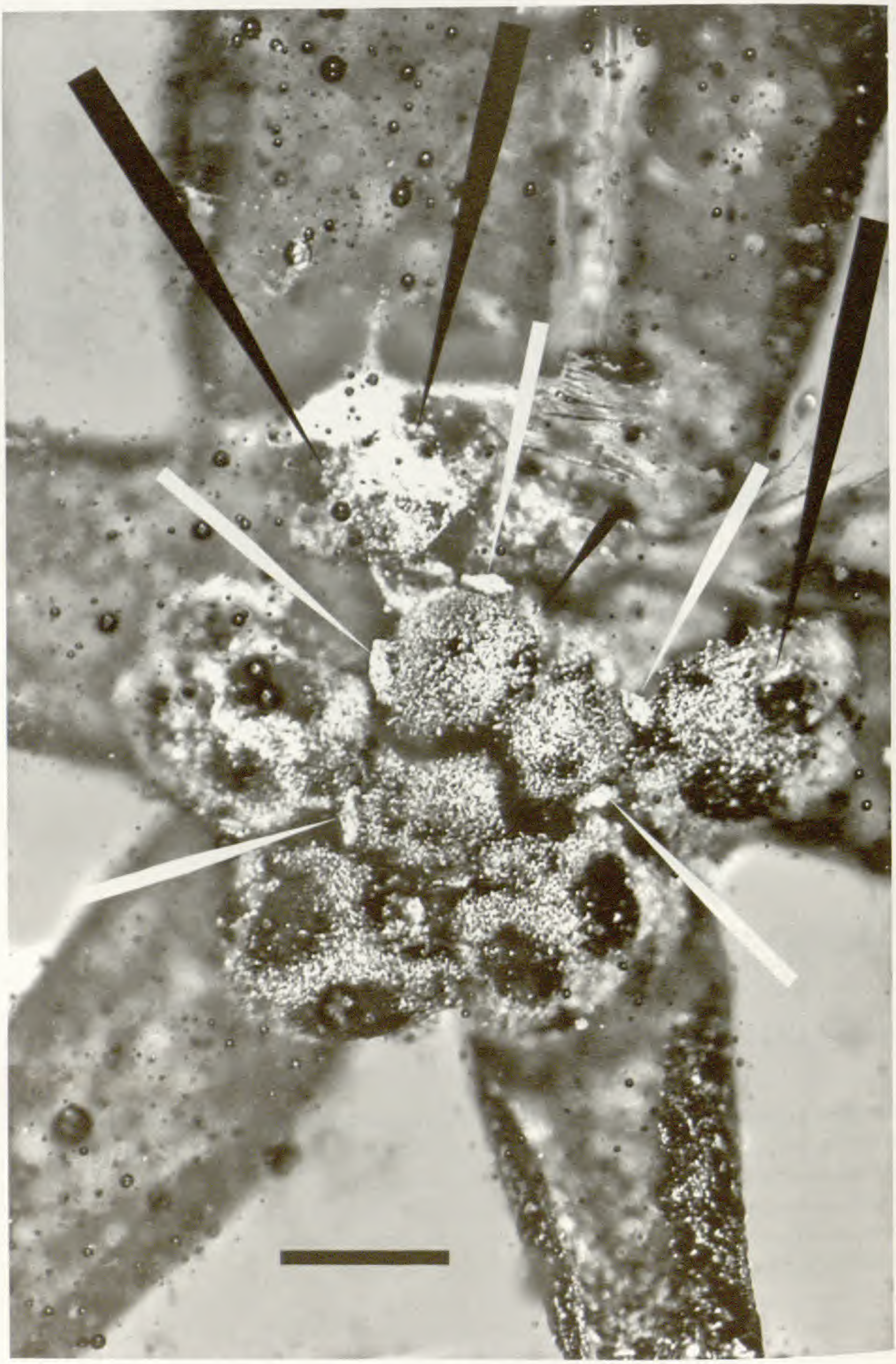

Fig. 2. *Treptostemon domingensis,* enlarged view. White arrows indicate 5 of 6 upraised valves on stamens of whorl 3; long black arrows show 3 apical valve remnants by pores on anthers of whorl 1; short black arrow points to gland of whorl 3 staminode. Note involute, glabrous margins of tepal at lower right. Scale bar = 0.7 mm.

in, as shown by a cloud of tiny pollen grains below 2 tepals on one side of the fossil. Being dioecious, the plant would have had to release pollen from the staminate flowers in such a way that it would be easily available to visiting insects for transfer to pistillate flowers on another tree. It is likely that dioecy, nectar production, and extrorse anther dehiscence were adaptive features of the species' pollination syndrome, but we are too far removed in time to reconstruct other details of its floral biology. A brief review of reports on pollination in some present-day Lauraceae may be of interest, nonetheless, in conjunction with a discussion of available pollinators in the insect fauna already known from Dominican amber (Michener & Poinar 1997; Poinar & Poinar 1999).

A report on pollinators identified from modern tropical rain forests in Costa Rice (Bawa et al. 1985) lists only one member of Lauraceae, an unidentified species of *Ocotea*. It is cited as hermaphroditic and a member of the subcanopy, its major pollinators being beetles. Whether the flowers offer both nectar and pollen as food rewards is not mentioned. However, in her generic description of *Ocotea*, Allen (1945) states that stamens of the inner series always bear two sessile or stipitate glands, presupposing the presence of a nectar reward for visitors. In a study of dichogamy and dioecy in Neotropical Lauraceae, Kubitzki and Kurz (1984) included observations of pollinators for 3 dioecious species of *Ocotea*. Two species were seen to be visited by brown bees, about 1 cm in length, while small diptera, wasps and moths sucking nectar were occasionally encountered. Larger flies were observed visiting flowers of *O. guianensis* and *O. opifera* but could not be caught for identification. A more detailed study of pollination in a single dioecious species, *Laurus azorica* of Macaronesia, was published by Forfang and Olesen (1998). In a sample of over 200 trees, flower visitors included at least 11 different insect species. These were: Hymenoptera–2 species of Halictidae, 1 of Apidae, and 1 of Ichneumonidae; Diptera–1 species of Musicidae, 1 of Syrphidae, 1 of Tachinidae, and 1 of Bibionidae; Lepidoptera–1 species of Nymphalidae; Coleoptera–1 species of Nitidulidae; Hemiptera–1 species of Pentatomidae. Only Halictidae and Tachinidae were common, comprising 97% of the visits. Bees are also considered to be the principle pollinators of the avocado, *Persea americana*, even though flies and other insects also visit the flowers (Free 1993).

Generalized, radially symmetrical flowers of Lauraceae, with spreading perianth and exposed stamens and pistil, are open to visits by many different groups of anthophilous insects. A potential pollinator might develop a specific attraction to the odor of pollen or nectar in such a flower and become faithful to one or a few species (Faegri & van der Pijl 1979). However, it is unlikely that an unspecialized flower like that of *Treptostemon*, even with its modified form of pollen presentation atypical of the family, would have been closely adapted to a single kind of pollinator. Since their origination in the Early Cretaceous (Danforth & Poinar 2011), bees, which rear their young on pollen, have been among the most dependable pollinators of angiosperms. Based on the above reports indicating that bees are frequent visitors of present-day Lauraceae, it is likely that this group of insects also visited and pollinated *T. domingensis* in the Tertiary forests of Hispaniola. The bee fauna of Dominican amber includes representatives of families Apidae, Andrenidae, Colletidae, and Halictidae (Michener & Poinar 1997). Of these, the most common bee in Dominican amber is the small, stingless *Proplebia dominicana* (Apidae, tribe Meliponini), which could well have been significant in the pollination system of *Treptostemon*. Despite their presence in the fossil record, stingless bees do not occur in Hispaniola today. Their disappearance as keystone species could have led to the elimination of many plant species, including *Treptostemon*.

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A NEW FOSSIL SPECIES OF *COLPOTHRINAX* (ARECACEAE) FROM MID-TERTIARY MEXICAN AMBER

Kenton L. Chambers
Department of Botany and Plant Pathology
Oregon State University
Corvallis, Oregon 97331, U.S.A.
chamberk@science.oregonstate.edu

George O. Poinar, Jr.
Department of Zoology
Oregon State University
Corvallis, Oregon 97331, U.S.A.

Alex E. Brown
629 Euclid Ave.
Berkeley, California 94708, U.S.A.

ABSTRACT

A fossil palm flower in Late Oligocene to Early Miocene amber deposits of Chiapas, Mexico, is described as the new species **Colpothrinax chiapensis.** The flower is perfect and complete, with a calyx tube bearing 3 small, triangular lobes, and 3 ovate-lanceolate, spreading or recurved petals that are connate basally into a shallow tube. The 6 stamens are attached at the mouth of the corolla tube; their slender, subulate filaments are widened basally, slightly connate, and bear large, versatile, laterally dehiscent anthers. The ovary, loosely enclosed in the corolla tube, is composed of 3 closely adjacent, separate carpels. The united style is three-grooved, well-exserted, and slightly shorter than the filaments, with an acute tip and smooth, non-papillate stigma. The 3 modern species of *Colpothrinax* differ from the fossil in having the filaments shorter, more widely tapering, and united basally to form a better developed staminal tube.

RESUMEN

Una flor fósil de palmera de depósitos de ámbar del Oligoceno tardío al Mioceno temprano de Chiapas, México, se describe como la nueva especie **Colpothrinax chiapensis.** La flor es perfecta y completa, con tubo del cáliz que lleva tres lóbulos triangulares pequeños y 3 pétalos ovado-lanceolados, extendidos o recurvados que están connados basalmente en un tubo poco profundo. Los 6 estambres están adheridos a la boca del tubo de la corola; sus filamentos delgados, subulados, están extendidos basalmente y ligeramente connados, y llevan unas anteras grandes, versátiles, dehiscentes lateralmente. El ovario, incluido en el tubo de la corola, está compuesto de 3 carpelos independientes muy próximos entre sí. El estilo unido con tres surcos está bien exerto y es ligeramente más corto que los filamentos, con un extremo agudo y estigma liso no papiloso. Las 3 especies modernas de *Colpothrinax* difieren de las fósiles por tener los filamentos más cortos, menos afilados, y unidos basalmente para formar un tubo estaminal mejor desarrollado.

INTRODUCTION

A new fossil species of palms, described here as *Colpothrinax chiapensis*, is represented by 4 flowers embedded in Mid-Tertiary amber from a mine in the state of Chiapas, Mexico. The floral morphology of the species is similar in general features to the modern genus *Colpothrinax*, whose three species are found in Cuba and Central America, from Guatemala to Panama (Evans 2001). The pistil, in particular, is like that of this genus, with 3 separate but apposite carpels and an elongate style, which appears to be fused and grooved rather than composed of 3 separate units. The style tip is tapering and lacks an enlarged stigma. The basally connate petals, forming a short tube surrounding the ovary, and the almost completely united sepals with short, triangular lobes, provide further similarities. Principal differences are in the androecium of *C. chiapensis*, in which the longer, linear-subulate filaments are widened only near the base and slightly united into a staminal tube. The anthers are large, dorsifixed, and latrorse in dehiscence, as described for *Colpothrinax* (Dransfield et al. 2008). The probable age of the fossils, 22.5–26 Ma, is commensurate with an estimated mean stem age for the genus of 28.56 Ma (Bacon et al. 2012). The species' Mexican origin gives evidence for an evolutionary radiation of *Colpothrinax* in the Caribbean region, as suggested by Bacon et al. (op. cit.) for *Copernicia* and certain other genera of tribe Trachycarpeae.

MATERIALS AND METHODS

The specimen originated from an amber mine in the northern mountain ranges (Chiapas Highlands) of the Simojovel area in Chiapas, Mexico. Maps of the area are given in Poinar (1992). Amber from Chiapas, which was produced by *Hymenaea mexicana* (Poinar & Brown 2002), occurs in lignitic beds among sequences of

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primarily marine calcareous sandstones and silts. The particular amber under study is associated with the Balumtun Sandstone of Early Miocene and the La Quinta Formation of Late Oligocene, with radiometric ages from 22.5–26 Ma (Berggren & Van Couvering 1974). The amber is secondarily deposited in these marine formations and may be somewhat older than the above dates. The original vegetation was probably a wet to moist tropical to subtropical forest.

DESCRIPTION

Colpothrinax chiapensis K.L. Chambers, Poinar, & A.E. Brown, sp. nov. (**Figs. 1–4**). TYPE: MEXICO. CHIAPAS: amber mine in Chiapas Highlands, Simojovel area, 2011, *unknown amber miner s.n.* (HOLOTYPE: see Fig. 1, catalogue number Sd-9-181A, deposited in the Poinar amber collection maintained at Oregon State University, Corvallis, Oregon 97331, U.S.A.; PARATYPES: see Fig. 2, catalogue number Sd-9-181B, Figs. 3–4, catalogue number Sd-9-181C, similarly deposited at Oregon State University).

Flowers hermaphrodite, ca. 6 mm in diameter when petals spread, calyx cupulate, glabrous, 0.4 mm (Fig. 4), sepals united, with 3 free, triangular, 0.4–1.1 mm lobes, petals 3, glabrous, ovate-lanceolate, ca. 3.3 mm, spreading or reflexed, with numerous parallel veins and no raised mid-nerve adaxially (Fig. 1), shallowly grooved abaxially (Fig. 2), tip boat-shaped (Fig. 1), stamens 6, exserted, glabrous, filaments subulate, 1.0–1.2 mm, widened at base, the connate portion short (Fig. 3), attached at the mouth of the corolla tube, anthers ca. 2.3 mm, dorsifixed, locules 4, dehiscence latrorse (Fig. 2), gynoecium glabrous, 3-carpellate, ovary loosely enclosed in corolla tube (Fig. 1), carpels free, apposite, style appearing united, ca. 1.2 mm, 3-grooved, tip acute, stigma not enlarged (Fig. 2).

Etymology.—from the fossils' origin in Chiapas, Mexico.

DISCUSSION

The fossils differ from other genera of Trachycarpeae in such features as the enlarged anthers, persistent petals (cf. *Pritchardia*), cupulate calyx (cf. *Brahea*, *Acoelorrhaphe*), long filaments (cf. *Copernicia*), and presence of a staminal tube (cf. *Serenoa*) (see Dransfield et al. 2008, pp. 272–285, for illustrations). The orientation of the flowers does not allow measurement of the depth of the corolla tube. In other respects, the fossils can be matched with excellent descriptions and floral illustrations of *Colpothrinax* in Uhl and Dransfield (1987), Dransfield and Uhl (1998), Dransfield et al. (2008), and Evans (2001). Whether the proposed new species falls within the full morphological variation of any of the extant taxa is uncertain, but we believe that the androecium, in particular, sets it apart from *Colpothrinax wrightii* (Bailey 1940) and *C. cookii* (Read 1969), and the large petals and long, subulate, scarcely united filaments are adequately distinct from *C. aphanopetala* (Evans 2001). The published treatments of the 3 modern species include much information about stem and leaf morphology, inflorescence, pollen (esp. Dransfield et al. 1990), habitats, and associated vegetation. Vegetative and inflorescence morphology is, of course, unknown for *C. chiapensis*, as is the pollen; however, the species' preservation in resin from *Hymenaea mexicana* is evidence of moist tropical or subtropical forest vegetation as the preferred habitat.

The phylogenetic relationships of the genera of tribe Trachycarpeae (Dransfield et al. 2008 [formerly Livistoneae, Dransfield et al. 2005]) have begun to be clarified by recent molecular studies utilizing nuclear and plastid DNA (Asmussen et al. 2006; Roncal et al. 2008; Baker et al. 2009; Bacon et al. 2012). In the first 3 papers cited, *Colpothrinax* is in a clade that includes several other genera with which it had previously been associated, including *Pritchardia*, *Washingtonia*, *Serenoa*, *Acoelorraphe*, *Brahea*, *Livistona*, and *Chamaerops*. However, in the report by Bacon et al. (2012), involving *matK*, *ndhF*, *trnD-trnT* and 3 nuclear loci, *Colpothrinax* is alone in a highly supported clade that is sister to 2 large clades containing, *inter alia*, *Brahea*, *Chamaerops*, *Serenoa*, *Acoelorraphe*, and *Livistona*, and is well separated from *Washingtonia* and *Pritchardia*. The subtribal classification of Trachycarpeae is presently in flux, it appears, as perhaps is true also in other large families now under intensive molecular phylogenetic study.

The new intrafamilial relationships of palms revealed by molecular research have been used to investigate additional questions beyond taxonomy alone. These include the origin and global diversification of tropical rain forests (Couvreur et al. 2011) and the effects of Miocene dispersal on island radiations in tribe Trachycar-

Fig. 1. *Colpothrinax chiapensis,* holotype. Apical view, with single remaining anther not yet dehisced. Note parallel-veined petal with boat-shaped tip (upper arrow), gap between carpels (middle arrow), and sepal lobe (lower arrow). A bit of debris in the amber partially obscures the lower petal. Bar = 1.0 mm.

Fig. 2. *Colpothrinax chiapensis,* first paratype. Note laterally dehisced anthers, grooved style (long arrow), and lobe of united calyx (short arrow). Flower at right has petal cupped upward and anther not yet dehisced. Extraneous egg-like mass rests on floral pedicel. Bar = 1.0 mm.

Fig. 3. *Colpothrinax chiapensis,* second paratype. Apical view, showing slight basal fusion between adjacent filaments (arrow). Bar = 0.9 mm.

Fig. 4. *Colpothrinax chiapensis,* second paratype. Lateral view, showing lobed calyx cup (arrow) and stout pedicel. Bar = 0.47 mm.

peae (Bacon et al. 2012). In the first paper, a complete phylogenetic analysis of genera in family Arecaceae derived by Baker et al. (2009) is the basis for a plot of the number of palm lineages, from 120 Ma (Lower Cretaceous) to 26 Ma (Late Oligocene), showing a linear increase with time. Throughout this period and up to the present, tropical rain forests have been the predominant habitat for palms, but exceptions exist for certain "not tropical rain forest" groups (*Washingtonia* and *Serenoa* are examples) and others, like *Colpothrinax*, which the authors designate as "ambiguous." As suggested above, *C. chiapensis* was associated with the arborescent legume *Hymenaea*, marking its habitat as tropical or subtropical rain forest. One of the modern species, *C. wrightii*, has diverged ecologically and is distributed in semidry savannas and grasslands (Bailey 1940), while *C. cookii* and *C. aphanopetala* are in premontane and lower montane rain forests on upper slopes and ridges up to 1600 m elevation (with some exceptions at lower elevations in the latter taxon [Evans 2001]). The earlier-described amber fossil *Socratea brownii* (Poinar 2002) was another palm species associated with *Hymenaea mexicana* in the same Mid-Tertiary tropical forests as was *Colpothrinax chiapensis*.

The question of island dispersal and radiation, specifically in genera of tribe Trachycarpeae, is given detailed attention by Bacon et al. (2012). Of interest here is the authors' estimation of the age of crown and stem nodes for the clades that they resolve within this tribe. The clade comprising *Colpothrinax* alone, mentioned above, is assigned a mean stem age of 28.56 Ma (dates for upper and lower age estimates were not well supported in posterior probabilities analysis). The mean crown age for the genus is 7.87 Ma, with upper and lower estimates of 14.44 and 2.74 Ma. The age range assigned to the Mexican amber (Berggren & Van Couvering 1974) of 26–22.5 Ma is therefore in good agreement with a stem position for *C. chiapensis*. It is reasonable that crown species radiation would have occurred later, in the Central American and Caribbean area. This is one of the regions of interest to Bacon et al. (op. cit.), which they specifically mention as characteristic of the evolution of this genus, as well as of *Rhapidophyllum*, *Brahea*, *Washingtonia*, and Caribbean *Copernicia* (their Fig. 5).

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ADDITIONAL FOSSILS IN DOMINICAN AMBER GIVE EVIDENCE OF ANTHER ABORTION IN MID-TERTIARY *TRICHILIA* (MELIACEAE)

Kenton L. Chambers
Department of Botany and Plant Pathology
Oregon State University
Corvallis, Oregon 97331, U.S.A.
chamberk@science.oregonstate.edu

George O. Poinar, Jr.
Department of Zoology
Oregon State University
Corvallis, Oregon 97331, U.S.A.

ABSTRACT

Three additional fossil flowers recovered from amber of the Dominican Republic, are similar in perianth shape, pubescence, staminal tube, and anther arrangement to 2 previously described *Trichilia* species from these deposits. Their androecia display variation in the degree of anther reduction in functionally pistillate flowers, leading to vestigial filaments and tiny, knob-like, non-functional anthers on the rim of the staminal tube. The 3 newly discovered flowers are illustrated to show features of perianth pubescence, anther development, and ovary pubescence characterizing the genus in these Mid-Tertiary tropical forest deposits. None of the newly found fossils is well enough preserved to allow an unequivocal placement within the earlier published species or to permit the description of separate taxa. The fossils indicate an early evolution of the unisexual flowers present in modern day dioecious and polygamous species of *Trichilia*.

RESUMEN

Tres flores fósiles adicionales recuperadas de ámbar de la Republica Dominicana, son similares en la forma del perianto, pubescencia, tubo estaminal, y colocación de las anteras a 2 especies de *Trichilia* descritas previamente de estos depósitos. Sus androceos muestran variación en el grado de reducción de las anteras en las flores funcionalmente pistiladas, dando lugar a filamentos vestigiales y anteras pequeñas como un nudo, no funcionales en el borde del tubo estaminal. Las 3 nuevas flores descubiertas se ilustran para mostrar las características de la pubescencia del perianto, desarrollo de la antera, y pubescencia del ovario que caracterizan a este género de depósitos de bosques tropicales del Terciario medio. Ninguno de los fósiles encontrados está lo suficientemente bien conservado como para permitir un emplazamiento inequívoco en alguna especie publicada previamente o para permitir la descripción de taxa diferentes. Los fosiles indican una evolución temprana de las flores unisexuales presentes actualmente en especies dioicas y polígamas de *Trichilia*.

INTRODUCTION

We recently described two new fossil species of *Trichilia* (Meliaceae) from Dominican amber, *T. antiqua* and *T. glaesaria* (Chambers et al. 2011). Since then, three additional pistillate flowers from the same deposits have been found in the Poinar amber collection at Oregon State University. These flowers show differing degrees of anther abortion and allow an improved interpretation of the earlier described taxa, integrating them into a gradient of anther reduction in the genus. In the original flower of *T. antiqua*, which had been browsed by an insect so that the pistil and one petal were missing, just one small, knob-like vestigial anther was present (op. cit., Fig. 5). We suggested that the other anthers might have been eaten by the insect; hence their functionality was unknown, and the gender of the flower could not be specified. One of the recently found specimens has at least 4 such knob-like anthers along with a number of missing anthers. It is not insect-damaged, therefore making clear that it and the fossil of *T. antiqua* are pistillate flowers displaying an extreme degree of anther reduction and loss.

Two other fossils illustrate nonfunctional anthers with much reduced locules, comparable to, or even smaller than, the anthers illustrated for *T. glaesaria* (op. cit., Fig. 1). Taken together, these fossils give evidence that in *Trichilia* species of that period, there was variation in anther development in pistillate flowers, ranging from nearly normal size to cases of missing or vestigial anthers. The nature of preservation of the 3 newer fossils obscures some other features necessary for a complete floral description. Despite their androecial variation, which in fact may be matched in some extant species (see below), it is not considered advisable to propose any new species based on the here described additional fossils.

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MATERIALS AND METHODS

The fossils originated from mines in the Cordillera Septentrional of the Dominican Republic, between the cities of Puerto Plata and Santiago, island of Hispaniola. Two differing ages have been proposed for this amber deposit, the older being 45–30 Ma, based on fossil coccoliths (Cépek in Schlee 1999) and the younger being 20–14 Ma, based on foraminifera (Iturralde-Vinent & McPhee 1996). Most of the amber is secondarily deposited in turbiditic sandstones of the Upper Eocene to Lower Miocene Mamey Group (Draper et al. 1994). The specimens described here were found during a search of the Poinar amber collection for additional flowers of Meliaceae that might relate to those already described. They are designated as numbers D-9-27C, D-9-27D and D-9-27E in this collection. A newly described species of *Swietenia,* which incidentally had been illustrated earlier (Poinar & Poinar 1999), is also representative of fossil Meliaceae flowers in these amber deposits from the Dominican Mid-Tertiary tropical forest (Chambers & Poinar 2012).

RESULTS

The first illustrated flower, designated A (Figs. 1, 2) resembles *Trichilia glaesaria* in the shape and pubescence of its calyx and corolla (cf. Fig. 2 in Chambers et al. 2011). Its lobed, strigillose calyx differs from that of *T. antiqua*, which was described as glabrous and rotate. In apical view (Fig. 1), the ovary of flower A is well developed, 1 mm wide, strigillose, and situated at the base of the staminal tube. Four anthers can be seen, showing different degrees of extreme abortion. Three have knob-like terminal structures, which resemble the one much reduced anther seen in *A. antiqua* (op. cit., Fig. 5). A short filament is present on one of these (upper left arrow, Fig. 1), while the fourth remnant is a tiny filament with a mere suggestion of an anther (upper right arrow). Anthers are absent at other potential sites on the irregularly lobed, partly obscured staminal tube. On the evidence from this flower, the filament stubs of *T. antiqua* shown in Fig. 3 of Chambers et al. (op. cit.) might be reinterpreted as lacking anthers from the beginning, rather than having them removed earlier by an herbivorous insect.

In the flower designated B (Figs. 3, 4), the adaxial and abaxial sides of the petals are densely covered with shiny droplets of a glassy deposit, which obscures the natural pubescence of these surfaces. The calyx, barely in view, also has this deposit. In lateral view (Fig. 3), anthers with much reduced locules are visible in alternating higher and lower notches between acute lobes on the rim of the staminal tube. The apical view of this flower (Fig. 4) shows approximately 10 anthers, which are also covered with the glassy deposit. The stigma of the pistil is visible, but the ovary is too deeply placed to be characterized as to its pubescence or size.

The third flower, C, is illustrated in lateral view in Figure 5. Its calyx is not in view, and its petals are mostly too darkly stained to show the necessary details for a complete description. However, on the petal at the left (arrow), the abaxial surface can be seen to be strigillose, as was the abaxial petal surface in *T. glaesaria* (Chambers et al. 2011, Figs. 1, 2), and the petal at the right appears to have the papillate adaxial surface characteristic of flower A. At least 8 much reduced anthers are present on the rim of the staminal tube, in alternating higher and lower positions between acute lobes as in flower B, above, and in *T. glaesaria* (op. cit., Fig. 1). The locules of these anthers appear to be more reduced than in flower B. In an apical view of flower C (not shown), the ovary is glabrous, unlike that of flower A. It is interesting that in two extant *Trichilia* species, the ovary is glabrous before fertilization but develops pubescence afterward, as does the fruit (Pennington et al. 1981, p. 11). The intense staining of flower C does not allow further details to be observed. Flowers A and C differ greatly in anther development; however, as noted by an anonymous reviewer, "(t)he range of anther reduction between the 3 flowers described here could easily be found in a single modern day species."

DISCUSSION

The flowers under consideration here were not discovered until our earlier paper had been published. All 5 fossils are linked through their having been excavated from amber mines in the same ocean-deposited Mid-Tertiary strata, now uplifted in the Cordillera Central of Hispaniola. As discussed by Poinar and Poinar (1999), these amber deposits sample a characteristic Caribbean tropical forest over a span of many millennia, and it is

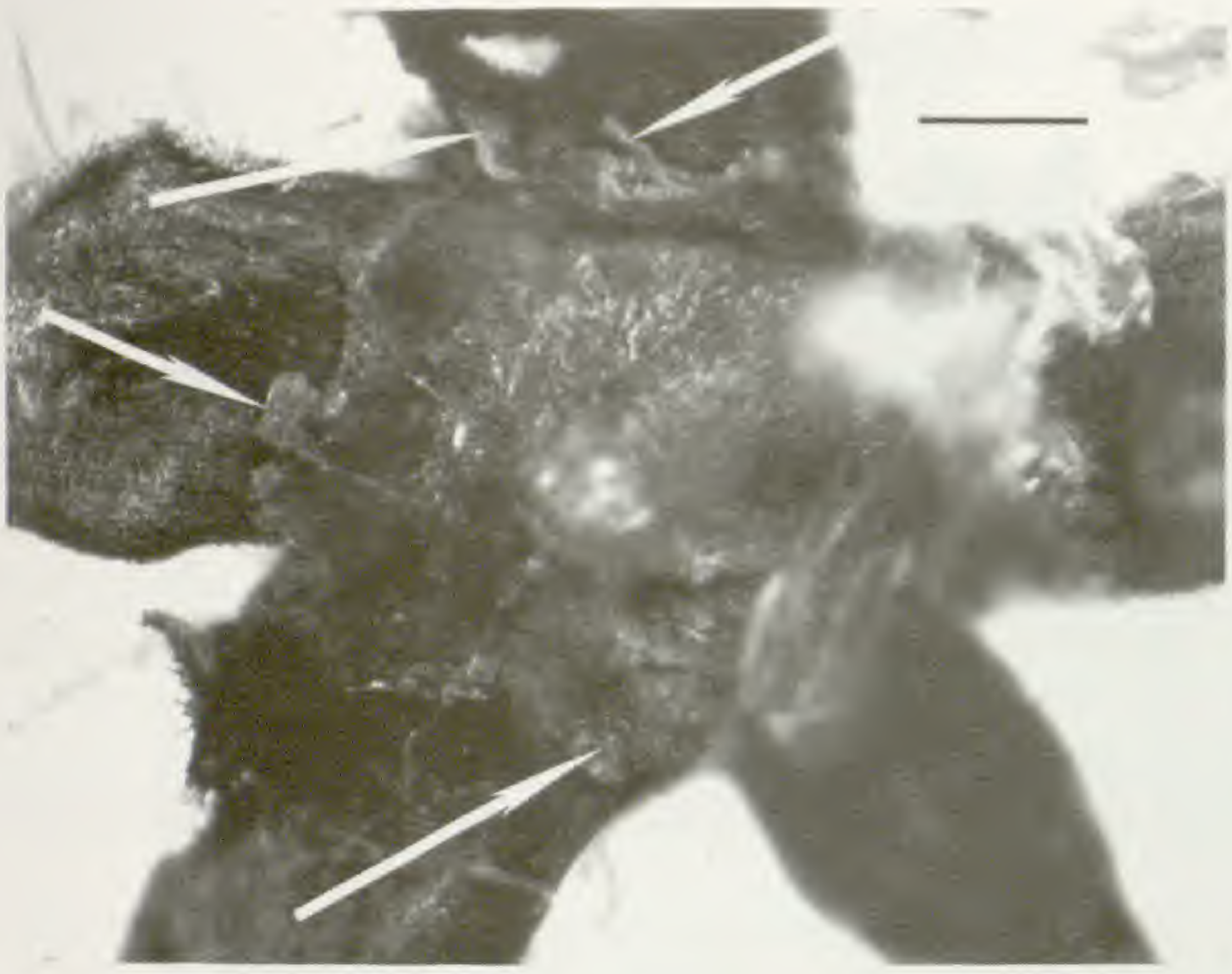

FIG. 1. *Trichilia* flower A, apical view. Arrows indicate 4 vestigial anthers. As far as can be seen, anthers are absent at other potential sites on rim of staminal tube. Bar = 0.86 mm.

FIG. 2. *Trichilia* flower A, lateral view. Note strigillose pubescence on abaxial surface of calyx and corolla. Bar = 0.48 mm.

possible that the *Trichilia* fossils described here do not represent contemporaneous species. What they illustrate is that *Trichilia* taxa in these forests were diverse in features such as perianth pubescence, pistil pubescence, and especially the nature of anther reduction and loss in pistillate flowers. However, lacking evidence relating to staminate flowers or to differences in the vegetative parts and inflorescence structure of the sampled taxa, we are limited as to any broad taxonomic conclusions that might be drawn from the observed variability in pistillate flowers. It is important, nevertheless, that these fossils be placed on record as part of the history of floral evolution in the genus, to be considered in possible future discussions of Meliaceae phylogeny.

The loss and extreme reduction of anthers in flower A, and probably also in *Trichilia antiqua*, goes beyond the description by Pennington et al. (1981) of androecia in functionally female flowers. These authors simply note (p. 26) that in *Trichilia* the "antherodes [are] narrower than anthers, not dehiscing, without pollen." In view of the review comments quoted above, this may be a generalization that omits a complete description of anther abortion and loss in modern species. That two of the Dominican fossils display such androecial reduction is evidence of its occurrence earlier in *Trichilia* floral evolution than might have been expected.

As discussed by Pennington et al. (1981), *Trichilia* is today the largest genus of Meliaceae in the New World, with ca. 85 species in lowland tropical America as well as ca. 14 species in Africa and 2 in the Indo-Malesian region. Its floral diversity, particularly in the androecium, well exceeds our sample of amber fossils (Pennington et al. op. cit., illustrations on pages 36–226). Respecting the age of *Trichilia*, Muellner et al. (2006) use evidence from known Meliaceae fossils, combined with chloroplast *rbcL* data, to estimate divergence times in the family. The DNA cladogram presented by these authors includes a monophyletic clade of *Trichilia* and 11 other genera, which is assigned an origin in the Oligocene. Apart from *Trichilia*, members of this clade are today limited to the Old World tropics, from Africa to Madagascar, India, Into-China, Malesia, and Austroasia. Muellner et al. (2006) propose a West Gondwanan Cretaceous origin for the family, followed by dispersal across Eurasia and between Eurasia and North America over the Beringian and North Atlantic land bridges. Further movement from North to South America occurred via island hopping and/or direct land connections during the Tertiary (see also Muellner et al. 2010, with a dense sampling of Cedreleae). As noted previously (Chambers et al. 2011), Pennington et al. (1981) recognized only two sections in *Trichilia*, Sect. *Trichilia* and Sect. *Moschoxylum* C. DC. The fossils discussed here are best placed in the emended Sect. *Moschoxylum*, the defining traits of which are the valvate petals and completely united filaments.

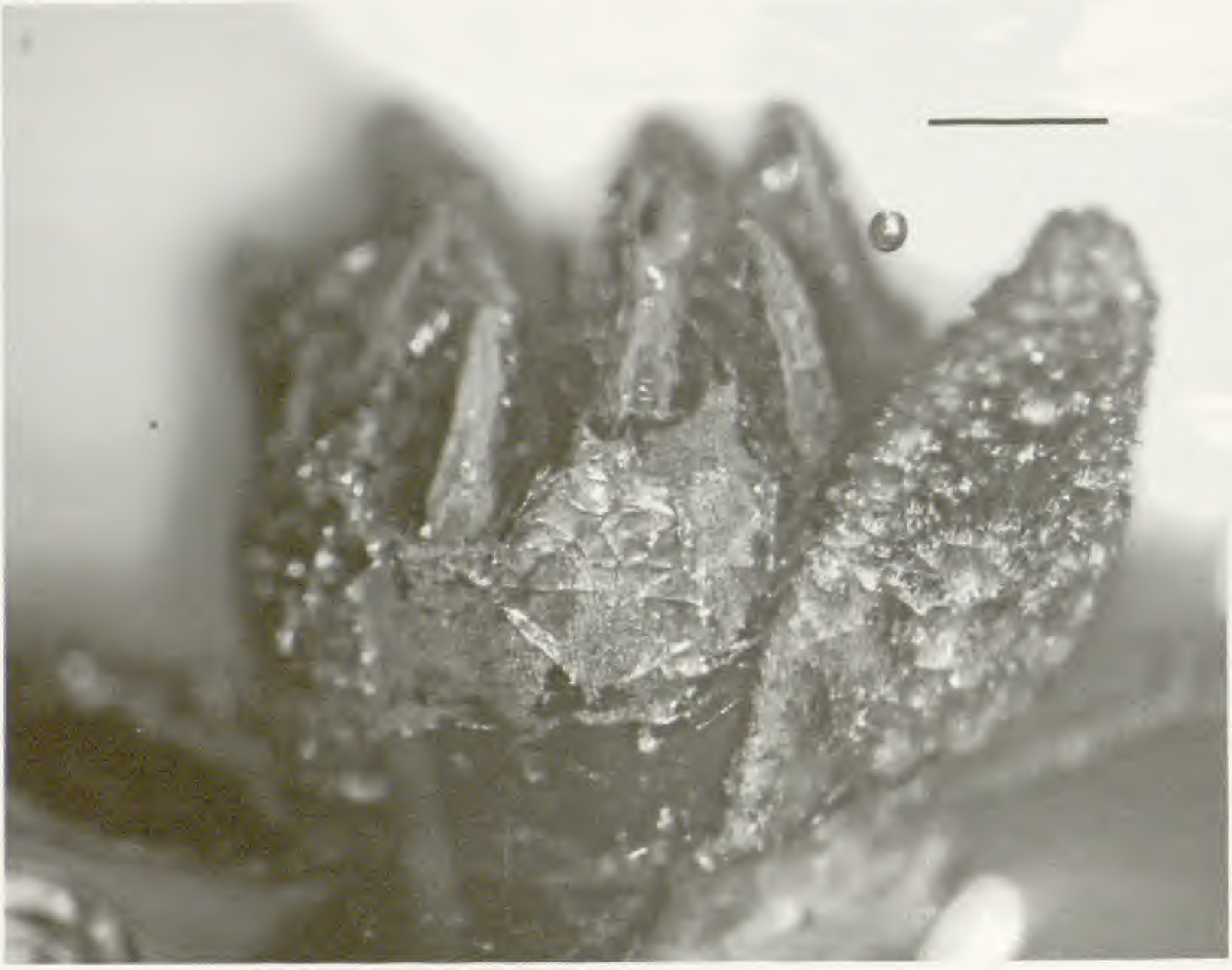

Fig. 3. *Trichilia* flower B, lateral view. Abortive anthers at higher and lower positions on rim of staminal tube. Bead-like deposits on perianth, formed during preservation, obscure surface features. Bar = 0.77 mm.

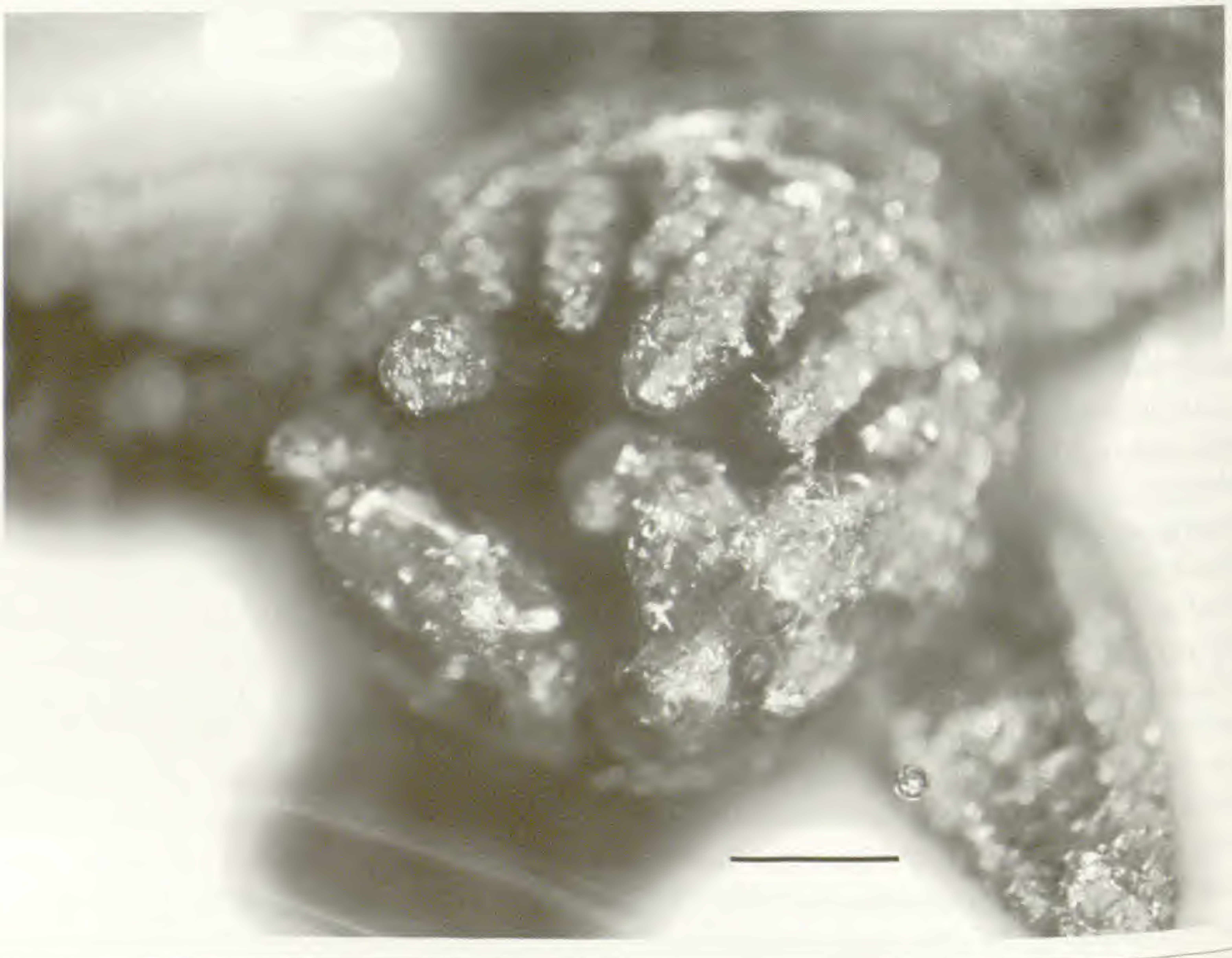

Fig. 4. *Trichilia* flower B, apical view. Stigma visible within filament tube. Bar = 0.80 mm.

FIG. 5. *Trichilia* flower C, lateral view. Note abortive anthers and strigillose abaxial surface of petal on left (arrow). Bar = 0.79 mm.

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BOOK REVIEW

Scott Calhoun. 2012. **The Gardener's Guide to Cactus: The 100 Best Paddles, Barrels, Columns, and Globes.** (ISBN-13: 978-1-609469-200-6, pbk.). Timber Press, Inc., The Haseltine Building, 133 S.W. Second Avenue, Suite 450, Portland, Oregon 97204-3527, U.S.A. (**Orders:** www.timberpress.com, 800-327-5680). $24.95, 227 pp., color throughout, 8" × 9".

Thinking of going to the Desert Botanical Garden in Phoenix, Arizona? If so, now is the time to read Scott Calhoun's *The Gardner's Guide to Cactus: The 100 Best Paddles, Barrels, Columns, and Globes.* The juxtaposition of Dale Chihuly's innovative glass sculptures with cactus and succulents was a stroke of genius. Likewise is Mr. Calhoun's new cactus guidebook.

Succulent plant expert Scott Calhoun has selected 100 of the best cactus available and shows how they can make striking additions to desert gardens or serve as dazzling container specimens. His writing style is one which offers a clean, helpful, well-presented text with reliable design suggestions.

Mr. Calhoun's stunning photograph on the book cover clearly demonstrates to the book publishing world and its gardening readership how easily cactus appreciation can be for everyone—not just specialists. He is the quintessential model of cactus authorship. It is a great book for beginners and expert gardeners.

Paddles, barrels, columns, and globes add new meaning to the cactus gardening neophyte! One look at the Tuna Colorado cactus in its purple high-winter coloration photograph at the Desert Botanical Garden surrounded by a purple Chihuly glass sculpture suggests Mr. Calhoun's new book is set apart from normal cactus guidebooks. First of all, it is a total delight to look at!

As an effort to simplify the issues related to plurals, Mr. Calhoun has chosen to call the plants cactus. He describes cactus conservation and defines Crassulacean Acid Metabolism (CAM). A glance at the Introduction and Table of Contents describes planting and care, cactus planted in the ground and containers, tools of the prickly trade, and the art of showing cactus. Mr. Calhoun not only describes how one plants and cares for cactus; he gives tips for staging cactus at shows sponsored by the Cactus and Succulent Society of America (CSSA). The 100 plants are grouped as follows: low and mounding, barrels and globes, paddles and rods, and columns. Each entry has a colorful photograph, scientific and common names, habitat, mature size, hardiness, flowering season, cultivation, design suggestions, and, yes, culinary value!

In addition, the book has extensive cross-referenced index, bibliography, plant hardiness tables, cactus pests, cactus for special purposes, and selected cactus nurseries. One can tell after reading *The Gardner's Guide to Cactus: The 100 Best Paddles, Barrels, Columns, and Globes*, cactus sagacity can be great fun and rewarding.

When is your first CSSA entry to demonstrate what you have learned from Mr. Calhoun?—*Kay M. Stansbery, Ph.D., Library Volunteer, Botanical Research Institute of Texas, 1700 University Dr., Fort Worth, Texas 76107-3400, U.S.A.*

LIMITATIONS TO NATURAL PRODUCTION OF *LOPHOPHORA WILLIAMSII* (CACTACEAE)

II. EFFECTS OF REPEATED HARVESTING AT TWO-YEAR INTERVALS IN A SOUTH TEXAS POPULATION

Martin Terry

Sul Ross State University
Department of Biology
Alpine, Texas 79832, U.S.A.
mterry@sulross.edu

Keeper Trout

Cactus Conservation Institute
P.O. Box 561
Alpine, Texas 79831, U.S.A.

Bennie Williams

Cactus Conservation Institute
P.O. Box 561
Alpine, Texas 79831, U.S.A.

Teodoso Herrera

Rio Grande Native American Church
P.O. Box 460346
San Antonio, Texas 78246, U.S.A.

Norma Fowler

The University of Texas at Austin
Department of Integrative Biology C0930
1 University Station
Austin, Texas 78712, U.S.A.

ABSTRACT

In 2008 we began a long-term study of the effects of harvesting on a wild population of the cactus *Lophophora williamsii* (peyote), including harvesting treatments similar to those used to harvest it for legally protected religious use by members of the Native American Church. Here we assess the effects of harvesting in three different treatments: (1) plants that were harvested once, (2) plants that were harvested every two years (typical of commercial harvesting rates), and (3) control plants that were never harvested. After four years, the survival rate was significantly greater in the unharvested control plants (94%) than in the harvested plants (73%). Average harvested mass of fresh tissue per plant decreased significantly (by 44%) between the first and second harvests, and then further decreased significantly (by 32%) between the second and third harvests. The average number of crowns per plant, which increased after the first harvest, decreased after the second harvest. Estimated total volume of the above-ground crown(s) of each plant, which was closely related to harvested plant mass, was used to compare growth rates between treatments. The average growth rate of the multiple-harvest plants was significantly lower than the average growth rates of plants in the other two treatments. Growth rates in the control and single-harvest treatments did not differ significantly in 2012, but because the single-harvest plants were so much smaller than the control plants in 2010, they remained smaller than the control plants in 2012. The annual number of crowns harvested and sold commercially as "buttons" by licensed peyote distributors continued its slow decrease in 2011, while the price per unit continued to rise. These trends and the results of this study all indicate that present rates of peyote harvest are unsustainable.

Key Words: cactus conservation, peyote harvest, cactus overharvesting, Native American Church, peyote conservation status

RESUMEN

En el año 2008 empezamos un estudio a largo plazo sobre los efectos de cosechar el cactus *Lophophora williamsii* (peyote) en una población silvestre, utilizando tratamientos de cosechar similares a los que se utilizan para cosechar el peyote para su legalmente protegido uso religioso por los miembros de la Native American Church. Aquí evaluamos los efectos de cosechar en plantas de tres tratamientos distintos: (1) plantas que se cosecharon una sola vez, (2) plantas que se cosecharon cada dos años (cual tasa es típica en la cosecha comercial), y (3) plantas controles que no se cosecharon nunca. Después de cuatro años, la tasa de supervivencia fue significativamente mayor en las plantas controles (94%) que en las plantas cosechadas (73%). En el promedio la masa de tejido fresco cosechado disminuó significativamente (por un 44%) entre la primera cosecha y la segunda, y después volvió a disminuir significativamente (por un 32%) entre la segunda cosecha y la tercera. El número mediano de coronas por planta, lo cual se aumentó después de la primera cosecha, disminuó después de la segunda cosecha. El volumen total aproximado de las coronas por encima del suelo de cada planta, lo cual fue muy cercamente relacionado al peso del tejido cosechado de la planta, se utilizó para comparar las tasas de crecimiento entre los tratamientos. La tasa de crecimiento mediana de las plantas cosechadas más de una vez fue significativamente más baja que las tasas de crecimiento medianas de las plantas en los otros dos tratamientos. Las tasas de crecimiento en el tratamiento control y el tratamiento de una sola cosechada no fueron significativamente diferentes en 2012, pero por el hecho de que las plantas de una sola cosechada fueron mucho más pequeñas que las plantas controles en 2010, todavía se quedaron más pequeñas que las plantas controles en 2012. El número anual de coronas cosechadas y vendidas comercialmente como "botones" por los distribuidores registrados de peyote siguió disminuyendo en 2011, mientras que el precio por unidad siguió subiendo. Estas tendencias y los resultados de este estudio todos indican que las tasas actuales de cosechar el peyote no son sostenibles.

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INTRODUCTION

Lophophora williamsii (Lem. ex Salm-Dyck) J.M. Coult. (Cactaceae), known as peyote both in Spanish and in English, is a small cactus (rarely exceeding 10 cm in diameter) of northeastern Mexico and adjacent border areas of Texas. The aerial crowns of plants are approximately hemispherical in shape. Some plants are caespitose; i.e., they have multiple crowns arising from a single rootstock. The literature on the biology of this plant up to the mid-1990s is summarized by Anderson (1996), who first suggested that the species might be endangered by overharvesting (Anderson 1995).

There is active commercial trade in the harvested crowns of peyote, which are collected and sold by licensed distributors to the Native American Church (NAC) for religious use as protected by U.S. law. There is substantial concern that the rate of harvest of peyote from wild populations is not sustainable. Anecdotal reports by members of the NAC include descriptions of the decline or decimation of natural populations and a decrease in both the availability and the quality of peyote being offered for sale in the regulated peyote market (TH, pers. obs.). A number of papers in the scientific literature have described the decline of peyote in its native habitat, apparently due to overharvesting (Anderson 1995; Trout 1999; Terry & Mauseth 2006; Powell et al. 2008; Terry 2008a,b,c; Terry et al. 2011). Despite such reports involving both Texas and Mexican populations, the species is not (yet) considered in danger of extinction (NatureServe 2012; Fitz Maurice and Fitz Maurice 2009), except in Texas, where NatureServe determined it to be in the S4 (imperiled) category. The work of Terry et al. (2011) was the first experimental investigation of the effects of harvesting on peyote plants in situ. In that paper we reported the effects that were detectable two years after the initial harvest. The present report focuses on effects detectable four years after the initial harvest.

MATERIALS AND METHODS

The study site was described in Terry et al. (2011). Because of the multi-year duration of the ongoing study and the complexity of the study design, it is appropriate to provide a clear, detailed description of what was done to which plants, and when.

At the start of the study, in March 2008, 100 *L. williamsii* plants that appeared not to have been previously harvested were individually numbered and tagged along a transect through the population. The number of crowns on each plant was counted and the horizontal diameter of each crown was measured. Fifty of these plants that were single-crowned were then harvested (i.e., the crown of each plant was cut off transversely at ground level and removed), and the other 50 plants (most but not all of which were single-crowned) were left unharvested as controls. The harvested crown of each plant in the harvested group was weighed, to determine the harvested fresh biomass obtained from each of these "virgin" plants.

At the end of the second year of the study, in March 2010, all surviving plants from the original groups of 50 harvested and 50 control plants were located, the number of crowns on each plant was counted, and the diameter of each crown was measured. Then the 43 surviving plants in the harvested group were divided into two subgroups: 20 multiple-harvest plants and 23 single-harvest plants. All regrowth crowns were harvested from the 20 multiple-harvest plants, leaving these now twice-harvested plants without crowns (and thus without photosynthetic tissue) for the second time in two years. Reharvest at two-year intervals is typical in current commercial harvest (MT, pers. obs.). The harvested crown(s) of each multiple-harvest plant were weighed to obtain harvested fresh biomass at a second harvest. A comparison of harvested biomass between the 2008 and 2010 harvests was reported by Terry et al. (2011). The single-harvest plants were not reharvested, and the surviving plants of the 50 original control plants continued to serve as unharvested controls.

At the end of the fourth year of the study, in March 2012, all surviving plants were again located, counted, and measured. In addition, all new regrowth crowns were again harvested and weighed from the 16 surviving plants in the multiple-harvest treatment. In summary, control plants have never been harvested, single-harvest plants were harvested once, in 2008, and multiple-harvest plants have so far been harvested three times, in 2008, 2010, and 2012.

All statistical analyses were done with SAS 9.1 (SAS Institute, Cary, NC, USA).

RESULTS

Survival.—Of the 100 plants of the initial (2008) census, 4 (2 control, 2 harvested) were dug up by feral hogs and were therefore dropped from all further analyses, leaving 96 plants. Of these 96 plants, 6 (1 control, 5 harvested) died before the second (2010) census. Ninety plants were still alive in 2010 (census 2): 47 control plants and 43 plants that had been harvested in 2008. Of these 43 surviving plants that had experienced one harvest, 23 were assigned to the single-harvest treatment and 20 were assigned to the multiple-harvest treatment.

Of the 47 control plants alive in 2010, 45 were still alive at census 3 in 2012. Nineteen of the 23 single-harvest plants (83%) and 16 of the 20 multiple-harvest plants (80%) were still alive in 2012. By 2012 the survival rate of control plants from census 1 through census 3 was significantly higher than the survival rate of harvested plants over the same interval (94% [45/48] versus 73% [35/48], $\chi^2 = 8.65$, $P = .0033$; Fig. 1).

Harvested mass.—Weights of all the crowns of a plant were summed to calculate harvested fresh mass per plant. Mass per crown was calculated for each plant by dividing its total mass by its crown number; these values were then averaged for statistical analysis and for Figure 2. Average harvested mass per plant decreased from census to census: 44% between the first and second censuses and 32% between the second and third censuses (Fig. 2, solid line). The differences between harvests were significantly different from zero (paired *t*-tests: harvest 1 vs harvest 2: 14.0 g average difference, N = 20, $t = 6.73$, $P < 0.0001$; harvest 2 vs harvest 3: 6.9 g average difference, N = 16, $t = 4.24$, $P = 0.0007$).

Plants initially responded to harvesting by increasing the average number of crowns per plant (Fig. 2, dashed line), although this increase was not sufficient to counterbalance the decrease in mass per crown (Fig.2, dashed and dotted line). After the second harvest, both the average number of crowns per plant and the average mass per crown decreased.

Volume.—The above-ground volume of each plant was estimated by first estimating the volume of each crown as a hemisphere from its measured diameter: estimated volume = $\frac{2}{3}\pi\,(\text{diameter}/2)^3$.

The estimated volumes of all the crowns on the plant were then summed to estimate total plant above-ground volume. The estimated volume of each plant in 2012 was very closely correlated with its harvested fresh mass in 2012 (Fig. 3).

Volumes were log-transformed before analysis of covariance (ANCOVA) to improve normality of the residuals. Volume at census 2 (2010) was used as a covariate. Treatments did not differ significantly in their slopes: the slope of the relationship between log-transformed volume in 2010 (x-axis) and log-transformed volume in 2012 (y-axis) was the same for each treatment. Therefore the final ANCOVA model assumed equal slopes. Note that equality of slopes in a model fitted to log-transformed data does not imply that slopes will be linear when untransformed data are graphed on a linear scale (e.g., Fig. 4).

Estimated plant volume at census 3 (2012) was closely related to estimated plant volume at census 2; 74% of the variation in the former was explained by variation in the latter amount. Treatment accounted for an additional 10% of the variation among plants at census 3. The effects of the single-harvest treatment did not differ from those of the control (Scheffé contrast, $F_{1,75} = 1.33$, $P = 0.25$), but each of these treatments differed significantly from the multiple-harvest treatment (Scheffé contrasts; control versus multiple-harvest: $F_{1,75} = 29.20$, $P < 0.0001$; single-harvest versus multiple-harvest, $F_{1,75} = 41.46$, $P < 0.0001$; Fig. 4). In other words, the surviving single-harvest plants were growing (on a logarithmic scale) about as fast as the surviving control plants between 2010 and 2012, but they began the interval with much smaller sizes than the control plants. In contrast, the multiple-harvest plants were decreasing in size. For example, the final ANCOVA model predicts that a control plant with a volume of 10.0 cm^3, the average size of all 90 surviving plants at census 2, would have grown to 21.9 cm^3 and a single-harvest plant of the same size would have grown to 26.3 cm^3 (not significantly different from 21.9 cm^3), but a multiple-harvest plant with a volume of 10.0 cm^3 would have decreased slightly in size, to 9.66 cm^3.

Regional harvesting trends in South Texas.—Annual peyote sales data covering the years 1986–2011 (Texas Department of Public Safety, unpublished data) are presented in Figure 5. Although these figures do not in-

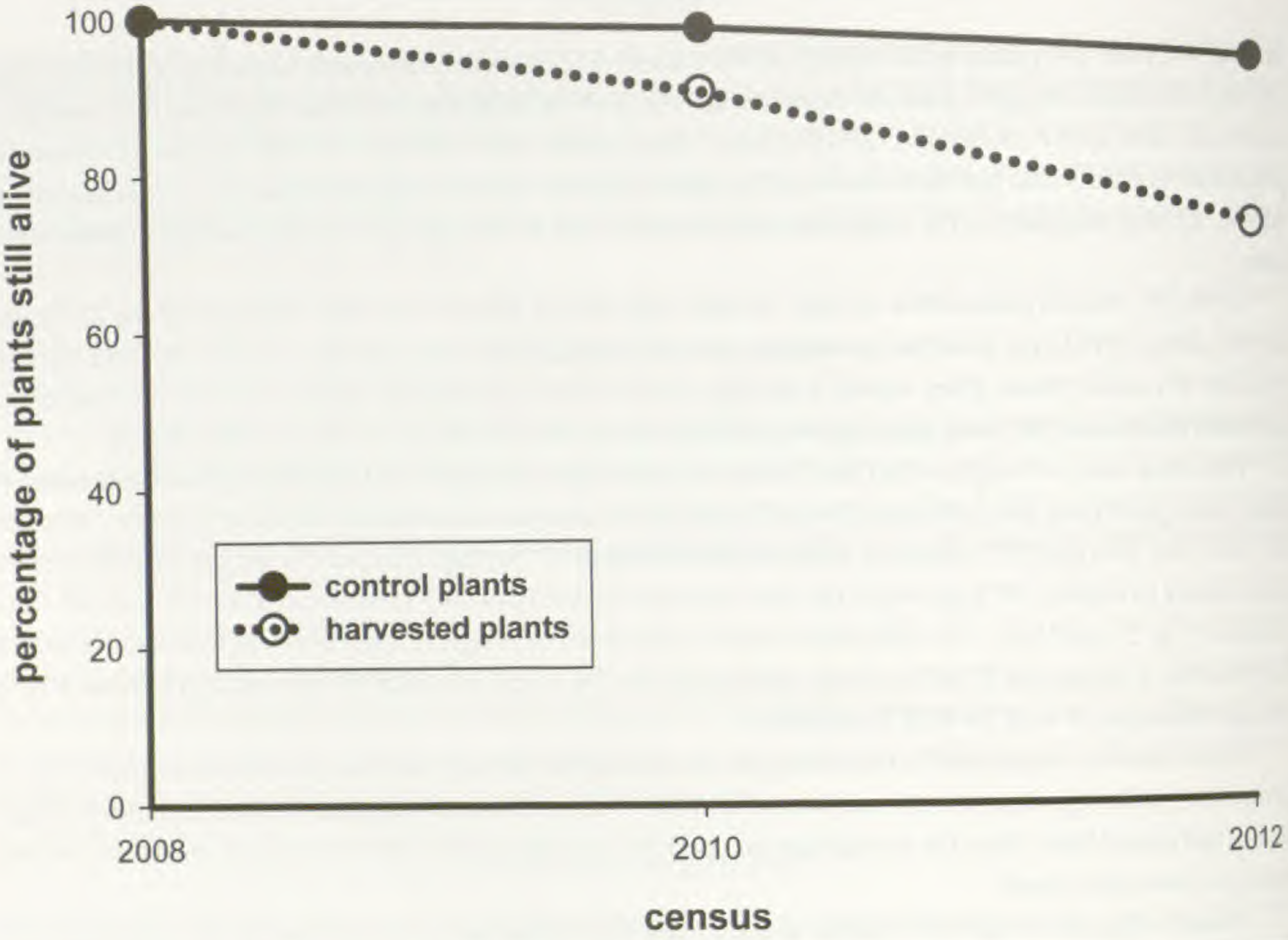

Fig. 1. Numbers of surviving plants at each census. Solid line: control plants; dotted line: harvested plants.

clude all sales of peyote (Terry et al. 2011), it is reasonable to assume that the number of buttons sold in the regulated trade is positively correlated with the total number of buttons harvested in the region of South Texas known as "the Peyote Gardens." In 2011, the DPS-regulated peyote sales totaled slightly over 1.4 million buttons, continuing the generally downward trend which such sales have followed since 1997. It is noteworthy that prior to the current decline there was a decrease in numbers of buttons sold during the late 1980s that appears to have corresponded to the historical decline in the available harvest of mature plants, followed in the early to mid-1990s by a marked increase in numbers of buttons sold when the proliferation of small regrowth buttons began to be harvested to meet the needs of the NAC. Anecdotal accounts from NAC meetings during the period of temporary increase in numbers of buttons noted the prevalence of fresh buttons as small as dimes (TH & KT, pers. obs.). The number of buttons sold in 2011 was the lowest for any year in the last quarter of a century. As the annual number of buttons sold has declined steadily since 1997, the price has shown a marked increase; the price per button is roughly equal to total sales (in U.S. dollars) divided by the number of buttons sold.

DISCUSSION

Effects of harvesting on plant survival and growth

The negative effects of harvesting on survival may be delayed. The initial harvest did not significantly reduce survival during the first two years after the harvest (2008 to 2010; Terry et al. 2011), but its effects were highly significant by 2012 (73% survival to the four-year time point in 2012 among plants harvested in 2008, versus 94% among control plants). Any delayed effects of the second (2010) harvest on survival were not yet evident in 2012.

The effects of precipitation may also be delayed. The six months preceding the 2010 census received sub-

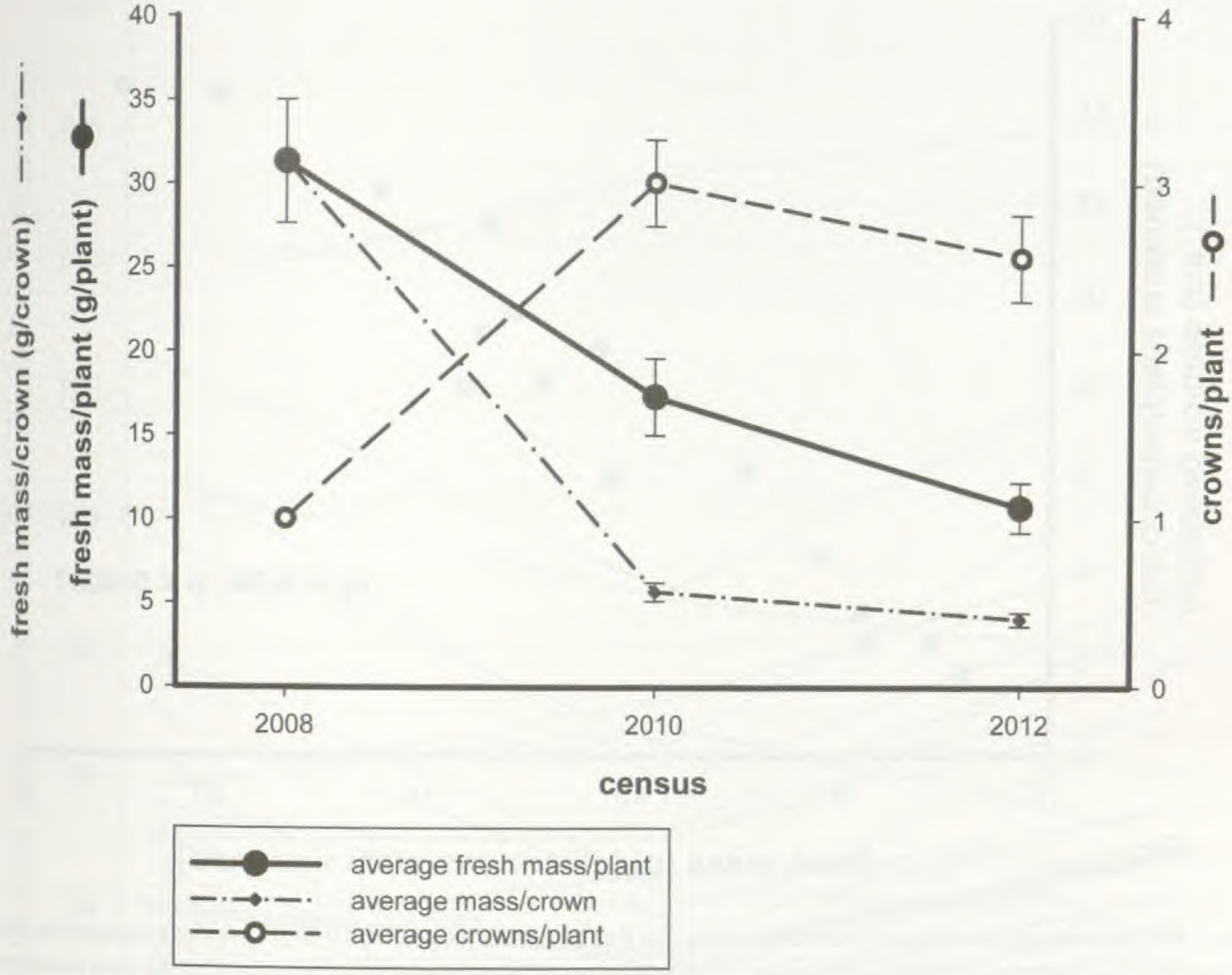

FIG. 2. Average fresh above-ground mass per harvested plant, number of crowns per plant, and average fresh mass per crown at each date. To calculate average fresh mass per crown, an average was calculated for all crowns of each plant, and then those values were averaged. Only multiple-harvest plants were used to calculate the values in this graph. Vertical bars: 1 standard error.

stantially more rain (32.4 cm October–March precipitation) than the six months periods preceding the other two censuses (6.0 cm and 15.4 cm October–March precipitation preceding the 2008 and 2012 censuses, respectively; U.S. Department of Agriculture 2012), but the average size of control plants declined in the first interval and increased in the second (Fig. 4). However, it may be that in wetter years peyote experiences more competition from other plants that have responded rapidly to the increased soil moisture. Harvesting also significantly, and strongly, affected plant growth rate and therefore plant size (Fig. 4). Each harvest reduced plant growth rates. The 2008 harvest reduced the average growth rate of all harvested plants (Terry et al. 2011). The 2010 harvest of the multiple-harvest plants significantly reduced their growth rate below that of the single-harvest plants (harvested only in 2008) as well as below the growth rate of the never-harvested control plants (Fig. 4). While the single-harvest plants and the controls had about the same growth rate between 2010 and 2012, the single-harvest plants were so much smaller in 2010 (due to the 2008 harvest) that they remained much smaller than the control plants in 2012. Meanwhile, the multiple-harvest plants continued to decline in size between 2010 and 2012. Plant size and plant survival are usually highly correlated (Harper 1977), so we expect to see continuing excess mortality of the multiple-harvest plants.

There are probably several reasons why harvesting reduces growth rate, size and survival rate. Microbial infection of the open wound created by the act of harvesting the crown of a plant, for example, cannot be ruled out. But one mechanism that appears to be an inevitable consequence of harvesting is that of exhaustion due to prolonged deprivation of solar energy. The crown, being the only aerial organ of the peyote plant, is the plant's

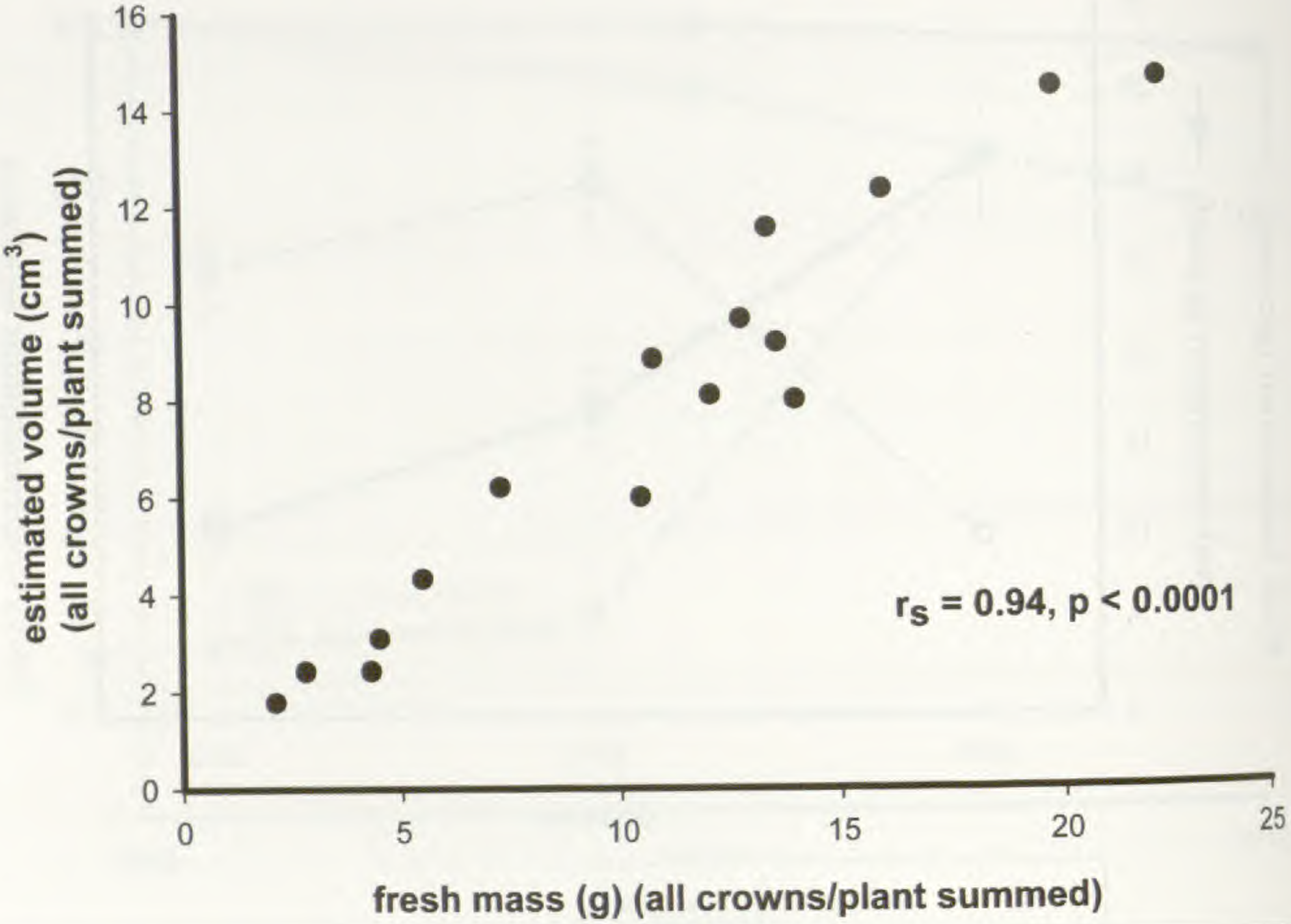

Fig. 3. Measured fresh mass and estimated volume of plants harvested from multiple-harvest peyote plants in 2012. Each point represents one plant. The volume of each crown was estimated as a hemisphere with radius equal to half the measured diameter of the crown, and then these volumes were summed to obtain plant volume. Crown masses were summed to obtain the above-ground mass of each plant.

only site of photosynthesis. Without photosynthesis, the plant cannot use solar energy to create and store carbohydrates, and nutrient, carbon, and water uptake are greatly reduced. The crown is also the part of the plant that is always harvested for ceremonial use. When the crown is harvested—thereby becoming a button in the peyote trade—the plant's ability to photosynthesize is ipso facto reduced to zero. The harvested plant then uses stored energy, nutrients, and water to regrow its above-ground biomass. If reharvesting occurs before the plant has had time to rebuild its stored reserves from photosynthesis in its regrown above-ground tissue, it will become successively smaller at each harvest and eventually die. The reduced size and growth rate, and increased mortality, of harvested plants strongly support the hypothesis that a two-year cycle of harvesting of this species is too frequent for plant recovery. A sustainable frequency of harvesting would be low enough to allow a plant to fully regrow and to fully rebuild its supply of stored resources between harvests. We hope eventually to be able to determine the maximum sustainable harvesting frequency. Whatever that frequency may be, our data indicate that harvesting on a two-year cycle is too frequent to be sustainable.

As is true of most plant species, the removal of the apical meristem (part of the harvested crown of peyote), in addition to stimulating regrowth, probably also de-represses axillary meristems, resulting in the formation of multiple crowns. In the absence of the continual secretion by the apical meristem of the hormone that normally suppresses lateral branching (presumably auxin, based on Mauseth and Halperin 1975), one (or more) of the axillary meristems in the areoles on the subterranean portion of the stem is de-repressed and begins to form a new crown at the apex of a lateral branch which emerges from the subterranean stem and grows toward the surface of the ground. This phenomenon accounts for harvested plants of this species having more crowns than unharvested plants (Fig. 2). It is a temporary phenomenon, however, because eventually a plant's stored resources are exhausted by too frequent harvesting, causing the number of crowns per plant to de-

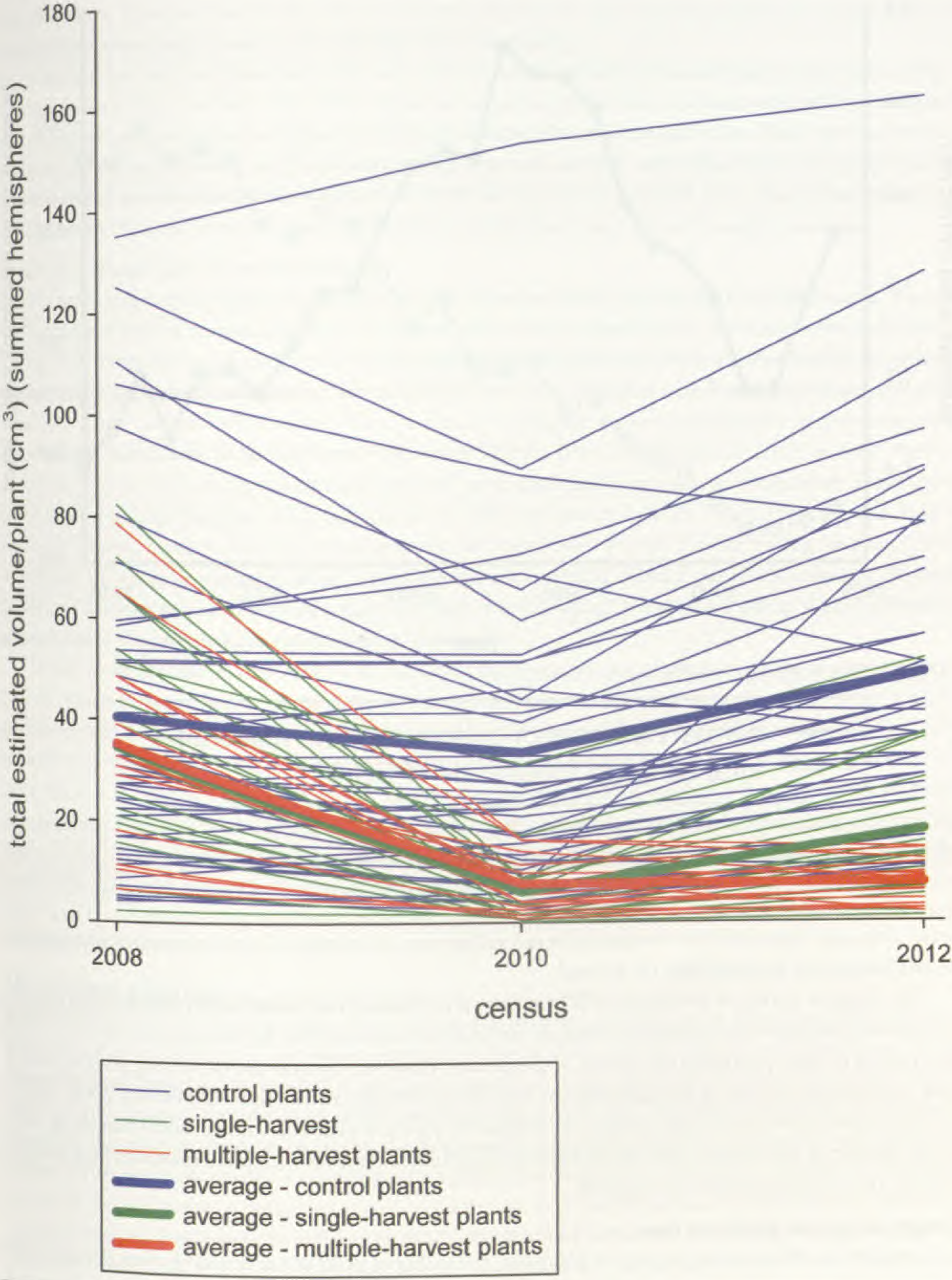

Fig. 4. Estimated above-ground volume per plant over time. Each thin line represents one plant. The volume of each crown was estimated separately, and then these volumes were summed for each plant separately, on each date separately. Control plants are blue, single-harvest plants are green, and multiple-harvest plants are red. The thick lines are averages for each treatment, using the same colors, and calculated by averaging estimated plant volumes. For simplicity, this graph has averages of untransformed values and a linear y-axis scale, but the statistical analysis used log-transformed data.

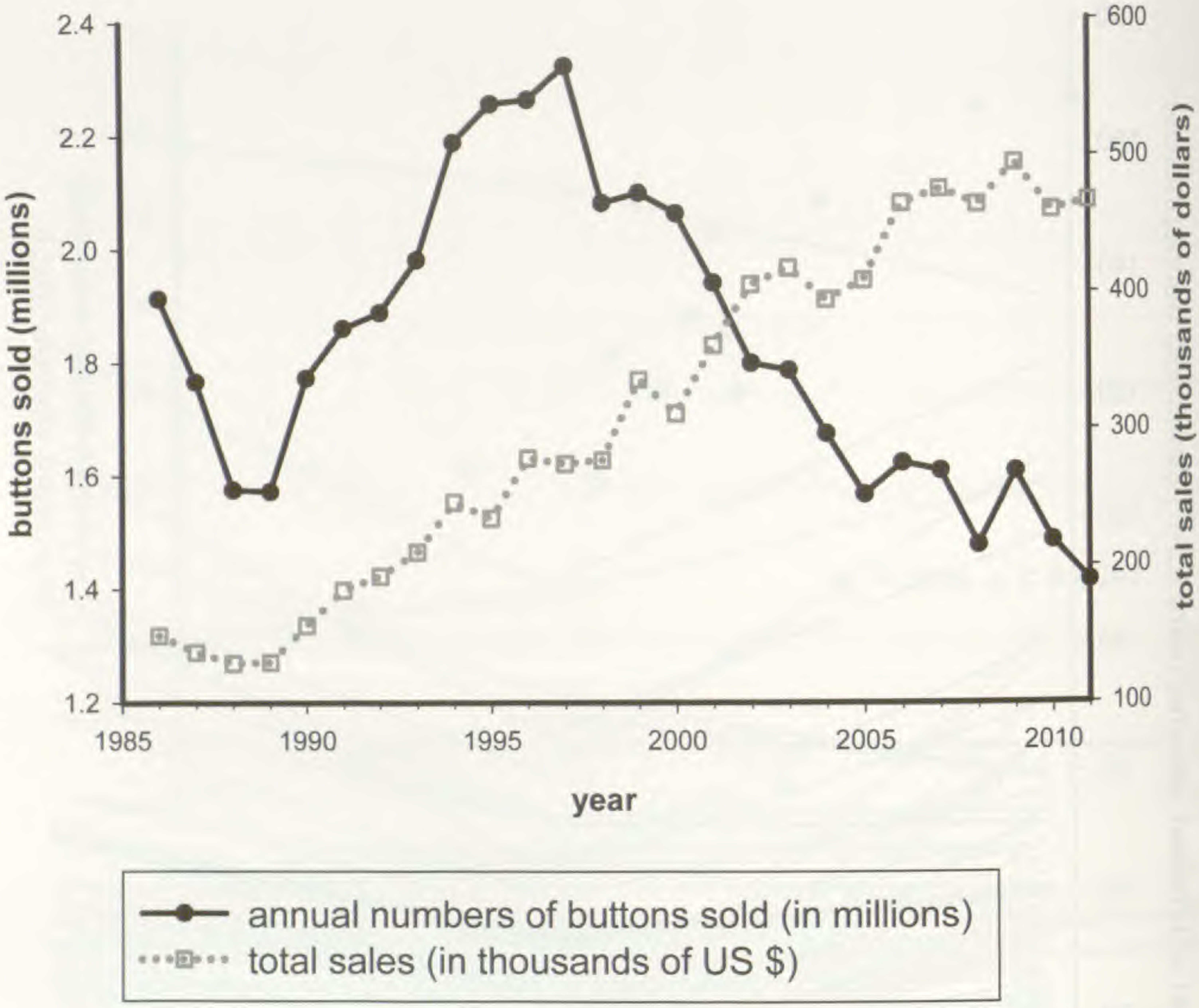

Fig. 5. Annual peyote sales by licensed distributors in South Texas from 1986 through 2011.

crease. This stage appeared to be reached at the second harvest: the number of crowns per plant increased after the first harvest but declined after the second.

The negative impact of harvesting will be greater if portions of the subterranean stem are also removed. To avoid such damage to the harvested plants, in this study we used only best harvesting practices, viz., cutting the crown at its base, parallel to the surface of the ground. However, commercial harvesting practices may remove a substantial portion of the subterranean stem along with the crown (Terry & Mauseth 2006). Such removal of subterranean stem tissue reduces the number of areoles available to initiate lateral branching, reducing the number of new crowns that can be formed. In addition it removes even more resources from the plant, reducing the amount available for regrowth.

Changes in harvest yield over time

As a result of the effects of harvesting on plant size, the yield per plant of harvested biomass decreased after each biennial harvest, first by 44% and then by 32% (Fig. 2, solid line). If one includes mortality in these calculations, the decrease in harvest yield is even more marked: the third harvest produced only 25% of the biomass that the first harvest did. For example, if we had begun with 100 plants, the first harvest would have yielded 3125 g (i.e., 100 plants × 31.25 g/plant), the second harvest would have yielded 1547 g (100 plants × 0.895 survival rate of harvested plants 2008–2010 × 17.27 g/plant), and the third harvest would have yielded 769 g (100 plants × 0.895 × 0.800 survival rate 2010–2012 × 10.73 g/plant), declines of about 50% per harvest. The absolute (as opposed to relative) decline was smaller in the second two-year period, but only because it began from a lower baseline. These are exactly the effects on harvest yield to be expected if harvesting is occurring too frequently for plants to regrow and to rebuild their stored resources.

The fact that harvested mass was even more closely correlated with estimated volume at census 3 (Fig. 3) than at census 2 (Fig. 3 in Terry et al. 2011) may seem surprising in that the crowns of most adult peyote plants do not appear to have a true hemispherical shape, but rather the shape of half of an oblate sphere. However, many of the younger plants—and especially young regrowth crowns—do indeed have vertically extended crowns, and all peyote plants tend to expand vertically in response to rain (MT, pers. obs.), which would tend to balance out the more flattened shape of the adults and the flattening effect of drought, over time.

Peyote as a classic case of overharvesting?

Peyote shows many of the hallmarks of a classic case of unsustainable harvesting of a wild resource. First, the decline in total harvest combined with an increase in price/unit is characteristic of overharvested wild species (cf. Fig. 1 in Schippman et al. 2002). A declining number of wild plants is a likely explanation for the failure of the harvest to increase in response to the increase in unit price (because a declining population causes decreases in "catch" per unit of harvesting effort, so that increasing the harvest is financially unrewarding even if there are still individuals to be harvested (Hilborn & Walters 1992; Thurstan et al. 2010). Second, there are anecdotal reports of declining unit (button) size (TH, pers. obs.). Declining body size is another classic indicator of overharvesting (Stergiou 2002; Berkeley et al. 2004; Genner et al. 2010). Third, there are anecdotal reports of declining quality of the harvested buttons (TH, pers. obs.). Fourth, the harvesting frequency (every other year) shown to be unsustainable by the present study is typical. Finally, our results may underestimate impacts of harvesting, as our harvests may have been less damaging to individual plants than a commercial harvest, due to the care taken in the harvests of this study.

As far as we are aware, this study is the first well documented case of overharvesting of a cactus species (but see Jiménez-Sierra and Eguiarte 2010, in which browsing was also involved). It is also one of a limited number of well documented cases of overharvesting of non-timber plant species in general. Most well documented cases of overharvesting of wild resources involve marine and freshwater animal species (Jackson et al. 2001; Allen et al. 2005; Genner et al. 2010). There are detailed reports of overharvesting of many tree species (e.g., Schwartz et al. 2002; Schulze et al. 2008). There are some detailed reports of overharvesting of herbaceous plant species, of which ginseng (*Panax quinquefolius*) is perhaps the best documented (Nantel et al. 1996; McGraw 2001; Case et al. 2007; McGraw et al. 2010). However, many hundreds (at least) of other plant species are threatened by overharvesting, especially plant species harvested for medicinal uses (Schippman et al. 2002), for lumber (Oldfield et al. 1998), or for collectors (Oldfield 1997).

The regulatory panorama

At the moment there are only two major interested parties with any standing in the discussion about the fate of peyote in its natural habitat: (1) the Native American Church (NAC), whose right to consume peyote for religious purposes is protected by legislation such as the American Indian Religious Freedom Act (AIRFA), and (2) the Drug Enforcement Administration (DEA), which is obligated by the Controlled Substances Act to regulate the use and distribution of peyote by and for the NAC, and to prevent the diversion of peyote to non-authorized persons. Neither of these parties is speaking very audibly about regulatory solutions to mitigate the deteriorating state of the wild peyote populations. This is unfortunate, as the problem has a feasible solution, namely the regulated cultivation of peyote by and for the NAC, which would reduce the harvesting pressure on the wild populations (as in, e.g., Kay et al. 2011). Furthermore, this solution is technically within reach (Chandra et al. 2006) and culturally acceptable (TH, pers. obs.). The barrier to bringing this solution to fruition is essentially a regulatory one. Cultivation of *L. williamsii* is anticipated in the American Indian Religious Freedom Act (as amended 1994), which "...does not prohibit such reasonable regulation and registration by the Drug Enforcement Administration of those persons who cultivate...peyote...." But to date no interested party (e.g., the NAC of North America) has petitioned the DEA to promulgate any such "reasonable regulation" spelling out the details for such registration. Pending such action, cultivation of peyote, though not illegal, lacks the needed regulatory framework to provide legal certainty and protection for NAC members who would prefer to produce their own sacrament by cultivation rather than continuing to overharvest the wild populations. Until such time as the NAC and the DEA negotiate specific regulations to govern cultivation, the harvesting pressure on the wild populations can only increase.

But let us assume that the current level of unsustainable harvesting pressure is maintained, and that populations of peyote continue to produce steadily decreasing yields, as demonstrated in this study and in the regulated peyote market. Under the current system—which can accurately be described as "management by extirpation"—at some point the conservation crisis will become so critical that the U.S. Fish and Wildlife Service will be obligated by the terms of the Endangered Species Act to evaluate the conservation status of the species *Lophophora williamsii*. At that point the regulatory situation will become substantially more complex. If a regulatory stalemate then ensues, the NAC's options may broaden (or narrow) to include the Supreme Court and/or Congress as sources of relief.

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BOOK REVIEW

Ellen Sousa, Foreword by William Cullina. 2011. **The Green Garden: A New England Guide to Planning, Planting, and Maintaining the Eco-Friendly Habitat Garden.** (ISBN-13: 978-1-59373-091-8, pbk.). Bunker Hill Publishing, 285 River Road, Piermont, New Hampshire 03779, U.S.A. (**Orders:** www.bunkerhillpublishing.com). $34.95, 224 pp., color throughout, 7" × 10".

A growing number of people are becoming more agricurious. They are interested in how things are grown, land stewardship, animal husbandry, and soundscape ecology.

Thus, planning an eco-friendly habitat garden and landscape is like becoming a creative gourmet cook orchestrating a perfect dinner party with tried and tested recipes. Ellen Sousa's *The Green Garden: A New England Guide to Planning, Planting, and Maintaining the Eco-Friendly Habitat Garden* is the ideal manual/reference book to use if one wants to establish a notable green garden, particularly for those wanting to stop the deterioration of the natural world around us. Ms. Sousa presents new concepts for gardening that allow the gardener to work with nature to develop an area's natural ability to maintain its own health and sustainability. Her cogent writing style is a true testimonial that she is a cognoscente of natural habitat gardening. She and her husband live on a farm landscaped as a Certified Wildlife Habitat and Monarch Waystation. Renowned native plant author William Cullina's Foreword in the book is a validation that Ms. Sousa is the real deal!

Even though the title suggests it is only about the New England area of the country, it is not. Remember, the fight for establishing eco-friendly habitats is a universal challenge.

Fifty-plus contributing photographers fill this book with amazing wildlife photos and native plants. It is not only a wonderful primer for those just learning about natural habitat gardening but also a valuable educational resource for seasoned gardeners seeking to increase their eco-friendly habitat gardening knowledge, designed and written in a practical, no-nonsense style with a comprehensive bibliography and index.

A quick glance at the Table of Contents denotes the principles Ms. Sousa cites are applicable from forests to seasides, from lots to farmlands and, yes, to what Victorian gardeners called a "moon garden" of fragrant white-flowering plants. These are for gardeners who are only able to enjoy their garden during the evening hours.

In addition, the book includes a guide of the best plants for the region. The plants are grouped by plant type in alphabetical order by genera. Common names are listed after each plant genus name. A key of numerous icons is included.

Thoreau wrote "the world is but a canvas for your imagination"—when are you going to begin developing your own Eden?—*Kay M. Stansbery, Ph.D., Library Volunteer, Botanical Research Institute of Texas, 1700 University Dr., Fort Worth, Texas 76107-3400, U.S.A.*

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A COST-EFFECTIVE METHOD FOR CONSTRUCTING MAGNETIC FUMICELS FOR HERBARIUM CABINETS

Richard Carter

Director, Herbarium (VSC), Biology Department
Valdosta State University
Valdosta, Georgia 31698-0015, U.S.A.

ABSTRACT

A method is described to construct magnetic fumicel packets for holding solid insect repellants (e.g., naphthalene and paradichlorobenzene) used in the herbarium. The fumicels are designed to attach magnetically to metal herbarium cabinets. They are made entirely of archival materials, and are inexpensive and easily assembled.

RESUMEN

Se describe un método para construir contenedores magnéticos de fumicel para contener repelentes de insectos sólidos (por ej. naftaleno y paradiclorobenzeno) usados en el herbario. Los fumiceles se diseñan para ser adheridos magnéticamente a las cabinas metálicas del herbario. Están realizados completamente en materiales de archivo, y son baratos y fáciles de ensamblar.

INTRODUCTION

Substantial literature exists on the importance and efficacy of various pest repellants in herbaria and their health risks (e.g., Hall 1988; Strang 1999). However, methods for containing and securing repellants such as naphthalene and paradichlorobenzene (PDB) in herbarium cabinets have received little attention. A variety of methods are used for containment in herbaria, e.g., cloth bags with drawstrings, paper envelopes, small paper bags, small cardboard boxes, or small compartments in cabinet doors, and some entomologists use fumicels constructed from small cardboard boxes with wire mesh tops (Anonymous 2012). Because naphthalene and PDB vapors are heavier than air and tend to settle at the bottom of the cabinet, the repellant is normally placed on top of the uppermost folder of specimens in the uppermost pigeonhole of each column of the herbarium cabinet. However, there are several annoying aspects of this widely used method. When specimens are retrieved from the uppermost pigeonholes, the packets of repellant fall out, often striking the individual removing the specimens, or the packets are inadvertently pushed toward the back of the pigeonhole where they slip out of sight. Retrieving the "lost" packets usually requires use of a ladder or step-stool, which is time-consuming and potentially hazardous.

I devised, tested, and recommend placement of solid repellant in fumicels constructed from acid-free glassine envelopes suspended from the metal ceilings of herbarium cabinets by small neodymium magnets affixed to small rectangles cut from herbarium paper. This method uses archival materials, is cost effective, and—except for magnets and glassine envelopes—employs materials commonly available in the herbarium.

MATERIALS AND METHODS

In the United States, neodymium magnets and glassine envelopes are normally sold by English units; thus, English units are primarily employed here. Paper magnet-holders were made from 2½ inch × 3½ inch [6.4 cm × 8.9 cm] paper rectangles cut from 0.12 caliper archival herbarium paper using a guillotine type paper cutter. The center of each rectangle was marked using a wooden pencil, and a ¼ inch × 1⁄16 inch [6.4 mm × 1.6 mm] N42 neodymium (NdFeB) disc magnet was affixed at the center with a small dot of water-base herbarium glue. The adhesive was allowed to dry, and the paper magnet-holder was placed in a 2¾ inch × 3¾ inch [7 cm × 9.5 cm] acid-free, glassine envelope with a single opening along one 2¾ inch end and a foldable end flap. Approximately 10g of naphthalene (three Enoz® moth-balls) was placed in the packet against the surface of the paper magnet-holder opposite the magnet. The envelope was closed, and a 1¼ inch stainless steel paper-clip was

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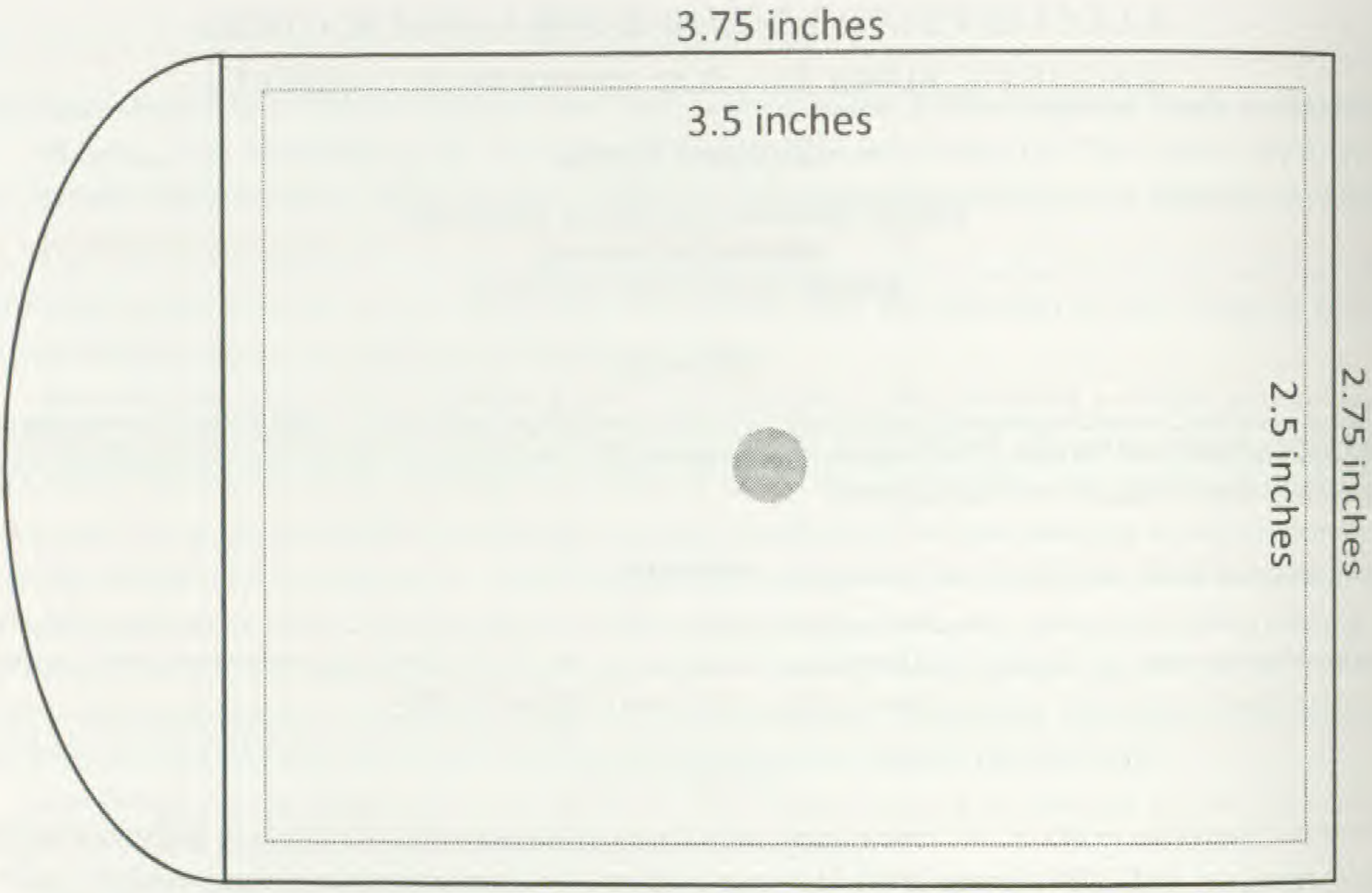

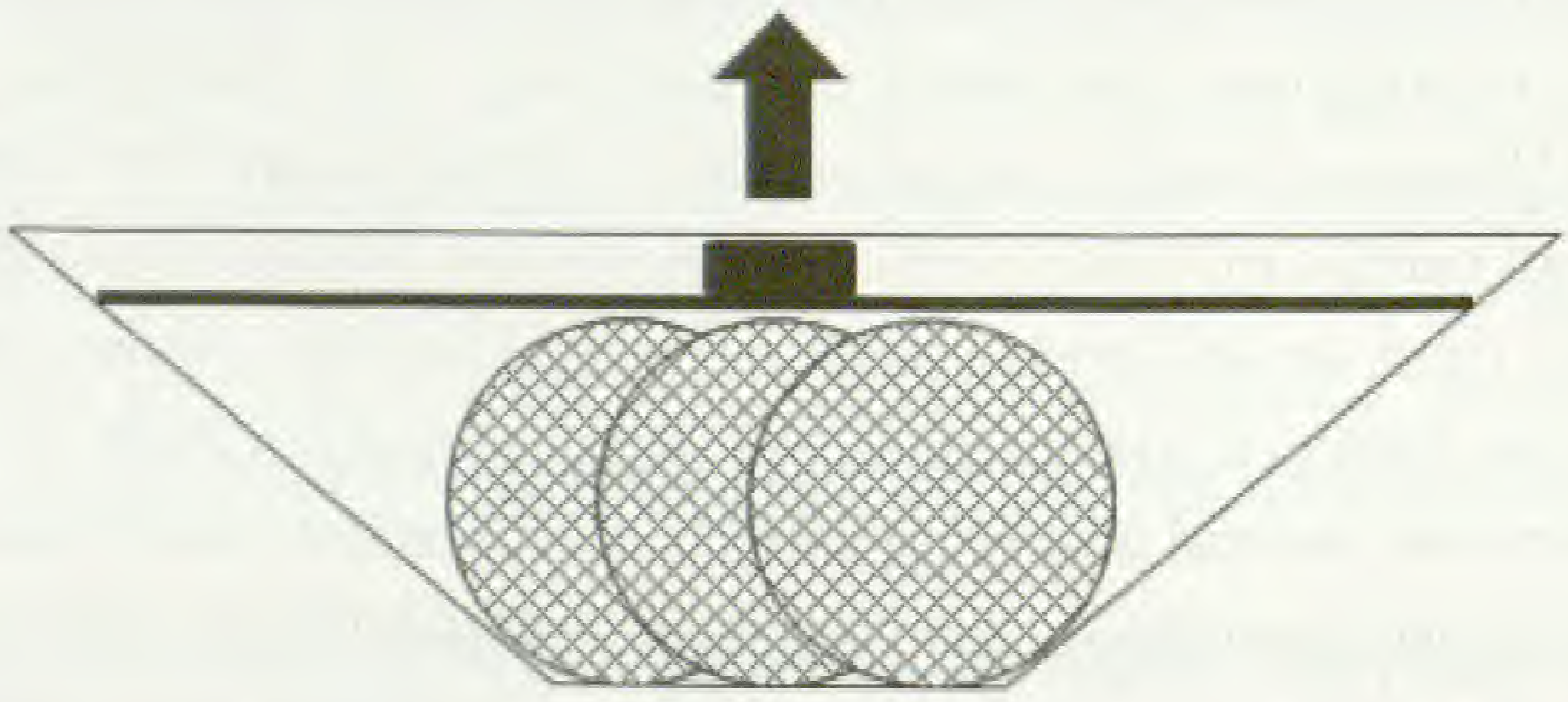

Fig. 1. Schematic diagram of fumicel showing inner paper rectangle with attached magnet (magnet-holder) enclosed within outer glassine envelope with open flap.

Fig. 2. Schematic cross-section of fumicel showing three naphthalene moth-balls suspended beneath paper magnet-holder. Arrow represents direction of magnetic attachment to metal surface of cabinet.

placed across one corner to secure the flap. See Figs. 1, 2 and 3. Alternatively, the loose flaps can be taped closed, but this would most likely prevent reuse of envelopes. Glassine paper is relatively non-porous and impervious. Therefore, I punctured the lower surface of each glassine envelope about 20 times with a steel sewing needle to increase its permeability to naphthalene.

Magnets.—¼ inch × 1/16 inch [6.4 mm × 1.6 mm] Grade N42 Neodymium (NdFeB) Disc Magnet, 3x nickel plated, pull force 2.5 lbs: MAGNETman® via amazon.com®. http://www.amazon.com/shops/A2WOM254LCFKNF

Glassine envelopes.—2¾ inch × 3¾ inch [7 cm × 9.5 cm] acid-free, glassine envelope with foldable end flap and single opening along 2¾ inch end: Uline®, 12575 Uline Drive, Pleasant Prairie, WI 53158, USA. http://www.uline.com/.

RESULTS AND DISCUSSION

The major expense was the cost of the neodymium magnets ($0.24 each, including shipping; pack of 100 for $12.99, excluding shipping), the acid-free, glassine envelopes ($0.07 each, including shipping; box of 1000 for

Fig. 3. Photograph of magnetic fumicel suspended from metal ceiling of herbarium cabinet.

$61.00, excluding shipping), and stainless steel paper-clips ($0.07 each, including shipping; box of 500 for $29.95, excluding shipping). The cost of the other, commonly used materials was negligible. Thus, I equipped 90 herbarium cabinets, each with two fumicels, at a cost of less than $0.40 per fumicel. Although I recommend attaching the fumicels to ceilings of cabinets, they also seem to work well on cabinet doors, which might be a consideration when the uppermost pigeonholes are packed with specimens.

Relative to their size, neodymium magnets are very strong, and they are readily available from several online vendors. Marketed as permanent, they are subject to chipping if allowed to snap together. Although I used only about 10g of repellant per fumicel, these small magnets are sufficiently strong to suspend at least 20g of solid repellant (i.e., six moth-balls and the maximum capacity of the fumicel envelope) securely, and they can be easily detached from the herbarium cabinet. In addition to being dangerous, larger, stronger neodymium magnets are more expensive and would require considerable effort to detach from the metal surface of the cabinet. Moreover, detaching them would most likely result in tearing both glassine envelope and paper magnet-holder. Both magnet grade and size recommended herein seem ideal for this particular application. However, neodymium magnets come in a variety of sizes and shapes, and heavier containers could easily be attached with larger, stronger magnets.

Disclaimer.—This article should not be construed to be a recommendation by either the author or this journal for using naphthalene, PDB, or other pest repellants in herbaria. Rather, its purpose is to provide information that might be beneficial to those who find it necessary to use repellants or other solid materials such as desiccants as a part of the overall program for herbarium pest management.

ACKNOWLEDGMENTS

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NUEVOS REGISTROS DE POÁCEAS PARA EL NORTE DE MÉXICO

Y. Herrera Arrieta[1], C.A. Silva Salas, L. Ruacho González y O. Rosales Carrillo

Instituto Politécnico Nacional, CIIDIR Unidad Durango-COFAA
Sigma 119, Fracc. 20 de Noviembre II, Durango, Dgo. 34220, MÉXICO
[1]yherrera@ipn.mx (Autor para correspondencia)

RESUMEN

Se presentan localidades nuevas de distribución geográfica para dos especies de gramíneas de México. *Muhlenbergia filiculmis* Vasey, especie conocida solamente del oeste de los Estados Unidos se registra por primera vez en México. Por otra parte, la distribución de *Distichlis eludens* (Soderstr. & H.F. Decker) H.L. Bell & Columbus, se amplía a nivel regional ya que ha sido recientemente colectada en Zacatecas, México.

Palabras Clave: Nuevos registros, gramíneas, flora, México

ABSTRACT

New localities of geographic distribution for two grasses of Mexico are presented. *Muhlenbergia filiculmis* Vasey, a species known only in the West of United States is registered for the first time in Mexico. So is the distribution of *Distichlis eludens* (Soderstr. & H.F. Decker) H.L. Bell & Columbus, is expanded into a regional level, since it has been recently collected in Zacatecas, Mexico.

Key Words: New records, grasses, flora, Mexico

INTRODUCCIÓN

Durante el desarrollo de estudios de biodiversidad (florística y citológica), cuyo objetivo principal fue realizar tesis de Maestría en el IPN CIIDIR Durango, sobresale el hallazgo de localidades no registradas con anterioridad, para dos especies de gramíneas (familia Poaceae), familia reconocida por su importancia ecológica y gran calidad alimenticia de muchas de sus especies (ejemplo cereales, forrajes, caña de azúcar). Se encontró que la localidad de colectas recientes en la vegetación de cimas del cerro Huehuento, San Dimas, Durango expande el área de distribución conocida de *Muhlenbergia filiculmis* Vasey (taxón de distribución boreal conocido de las montañas del W de Estados Unidos), resultando ser este el primer registro para México. Así también, colectas recientes en la Laguna de Salitrillo, Zacatecas expanden el área de distribución de *Distichlis eludens* (Soderstr. & H.F. Decker) H.L. Bell & Columbus, taxón escaso y endémico de suelos halófilos en terrenos inundables del norte-centro de México, cuya distribución conocida se restringía a dos localidades disyuntas: Humedal de Málaga, Durango y Salinas de Hidalgo, San Luis Potosí, siendo la nueva localidad un punto intermedio entre las localidades anteriormente conocidas.

MÉTODOS

Se estudiaron ejemplares de los taxa incluidos, provenientes de colectas recientes, realizadas en las áreas de distribución registradas en el reporte presente. La determinación de la identidad de las especies se llevó a cabo utilizando claves y descripciones de diversas obras florísticas para Norteamérica (Hitchcock & Chase 1951) y algunas regiones de México (McVaugh 1983; Herrera 1998; Herrera 2001; Herrera y Pámanes 2006; Herrera y col. 2010).

RESULTADOS

Se identificaron ejemplares con el nombre de *Muhlenbergia filiculmis* de la vegetación de alta montaña en el W de Durango y de *Distichlis eludens* proveniente de la laguna del Saladillo, Zacatecas. Ambas localidades amplían la distribución conocida de estas especies.

I. Nuevo registro para México y para el Estado de Durango

Muhlenbergia filiculmis Vasey es una especie que habita en lugares templados fríos de los bosques de

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coníferas de las montañas del NW de Estados Unidos, entre los 2500 y 3300 m de altitud, con distribución conocida en Arizona, California, Colorado, Nuevo Mexico, Utah, Washington y Wyoming (Herrera, 1998). Es una especie perenne pero de porte pequeño, de 10 a 35 cm de alto, por lo que pudo haber pasado desapercibida a los ojos de colectores anteriores, sumado a ello la característica de que es apetecida por los herbívoros y se encuentra generalmente ramoneada. Es una especie del complejo aparentemente monofilético de *Muhlenbergia montana* (Nutt.) Hitchc., propuesto por Herrera (1998), cuya característica morfológica principal es tener la segunda gluma 3-nervada; siendo ahora reconocido como un linaje natural (subgénero *Clomena*), con base en el análisis filogenético del ADN (Peterson y col. 2010).

Las colectas de material botánico en la vegetación de alta montaña de la Sierra Madre Occidental son escasas, especialmente en el municipio de San Dimas, Durango, donde lo inaccesible del terreno hace que sean pocos los colectores que se internan en sus caminos para realizar estudios florísticos.

La localidad del ejemplar de *M. filiculmis* [México. Durango. Municipio San Dimas: Cima del cerro Huehuento, 24°04'31"N, 105°44'24"W, 3262 m, *M. González 4288A* (CIIDIR)] es nueva para México y se constituye como el extremo septentrional de distribución para esta especie, a un límite altitudinal sobre los 3200 m, misma que sale del límite sur conocido hasta ahora, cerca del paralelo 32° N en Arizona y Nuevo Mexico hasta cerca de 24° N correspondientes a la nueva localidad en San Dimas, Dgo. Podría sospecharse la existencia de otras localidades en que posiblemente se encuentre creciendo esta especie, sin embargo dichas localidades debieran ser en las altas montañas de la Sierra Madre Occidental, a fin de compensar las diferencias de latitud con altitud que permite se presenten los requerimientos climáticos del hábitat de la especie.

Las localidades de alta montaña en México son escasas, Challenger (1998) marca 18 picos altos con vegetación alpina o subalpina, 10 de ellos en el Eje Volcánico Central, 7 en la Sierra Madre Oriental y 1 en la Sierra Madre Occidental (el cerro Mohinora). Sin embargo en la Sierra Madre Occidental, se encuentran otros picos que quizás no llegan a tener vegetación alpina típica, pero que presentan elementos de vegetación alpina por la altitud que alcanzan, como es el caso de los cerros siguientes: Cerro Mohinora (3,293 m), mpio. Guadalupe y Calvo, Chih.; Cerro Barajas (3,280 m), mpio. Guanaceví, Dgo.; Cerro Huehuento (3,233 m), mpio. San Dimas, Dgo., donde se encontró *M. filiculmis* para este registro; Cerro Gordo (3,328 m), mpio. Pueblo Nuevo, Dgo.; Cerro de las Antenas (3,221 m), mpio. Canatlán, Dgo. Ruacho (2011), inicio muestreos y dejo marcas en las localidades de algunas de estas montañas (en aquellas donde la seguridad actual lo permitió), con el fin de realizar monitoreo para ver cambios posteriores en la vegetación de la Sierra Madre Occidental.

II. Nuevo registro para el Estado de Zacatecas

El género *Distichlis*, fue propuesto por Rafinesque en 1819 (López y col. 2009). Se le conoce vulgarmente como "pasto salado" ya que habita en suelos naturalmente salitrosos o salinizados artificialmente, desde elevadas montañas hasta la orilla del mar, se destaca en la clasificación sintaxonómica, debido a la relación tan estrecha que tiene con los ambientes en los que habita (Pelliza y col. 2005). Generalmente, éstas plantas permanecen en estado verde durante el periodo de sequía, al tiempo que el resto de los pastos forrajeros en el sitio no están disponibles, por esta razón el ganado lo consume (Estrada-Hernández y col. 2005).

Un nivel elevado de salinidad en el suelo aumenta el punto de marchitamiento de las plantas como consecuencia del incremento de la presión osmótica y de los efectos tóxicos de las sales (Proyecto SoCo 2009). La salinidad puede llegar a ser un factor importante en la reproducción de las especies de *Distichlis*, lo que hace que su estudio sea de singular importancia (Proyecto SoCo 2009).

Distichlis está formado por un pequeño grupo de plantas herbáceas, dioicas, perennes y rizomatosas, con espiguillas multifloras y hojas conspicuamente dísticas, pertenecen a la familia Poaceae, subfamilia Chloridoideae, tribu *Cynodonteae* y subtribu *Monanthochloineae* (López y col. 2009). La taxonomía de este grupo, fue definida recientemente por Bell y Columbus (2008) con base en caracteres de la topología nuclear y del cloroplasto, adicionales a los caracteres morfológicos y anatómicos del grupo. Concluyendo que los géneros *Monanthochloe* y *Reederochloa* están anidados dentro de un *Distichlis* parafilético, conformado por unas siete especies distribuidas en sitios salinos del Hemisferio Occidental y Australia (Bell y Columbus 2008; Barkworth y Bell 2011), cinco de esas especies se encuentran en México.

Fig. 1. Fotografía de *Distichlis eludens* (Soderstr. & H.F. Decker) H.L. Bell & Columbus (*Reederochloa eludens*), *Silva, Carrillo & Herrera 29* (CIIDIR), orilla SE de la Laguna de Saladillo, Zacatecas.

Distichlis eludens (Soderstr. & H.F. Decker) H.L. Bell & Columbus (antes *Reederochloa eludens* Soderstr. & H.F. Decker) (Fig. 1) es una planta perenne, dioica, estolonífera que se desarrolla en zonas de alta concentración de sales en pastizales halófilos o en claros de matorral xerófilo y requiere de altos niveles de agua para su crecimiento. Se encuentra en cualquier época del año aunque esté marchita y es por ello que el ganado la consume. Es una planta que en ocasiones es difícil de encontrar por el tamaño tan pequeño que presenta y por el grado de ramoneo que el ganado ejerce sobre ella, así también en otras ocasiones, se puede llegar a observar fácilmente ya que la densidad de individuos que forman una colonia puede ser hasta de 10 m continuos. La especie se consideraba endémica de las dos localidades disyuntas, en los Estados de Durango y San Luis Potosí, el ejemplar recientemente colectado [México. Zacatecas: orilla SE de la Laguna el Saladillo, 22°38'38.7"N, 102°02'24.9"W, Silva, Carrillo y Herrera 29 (CIIDIR)], amplía el área de distribución conocida para este taxón al Estado de Zacatecas, región intermedia a las de distribución conocida.

El estudio citológico en poblaciones de *D. eludens* realizado por Silva (2011), proporciona un ideograma del cariotipo de esta especie, confirma el número cromosómico (x=9) y la aneuploidía ($2n=4x+2=38$) reportados anteriormente, con resultados novedosos adicionales que se reportarán en un artículo en proceso.

CONCLUSIÓN

La revisión y colecta de material botánico con fines de estudios de biodiversidad florística, citológica, ecológica o de otra índole, siguen aportando información novedosa y relevante para el conocimiento de nuestra flora mexicana. Se dan a conocer a la comunidad botánica localidades nuevas de dos importantes gramíneas que se reportan por primera vez: *Muhlenbergia filiculmis* nuevo registro para México y *Distichlis eludens* nuevo registro para el Estado de Zacatecas.

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Agradecemos a la Secretaría de Investigación y Posgrado del IPN por el financiamiento recibido en los proyectos: SIP-20110017 "Citología de Gramíneas y Ciperáceas de importancia económica del n-c de México" y SIP20110681 "Fitodiversidad y Ecosistemas de la Sierra Madre Occidental". Así también agradecemos al CONACyT por las becas de estudios de posgrado a la 2ª (VU: 331664) y 4° coautores. Por último agradecemos a J.J. Ortiz y un revisor anónimo por las observaciones y sugerencias al manuscrito del presente reporte.

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DISTRIBUCIÓN ACTUAL Y POTENCIAL DE *TAXUS GLOBOSA* (TAXACEAE) EN MÉXICO

Mario A. García-Aranda, César Cantú-Ayala, Eduardo Estrada-Castillón, Marisela Pando-Moreno y Antonio Moreno-Talamantes

Facultad de Ciencias Forestales
Universidad Autónoma de Nuevo León
Km 145 Carr. Nacional, Apartado Postal 41
C.P. 67700, Linares, N. L., MÉXICO
e-mail: mgarcia_20@yahoo.com.mx

RESUMEN

Con el objetivo de conocer la distribución potencial de *Taxus globosa* Schlecht., especie de conífera con distribución restringida y listada bajo estatus de conservación en la NOM-059-SEMARNAT-2010 se utilizó el método de modelación de distribución de máxima entropía o MaxEnt con base en 40 registros obtenidos en campo y 39 registros del REMIB-CONABIO. Se probaron estadísticamente dos escenarios con cubiertas geográficas ambientales, climáticas y topográficas. El escenario BIOCLIM con Topografía resultó el modelo con mayor precisión en el intervalo de probabilidad de 0.9 a 1.0 con un 55% de coincidencia siendo estadísticamente significativo (AUC= 0.985). La pendiente resultó la de mayor influencia en el modelado del hábitat potencial, seguida por Bio14 precipitación del mes más seco. De acuerdo con el análisis MaxEnt, las 19 variables BIOCLIM y las tres topográficas, las principales comunidades vegetales donde potencialmente se podría distribuir *Taxus globosa* en México son bosque de pino-encino, bosque de encino-pino, bosque de pino y bosque mesófilo de montaña. Los estados donde potencialmente se puede distribuir *Taxus globosa* en México son: Hidalgo, Nuevo León, Puebla, Tamaulipas y Veracruz.

Palabras Clave: *Taxus globosa*, Modelación, Hábitat, MaxEnt

ABSTRACT

To better understand the potential distribution of *Taxus globosa* Schlecht., we used a conifer species with restricted distribution, listed on the NOM-059-SEMARNAT-2010, a modeling distribution procedure of maximum entropy or MaxEnt, based on 40 occurrences of field records and 39 REMIB-CONABIO records. Two different scenarios of geographical and environmental coverages—climatic and topographic—were proved statistically. The BIOCLIM variables scenario with topography data show a more accurate model in the range of 0.9 to 1.0 probability with a 55% coincidence; it was statistically significant at (AUC=0.985). Slope variable indicates an environmental variable with more influence in potential modeling, followed by Bio14 (Precipitation of Driest Month). In agreement with the MaxEnt analysis with 19 BIOCLIM and 3 topographic variables, the main plant communities in the modeling area (where *Taxus globosa* is distributed in Mexico) are pine-oak forest, oak-pine forest, pine forest, and cloud mesic forest. *Taxus globosa* is potentially distributed in Hidalgo, Nuevo León, Puebla, Tamaulipas, and Veracruz.

Key Words: *Taxus globosa*, Modelling, Habitat, MaxEnt

La predicción de la distribución potencial de especies raras o en riesgo de extinción es relevante para llevar a cabo un seguimiento y conservación, ya que proporciona un punto de partida en practicas de recuperación de sus condiciones ambientales o del establecimiento de áreas de repoblación artificial (Leal 2009). *Taxus globosa* es una conífera incluida en la NOM-059-SEMARNAT-2010 en la categoría de sujeta a protección especial (SEMARNAT 2010). La información de registros de especies raras como *Taxus globosa*, en bases de datos o publicaciones, es escasa, aún lo es más sobre las áreas de distribución local o regional (Zamudio 1992; García y Castillo 2000; Contreras y Luna 2001; Zavala 2002; Zavala et al. 2001; Bonilla y Canchola 2008). Existen diversos métodos para el modelado de las áreas de distribución potencial (Phillips et al. 2006; Ward 2007; Phillips y Dudík 2008; Hernández et al. 2008; García 2008), algunos de los cuales se han aplicado en estudios en plantas en categoría de riesgo de extinción o de distribución restringida (Engler et al. 2004), además de un estudio previo sobre el modelado del nicho de *Taxus globosa* con análisis de los efectos del cambio en uso de la tierra y su conservación en México (Contreras et al. 2010).

El propósito del estudio fue modelar el área de distribución potencial de *Taxus globosa* y conocer la influencia de variables bioclimáticas y topográficas en la precisión del modelado a través de una comparación,

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con énfasis en las poblaciones del noreste de México con el objetivo de aportar información para planes de conservación, rehabilitación o implante de tal especie.

MATERIALES Y MÉTODOS

Se visitaron 40 sitios donde crece *Taxus globosa* en recorridos de campo en nueve localidades en los estados de Nuevo León y Tamaulipas, en el noreste de México, en estos sitios se tomaron las coordenadas geográficas, las cuales fueron incorporadas a una base de datos.

En estos sitios se colectaron ejemplares botánicos Estrada et al, con números de colecta 11804, 15993, 16129, 16299, 16373, 16383, 16507, 16545, 16820, 16828, 19155, 19436, 2000 los cuales fueron depositados en el herbario CFNL. Una serie de 39 registros (coordenadas geográficas) de *Taxus globosa* se obtuvieron de la consulta a la base de datos de la Red Mundial de Información sobre Biodiversidad REMIB, CONABIO, http://www.conabio.gob.mx/remib/doctos/remib_esp.html. Los 40 registros de campo se sumaron a los 39 registros de REMIB integrando una base de 79 registros totales utilizados en la modelación de la distribución potencial. Posteriormente del uso de esta base de datos, se utilizaron 42 registros de colecta adicionales obtenidos de visitas de campo posteriores con el propósito de realizar pruebas de validación de los modelos por porcentaje de coincidencias.

Del sitio web de WorldClim (Hijmans et al. 2005; http://www.worldclim.org/bioclim) se obtuvieron cubiertas geográficas de variables ambientales de 1960–1990 en formato raster de un km^2 de resolución. La base de datos BIOCLIM utilizada en el modelado de distribución consta de 19 cubiertas (Cuadro 1), la cual fue combinada en una segunda modelación con un grupo de tres variables topográficas altitud, exposición y pendiente (Cuadro 1) que fueron calculadas a partir de la cubierta 'altitude' de WorldClim (Hijmans et al. 2005; http://www.worldclim.org/bioclim), todas estas fueron recortadas en ArcGIS versión 9.2 a los límites de 118°20'3.42" a 86°25'3.42" Oeste y 34° 01'0.08" a 12° 55'30.76" Norte, correspondiente al territorio de México; las capas se transformaron en ArcGIS versión 9.2 a formato ASCII Grid.

Se utilizó el modelado Maximum Entropy Distribution o MaxEnt, el cual es el mejor método (Kumar y Stohlgren 2009), es de los que procesan bases de datos con pocos registros (Hernández et al. 2006; Pearson et al. 2007). Es un método basado en un protocolo que estima la probabilidad de ocurrencia de las especies basado en requerimientos ambientales que genera una estimación de probabilidad de presencia de la especie con valores de 0 y 1, donde 0 se considera como la mínima y 1 para la máxima probabilidad (Phillips et al. 2006), para realizar el análisis solo se requiere de datos de presencia de la especie (no ausencia) y cubiertas geográficas de variables ambientales de las áreas de análisis (continuas o categóricas). El software MaxEnt versión 3.3.2 es de uso libre y está disponible enhttp://www.cs.princeton.edu/~schapire/maxent/.

La base de datos compilada de 79 registros de *Taxus globosa* y los cuatro grupos de variables ambientales fueron utilizadas para la modelación de un escenario climático actual (periodo de 1950 a 2000). El programa generó imágenes logísticas acumulativas y analizó a un máximo de 500 aproximaciones sucesivas (iteraciones).

Los dos modelos generados se sometieron a las pruebas curva de respuesta (análisis de omisión/comisión y sensitividad ROC AUC=Area Under Curve) y una prueba Jackknife para medir el efecto de cada variable utilizada en la generación de los modelos. Para realizar esto se dividió la base de datos de 79 registros en un subgrupo de 40 registros para el modelado de hábitat potencial y otro de 39 para pruebas estadísticas de validación.

Con una base de 42 registros adicionales de *Taxus globosa*, a través del módulo Point Analyst 1.0 para Arcview, se registró el valor de los dos modelos de distribución potencial generados en formato raster los cuales presentan valores de probabilidad de hábitat de 0.1 a 1.0, de manera que solo se contabilizaron los registros con valores entre 0.8 y 1.0 para expresarlos en porcentaje de ocurrencias >80 % de probabilidad de tener un hábitat potencial para *Taxus globosa*.

Se realizó un análisis de distribución de la superficie actual y potencial (entre los pixeles de 0.8 a 1.0 probabilidad) generado en el mejor modelo de acuerdo al uso actual de la tierra y vegetación (INEGI 2005). Asimismo, se determinó su área de distribución actual y potencial en México.

Cuadro 1. Listado de las variables ambientales BIOCLIM[2] y topográficas usadas en el modelado MaxEnt y su porcentaje de contribución en los modelos de distribución generados para *Taxus globosa* en México.

Variable ambiental	BIOCLIM	BIOCLIM+Topo
BIO_01 = Temperatura media anual	2.9	3.8
BIO_02 = Intervalo medio diurno (Media por mes [Temp.Max–Temp.Min])	0.3	0.2
BIO_03 = Isotermalidad (P2/P7) (* 100)	19.2	0.0
BIO_04 = Temporalidad de la temperatura (desviación estándar *100)	4.1	1.1
BIO_05 = Temperatura máxima del mes mas cálido	39.4	2.5
BIO_06 = Temperatura mínima del mes más frío	10.3	7.5
BIO_07 = Intervalo de temperatura anual (P5-P6)	2.9	0.9
BIO_08 = Temperatura media del ¼ anual mas húmedo	1.5	0.1
BIO_09 = Temperatura media del ¼ anual mas seco	0.0	1.4
BIO_10 = Temperatura media del ¼ más cálido	0.0	0.2
BIO_11 = Temperatura media del ¼ más frío	0.1	0.2
BIO_12 = Precipitación anual	0.0	1.1
BIO_13 = Precipitación del mes mas húmedo	0.0	1.1
BIO_14 = Precipitación del mes más seco	15.3	25.5
BIO_15 = Temporalidad de la precipitación (Coeficiente de variación)	0.5	0.0
BIO_16 = Precipitación del ¼ anual más húmedo	1.6	0.1
BIO_17 = Precipitación del ¼ anual mas seco	0.4	0.0
BIO_18 = Precipitación del ¼ anual mas cálido	0.1	0.0
BIO_19 = Precipitación del ¼ anual más frío	0.0	0.2
TOPO_01 = Elevación	n/a	14.0
TOPO_02 = Exposición	n/a	0.4
TOPO_03 = Pendiente	n/a	39.8

[1] Tomado de: WorldClim (Hijmans et al. 2005).

Cuadro 2. Síntesis de resultados en las pruebas de validación internas MaxEnt.

Modelo BioClim	Modelo BioClim + Topografía	
Aumento Regularizado de puntos de entrenamiento	4.094	4.090
Área bajo la curva (AUC) de puntos de entrenamiento	0.998	0.998
Aumento No Regularizado de puntos de entrenamiento	4.536	4.558
Aumento de Prueba no Regularizada	5.082	5.365
Prueba de prueba de Área bajo la curva (AUC)	0.998	0.999
Desviación estándar[1]	0.001	0.000
Algoritmo terminado despues de	500 iterations	500 iterations

[1] Estimada con base en la ecuación dos (DeLong & Clarke-Pearson 1988).

RESULTADOS Y DISCUSIÓN

El modelo de distribución potencial para *Taxus globosa* en México se muestra en la Figura 1 el cual considera solo las 19 cubiertas geográficas BIOCLIM sin la de topografía. Este mapa tiene un alto nivel de predicción. El valor del área bajo la curva ROC (AUC = 0.987) (Cuadro 2). En contraste el mapa del modelo de hábitat potencial para *T. globosa* considerando las 19 cubiertas geográficas BIOCLIM y las tres cubiertas geográficas de topografía (Fig. 2), generó una tasa de éxito mayor en su predicción con un valor de área bajo la curva ROC (AUC = 0.985) (Cuadro 2), estos valores son menores al obtenido por el modelo (AUC = 0.997) generado por Contreras et al. (2010).

De acuerdo a los análisis de validación de MaxEnt (Cuadro 2), los dos modelos generados tuvieron altos valores de precisión, no obstante que las variables que generan sus respectivos modelos son distintos.

Las variables que tuvieron mayor ponderación en la generación de los modelos, fueron: para el modelo BIOCLIM: temperatura máxima del mes más cálido (Bio05) 39.4%, isotermalidad [P2/P7] [*100] (Bio03) 19.2%, precipitación del mes más seco (Bio14) 15.3% y temperatura mínima del mes más frío (Bio06) 10.3%;

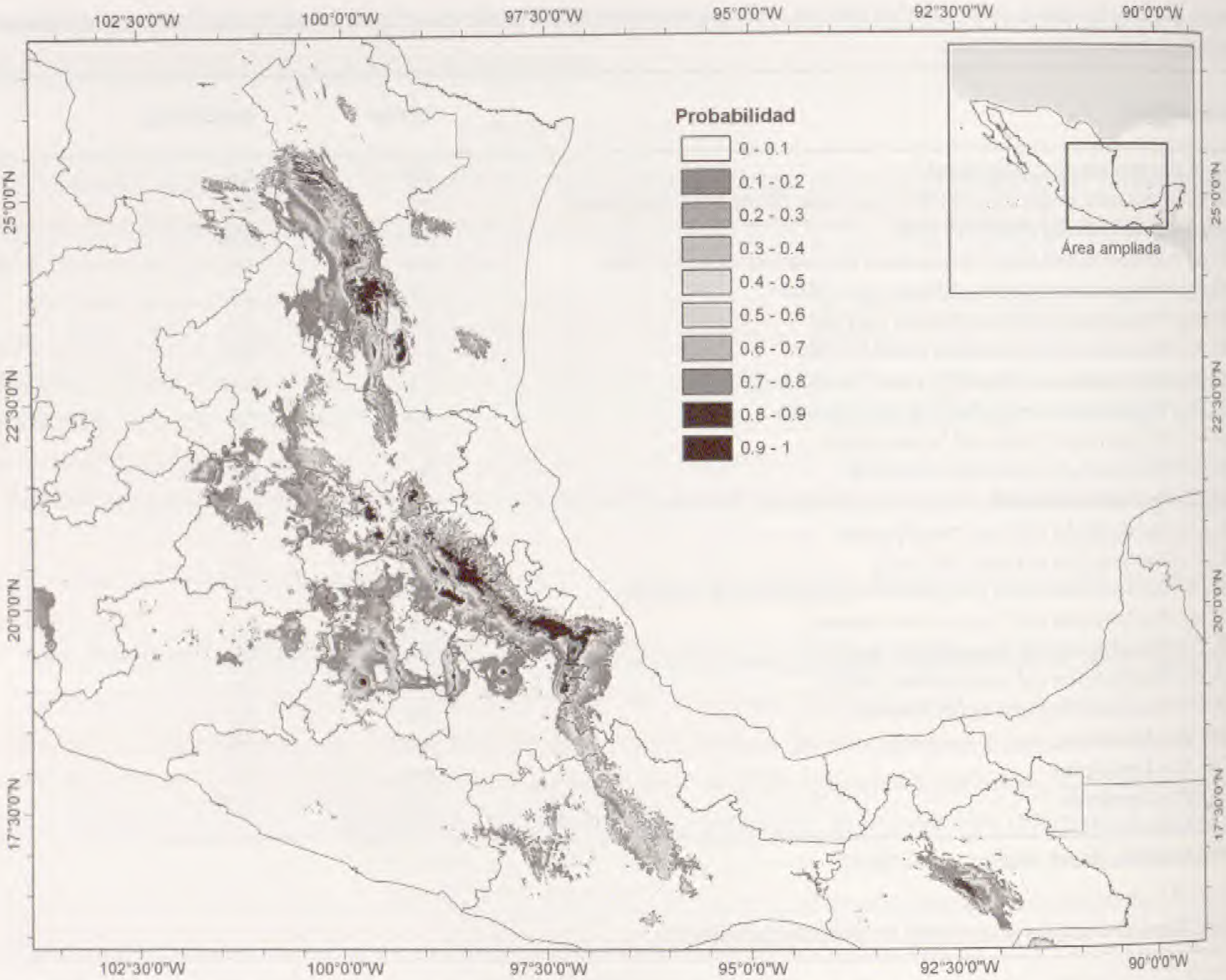

Fig. 1. Modelado de hábitat potencial para *Taxus globosa* en México, con base en variables BIOCLIM. Las áreas en tono más oscuro entre 0.8 y 1.0 son las de mayor probabilidad.

para el modelo BIOCLIM con topografía: Pendiente (Topo03) 39.8%, precipitación del mes más seco (Bio14) 25.5%, elevación (Topo01) 14.0% y temperatura mínima del mes más frío (Bio06) 7.5%, muestra que la pendiente del terreno tiene relevancia en uno de los dos modelados, seguida de la precipitación en el mes más seco y elevación. Esto significa que el segundo modelo produjo áreas más específicas que discriminan zonas por topografía (Fig. 3, Cuadro 1).

Los patrones de distribución biogeográfica están cambiando en respuesta a recientes alteraciones del clima, como lo establece un índice que mide la velocidad de cambio de la temperatura (km año) y la velocidad de cambio varía en los ecosistemas (Loarie et al. 2009). En relación a la influencia de la topografía, dicho índice establece que el efecto topográfico, influye de manera importante en la velocidad de cambio de la temperatura, siendo menor (0.11 km año) en el ecosistema con bosques de coníferas tropicales y subtropicales, donde se distribuyen las comunidades vegetales con presencia de *Taxus globosa*. Además, el tiempo de residencia (tiempo que permanece un ecosistema en una región) de éste es mayor (63.6 años) respecto a otros ecosistemas analizados (Loraie et al. 2009).

La Figura 4 muestra la distribución de los registros usados en el modelado de hábitat potencial con la variable Topo03 (pendiente), donde se observa que los datos se concentran entre los 89.99 y los 90.00 grados de pendiente, lo cual indica que la especie prefiere crecer en los cañones. En la Figura 5 se muestra la distribución de los registros en la variable Bio14 (precipitación del mes más seco), los datos se concentran entre 8.0 y 32 mm de precipitación (mes más seco del año), lo que indica zonas con períodos de sequía. La Figura 6, muestra la distribución de los registros para la variable Topo02 (elevación), en la que se observa una preferencia por eleva-

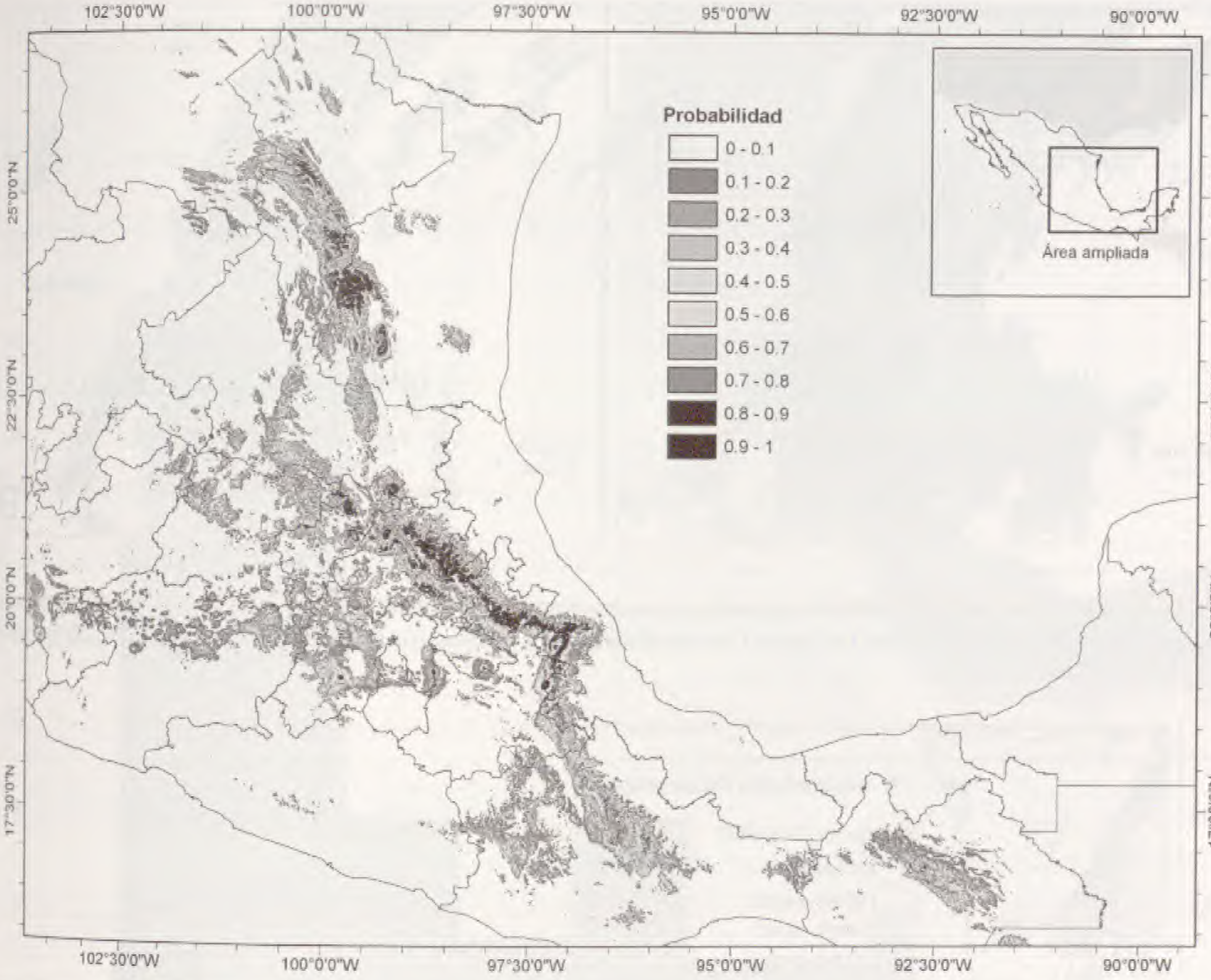

Fig. 2. Modelado de hábitat potencial para *Taxus globosa* en México, con base en variables BIOCLIM y topográficas. Las áreas en tono más oscuro entre 0.8 y 1.0 son las de mayor probabilidad.

ciones entre 1,200 y 3,000 m, ubicando la condición del hábitat en zonas elevadas. En la Figura 7, se muestra la distribución de los registros en la variable Bio06 (temperatura mínima del mes más frío), los datos se ubican entre 24 y 33°C, lo que denota una preferencia por sitios templados.

En el análisis de distribución por deciles de probabilidad (entre 0.1 y 1.0) de presencia de distribución potencial de *Taxus globosa* en México para lo dos modelos, se observó que los últimos dos deciles (0.8–0.9 y 0.9–1.0) representan las áreas donde se advierte mayor probabilidad de encontrar a la especie y coincide con la zona núcleo del área potencial de distribución de la especie (Figs. 1 y 2).

Para el penúltimo decil de probabilidad (0.8–0.9) la superficie calculada para la distribución potencial fue mayor en el modelo BIOCLIM con 9,299.38 km^2 que representa un 0.47% del territorio de México, mientras que en el modelo Biocilm+Topografía generó una superficie de 8,581 km^2 que representan el 0.43% del territorio nacional (Cuadro 3).

Por el contrario, en el decil de mayor probabilidad de distribución (0.9–1.0) el modelo de BIOCLIM presentó una superficie menor con 351 km^2 que representan el 0.02 % del territorio nacional, y el modelo BIOCLIM+Topografía generó una superficie de 1,804 km^2 (0.09% del territorio mexicano). Es probable que la diferencia en tendencia sea resultado del efecto de la pendiente y elevación ya que los registros tomados en campo están ubicados en zonas de elevación mayores a 1,200–3,800 m y con pendiente pronunciada (Fig. 4).

Utilizando un grupo de 42 registros adicionales de *Taxus globosa* se realizó una prueba de validación de los dos modelos generados, contabilizando los registros que coincidieran geográficamente con las zonas de los modelos que marcaron valores de probabilidad entre los deciles 0.8–0.9 y 0.9–1.0, estos se expresaron en valo-

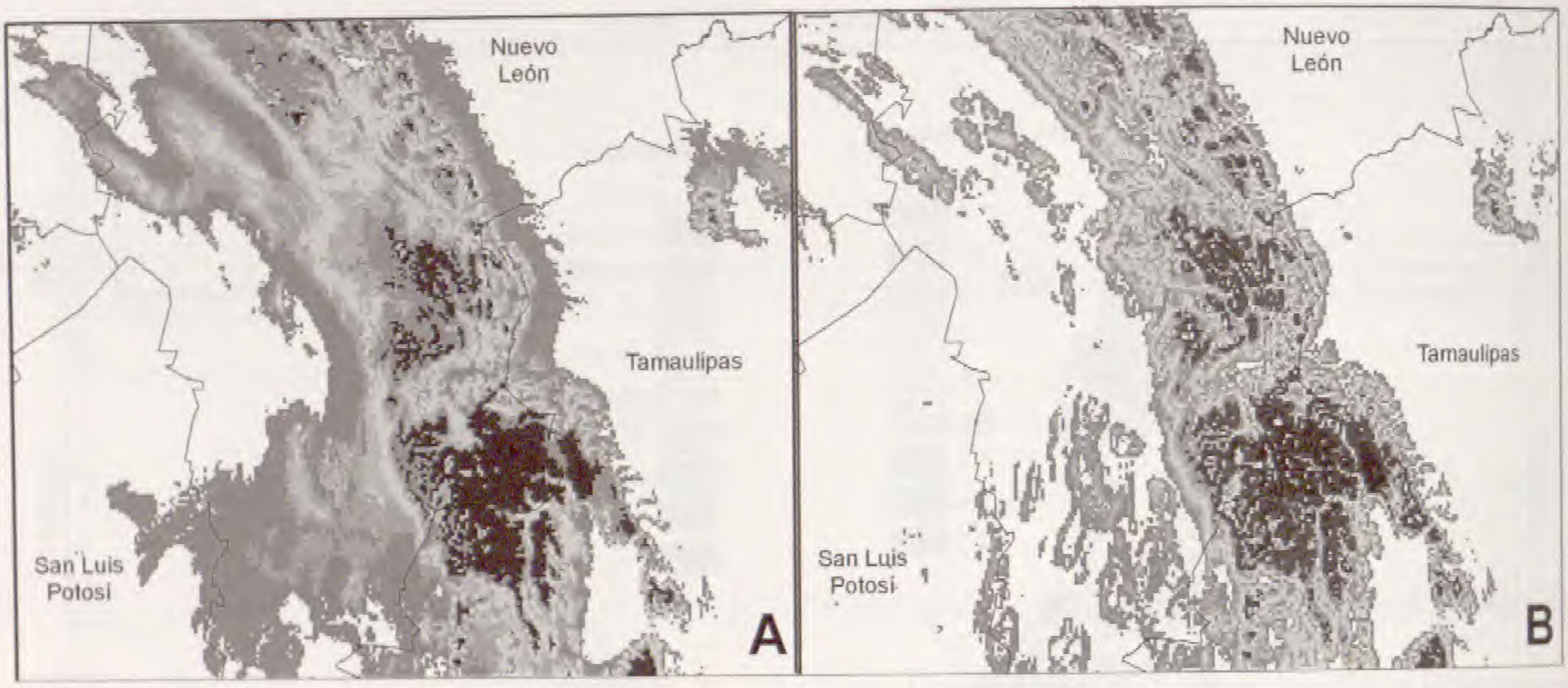

Fig. 3. Diferencial de modelos: A BIOCLIM y B BIOCLIM+Topografía que muestran efecto de distribución diferenciado entre valores de probabilidad de hábitat potencial por las variables usadas en ambos. Las áreas en tono más oscuro entre 0.8 y 1.0 muestran la mayor probabilidad de presencia de la especie.

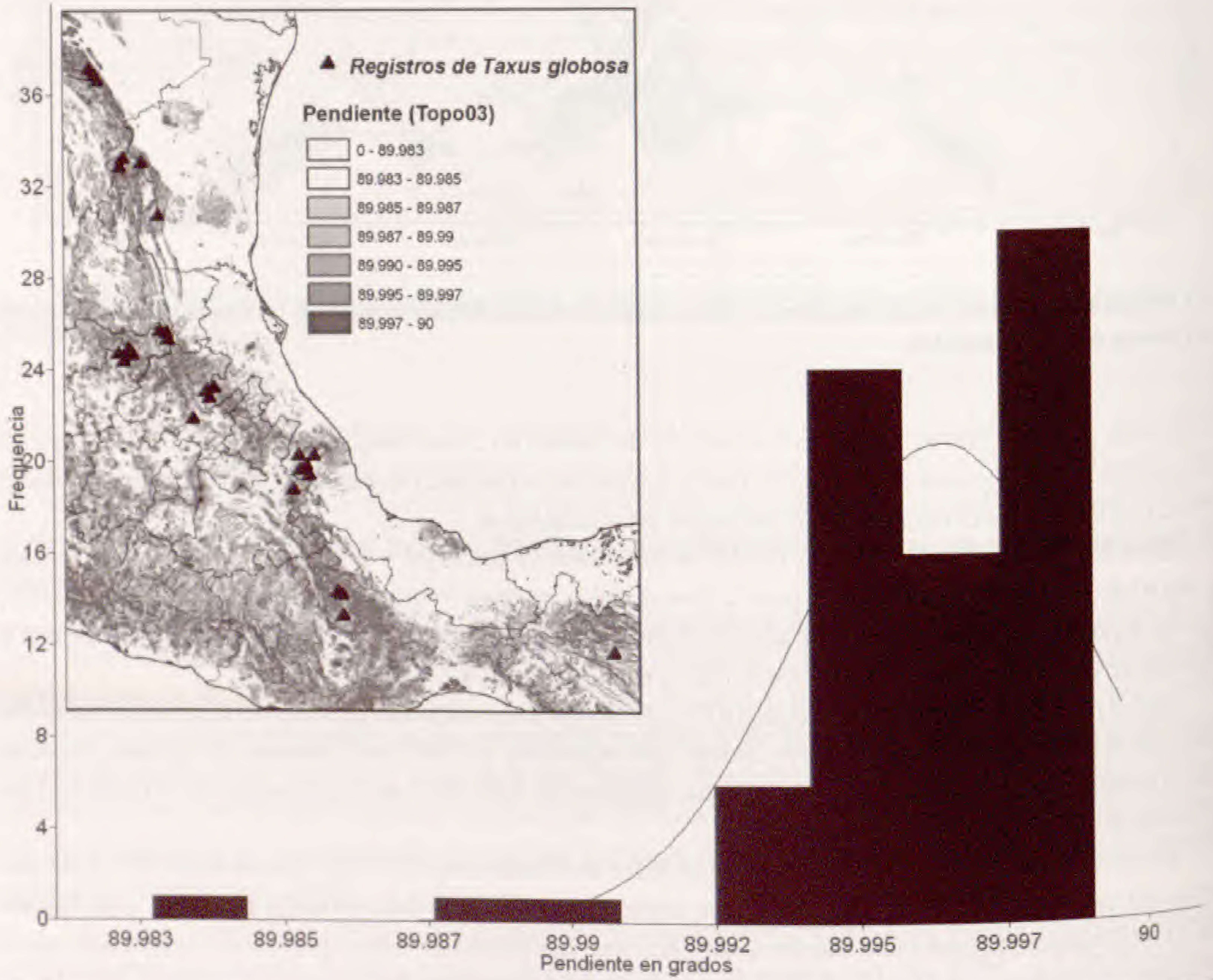

Fig. 4. Mapa de la distribución de 79 registros de *Taxus globosa* en relación con la variable ambiental Topo03 (grados de pendiente).

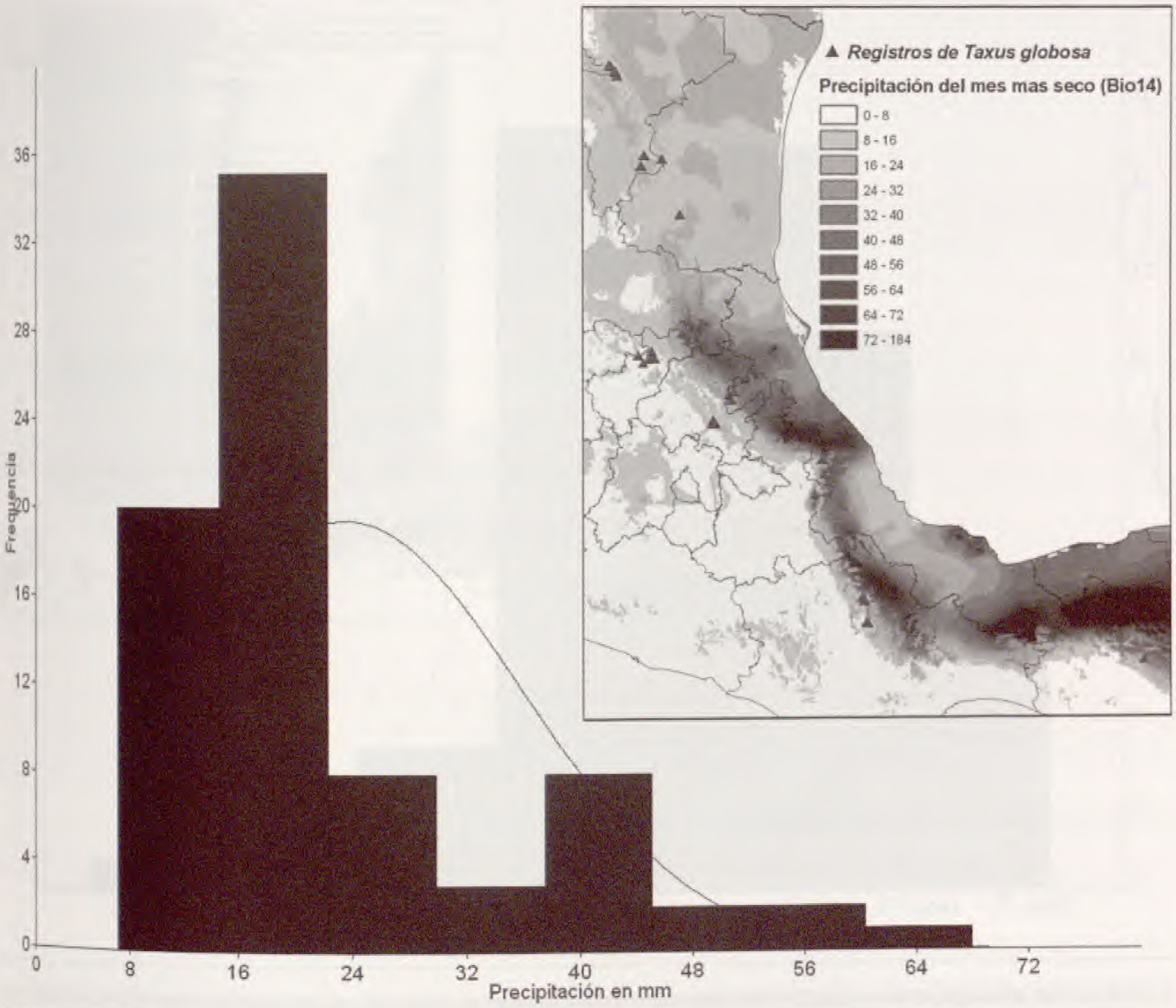

Fig. 5. Mapa de la distribución de 79 registros de *Taxus globosa* en relación con la variable ambiental Bio14 (precipitación promedio del mes más seco).

res porcentuales de coincidencia con los modelos. Para el modelo BIOCLIM se obtuvo una precisión general de 52% (45% en el decil 0.8–0.9 y 2% en el decil 0.9–1.0) mientras que para el modelo BIOCLIM+Topografía se obtuvo una precisión de 55% (36% en el decil 0.8–0.9 y 19% en el decil 0.9–1.0). Considerando el total de valores de probabilidad de los pixeles, el modelo BIOCLIM tiene mayor precisión con 83%, mientras que si consideramos valores del decil de mayor probabilidad de ocurrencia de hábitat potencial para *Taxus globosa*, el modelo BIOCLIM+ Topografía tiene la mayor precisión con 55% (Cuadro 4).

La prueba muestra que el modelo de BIOCLIM+Topografia tiene una mayor eficiencia en el último percentil de mayor probabilidad de ubicar *Taxus globosa* de 0.9–1.0, mientras que el modelo BIOCLIM es más preciso en un percentil de menor probabilidad de ubicación de *Taxus globosa* 0.8–0.9 (Fig. 8), en contraparte Contreras et al. (2010) obtuvieron un 94.5% de eficacia en la predicción para su modelo; esta diferencia se establece ya que no se subdividió el modelo en deciles y fue considerada la totalidad de la superficie del modelo, la eficiencia de los modelos considerando las coincidencias de los registros de la prueba de eficiencia son del 90% para el modelo uno y 81 % para el modelo 2, a partir de una probabilidad del 0.6 al 1.0.

Se realizó un análisis de la superficie del hábitat potencial (0.8–1.0) para *T. globosa*, de acuerdo al uso de la tierra y vegetación (INEGI 2005), al cruzarla información se analizó la distribución de los 10,385 km^2 en relación a los tipos de vegetación y uso actual de la tierra. De este análisis se obtuvo que la comunidad con más superficie del área de distribución potencial es el bosque de pino-encino con 2,230 km^2, (21.48%), el bosque de encino-pino con 1,638.5 km^2 (15.78%), el bosque de pino con 1,244.75 km^2 (11.99%). Existe un área abierta a la

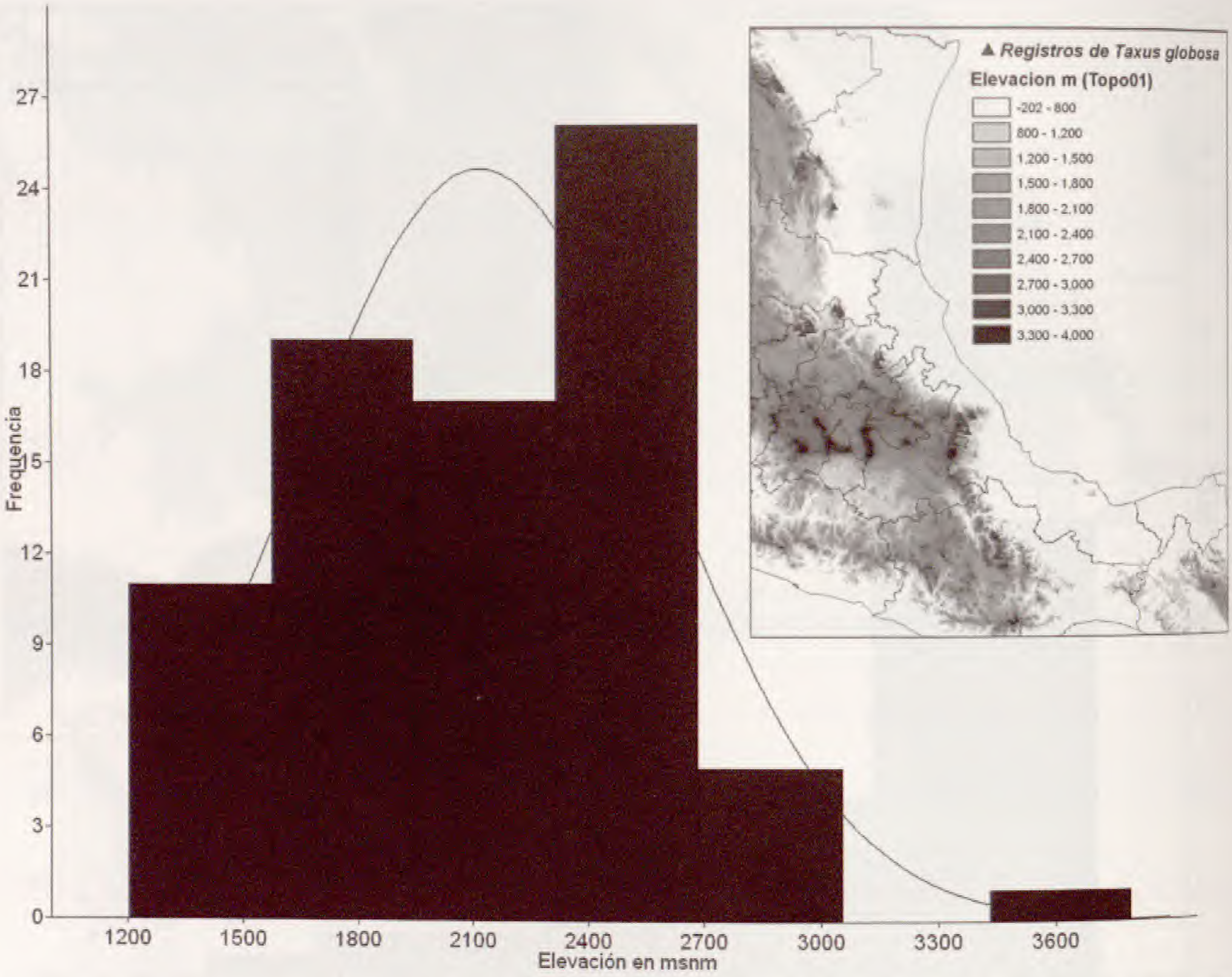

Fig. 6. Mapa de la distribución de 79 registros de *Taxus globosa* en relación con la variable ambiental Topo01 (elevación en msnm).

agricultura de temporal de 1,031.53 km^2 (9.93%), el bosque mesófilo de montaña con 1,027.12 km^2 (9.89%), el bosque de encino con 10,016 km^2 (9.78%), ver Cuadro 5.

En un análisis de distribución posterior de la superficie generada de hábitat potencial (0.8–1.0) para *T. globosa* de acuerdo al modelo BIOCLIM+Topografía, los estados con mayor superficie potencial son: Hidalgo, Nuevo León, Veracruz, Puebla y Tamaulipas. En el percentil de mayor probabilidad (0.9–1.0) los estados de Veracruz (474.5 km^2), Puebla (401.3 km^2), Hidalgo (329.9 km^2) y Nuevo León (310.1 km^2) son los que tienen mayor superficie. En el percentil medio (0.8–0.9) los estados de Hidalgo (1,935.95 km^2), Nuevo León (1,775 km^2), Veracruz (1,342 km^2), Puebla (1,258 km^2) y Tamaulipas (1,173 km^2) son los que tienen más superficie (Cuadro 6).

CONCLUSIONES

Los modelos desarrollados en MaxEnt para obtener distribución potencial para *Taxus globosa* en México, advierten un área muy reducida, con una superficie entre los 9,650 km^2 (BIOCLIM) y los 10,385 km^2 (BIOCLIM+Topografía) que representan entre el 0.49% al 0.52% del territorio nacional.

El modelo BIOCLIM (19 variables climáticas) resulta tener el mejor porcentaje de precisión global en el percentil de probabilidad (0.8–0.9) de presencia de hábitat potencial para *Taxus globosa* en México.

Para el percentil de mayor probabilidad de presencia de la especie (0.9–1.0), el modelo BIOCLIM+Topografía resultó ser más preciso con el 55% en la prueba de validación. La variable de pendiente es de mayor influencia en el modelado de hábitat potencial, seguida por Bio14 (precipitación del mes más seco).

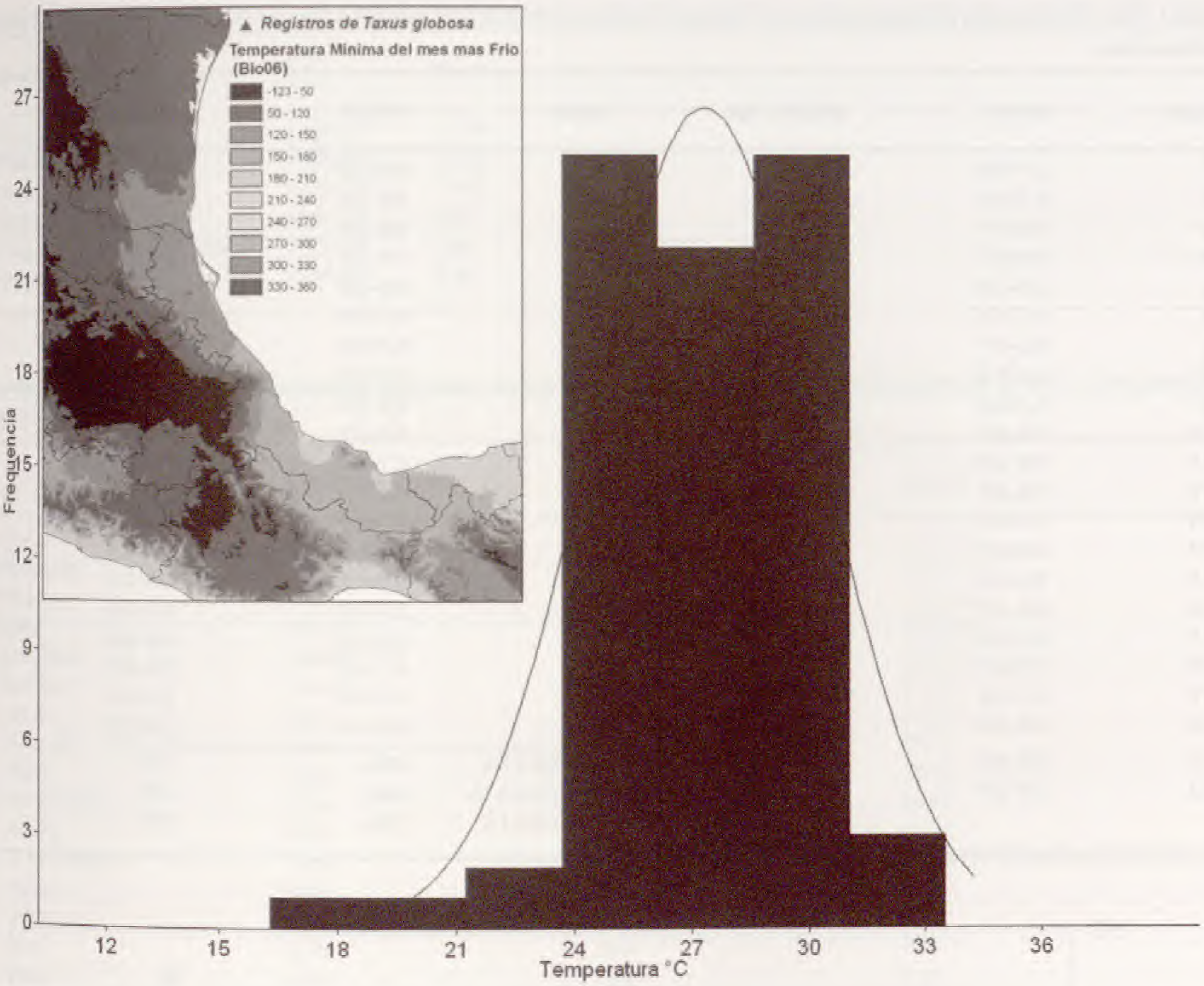

Fig. 7. Mapa de la distribución de 79 registros de *Taxus globosa* en relación con la variable ambiental Bio06 (temperatura mínima del mes más frío).

Cuadro 3. Análisis de superficie y porcentaje por deciles de probabilidad del hábitat potencial de *Taxus globosa* en México para los modelos BIOCLIM y BioClim + Topografía.

BioClim		BIOCLIM+Topografía		
Percentil de probabilidad	**km²**	**Porcentaje**	**km²**	**Porcentaje**
0-0-0.1	1,843,243.20	92.891	1,828,028.46	92.124
0.1-0.2	56,857.47	2.865	62,255.25	3.137
0.2-0.3	23,614.17	1.190	27,856.23	1.404
0.3-0.4	13,427.17	0.677	16,507.72	0.832
0.4-0.5	10,439.67	0.526	11,496.47	0.579
0.5-0.6	8,558.69	0.431	9,701.42	0.489
0.6-0.7	8,093.88	0.408	9,242.83	0.466
0.7-0.8	10,430.58	0.526	8,841.54	0.446
0.8-0.9	9,299.38	0.469	8,580.94	0.432
0.9-1.0	350.91	0.018	1,804.31	0.091

La ubicación del hábitat potencial de *Taxus globosa* en zonas de montaña correspondientes al bosque de coníferas indica que el hábitat presenta una baja tasa de cambio de temperatura por efecto global, así como una amplitud en tiempo de residencia de este hábitat.

Los tipos de vegetación que se ubican en el hábitat potencial de los últimos dos percentiles de probabilidad (0.8–1.0) son bosque de pino-encino, bosque de encino-pino, bosque de pino y bosque mesófilo de montaña,

Cuadro 4. Valores de probabilidad de hábitat potencial (0.1–1.0) para 42 registros de *Taxus globosa* usados en el modelado y los valores de precisión > 70% en cada modelado.

Registro	BIOCLIM	BIOCLIM + Topo
1	0.7–0.8	0.7–0.8
2	0.4–0.5	0.5–0.6
3	0.6–0.7	0.3–0.4
4	0.6–0.7	0.6–0.7
5	0.4–0.5	0.5–0.6
6	0.7–0.8	0.8–0.9
7	0.6–0.7	0.7–0.8
8	0.7–0.8	0.8–0.9
9	0.7–0.8	0.8–0.9
10	0.4–0.5	0.5–0.6
11	0.8–0.9	0.9–1.0
12	0.8–0.9	0.8–0.9
13	0.8–0.9	0.9–1.0
14	0.8–0.9	0.9–1.0
15	0.8–0.9	0.8–0.9
16	0.9–1.0	0.9–1.0
17	0.7–0.8	0.5–0.6
18	0.6–0.7	0.3–0.4
19	0.7–0.8	0.6–0.7
20	0.8–0.9	0.9–1.0
21	0.8–0.9	0.8–0.9
22	0.8–0.9	0.8–0.9
23	0.8–0.9	0.8–0.9
24	0.8–0.9	0.8–0.9
25	0.8–0.9	0.9–1.0
26	0.8–0.9	0.8–0.9
27	0.8–0.9	0.9–1.0
28	0.7–0.8	0.6–0.7
29	0.7–0.8	0.6–0.7
30	0.7–0.8	0.7–0.8
31	0.6–0.7	0.6–0.7
32	0.8–0.9	0.7–0.8
33	0.7–0.8	0.8–0.9
34	0.2–0.3	0.3–0.4
35	0.8–0.9	0.9–1.0
36	0.8–0.9	0.8–0.9
37	0.8–0.9	0.8–0.9
38	0.7–0.8	0.7–0.8
39	0.8–0.9	0.8–0.9
40	0.7–0.8	0.6–0.7
41	0.7–0.8	0.2–0.3
42	0.8–0.9	0.8–0.9
Prob. 0.8 a 0.9	45%	36%
Prob. 0.9 a 0.10	36%	19%
Prob. 0.8 a 1.0	52%	55%

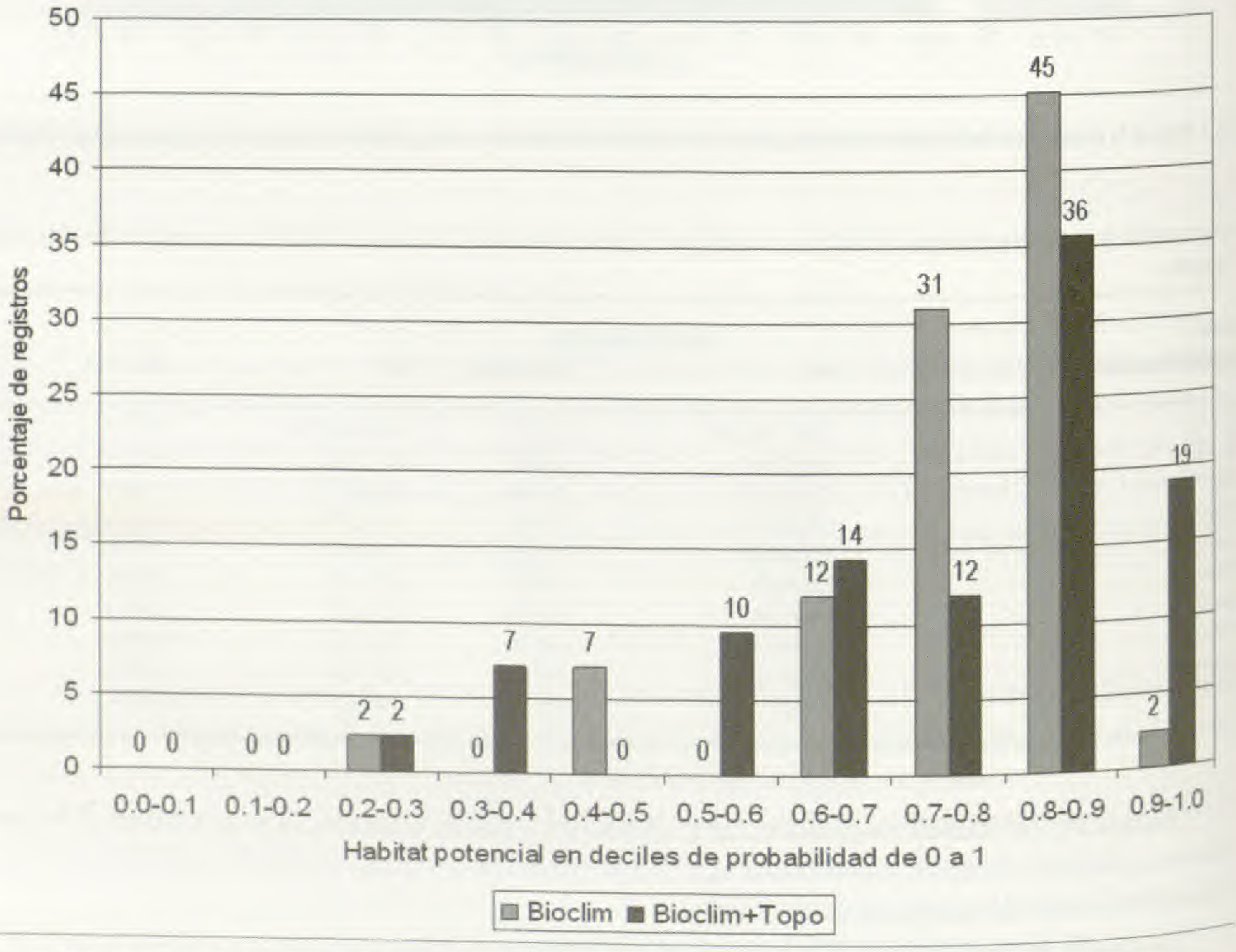

Fig. 8. Porcentaje de registros en hábitat potencial para *Taxus globosa* con los modelos generados en MaxEnt: BIOCLIM y BIOCLIM +Topografía.

Cuadro 5. Distribución de la superficie generada de hábitat potencial para *Taxus globosa* (0.8–1.0) con base en el mapa uso del suelo y vegetación (INEGI, 2005).

Tipo de vegetación	Km^2	Porcentaje
Bosque de pino-encino	2,230.25	21.48
Bosque de encino-pino	1,638.51	15.78
Bosque de pino	1,244.75	11.99
Agricultura de temporal	1,031.53	9.93
Bosque mesófilo de montaña	1,027.12	9.89
Bosque de encino	1,016.09	9.78

Cuadro 6. Superficies (km^2) de hábitat potencial para *Taxus globosa* (km^2) de los principales estados en México en los percentiles 0.8–0.9 y 0.9–1.0 de probabilidad según el modelado BIOCLIM+Topografía.

	Probabilidad 0.9–1.0	Probabilidad 0.8–0.9	Suma km^2
Hidalgo	329.92	1,935.95	2,265.87
Nuevo León	310.15	1,775.02	2,085.17
Veracruz	474.52	1,341.83	1,816.35
Puebla	401.30	1,257.94	1,659.24
Tamaulipas	109.83	1,173.30	1,283.13
Querétaro	115.20	556.02	671.22
Oaxaca	0.00	229.28	229.28
Guanajuato	10.15	80.37	90.52
Chiapas	0.00	75.66	75.66
San Luis Potosí	8.54	57.35	65.89
Coahuila	0.00	62.60	62.60
Edo. de México	32.69	26.19	58.88
Tlaxcala	4.48	4.20	8.68
Morelos	6.66	0.98	7.64
Jalisco	0.70	2.95	3.65
Colima	0.11	0.29	0.40
	1,804	8,579	10,384

existiendo para el 2005 una área abierta a la agricultura de 1,027 km^2 que representa casi un 10% de éste hábitat potencial en México.

De acuerdo al análisis MaxEnt utilizando las 19 cubiertas geográficas BIOCLIM y tres topográficas, los estados de Hidalgo, Nuevo León, Veracruz, Puebla y Tamaulipas poseen mayor superficie donde se puede distribuir *Taxus globosa* en México.

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DISTRIBUTION AND MORPHOLOGICAL CHARACTERISTICS OF *ARCEUTHOBIUM HONDURENSE* AND *A. NIGRUM* (VISCACEAE) IN MEXICO

Robert L. Mathiasen
School of Forestry
Northern Arizona University
Flagstaff, Arizona 86011 U.S.A.
Robert.Mathiasen@nau.edu

Shawn C. Kenaley
Department of Plant Pathology
and Plant-Microbe Biology
Cornell University
Ithaca, New York 14853 U.S.A.
sck26@cornell.edu

Brian P. Reif
School of Forestry
Northern Arizona University
Flagstaff, Arizona 86011 U.S.A.
Brian.Reif@nau.edu

ABSTRACT

The geographic and host distributions of *Arceuthobium hondurense* and *A. nigrum* (Viscaceae) in southern Mexico and Central America have remained unclear due to difficulties in their identification. This study was conducted to clarify the morphology, phenology, distribution, and host affinities of these dwarf mistletoes. Morphological measurements were made for these species across their geographic distributions and nr ITS sequences were generated and compared from selected populations in Mexico. Although subtle, interspecific differences in plant morphology were found, *A. hondurense* and *A. nigrum* can be differentiated by the dimensions of their staminate spikes, staminate flowers, and fruits. Our data also indicated that *A. hondurense* and *A. nigrum* were not sympatric. *Arceuthobium hondurense* is distributed from northern Nicaragua to northern Oaxaca, Mexico and *A. nigrum* is distributed from Veracruz to northern Durango. Although *A. hondurense* and *A. nigrum* flowered in the fall, *A. hondurense* consistently peaked in September and *A. nigrum* peaked in October, extending into January in central Mexico. A spring flowering period reported previously for *A. nigrum* was not observed. Additional information on the host distribution and molecular differences of these dwarf mistletoes is also presented.

Key Words: *Arceuthobium hondurense, Arceuthobium nigrum*, dwarf mistletoe, geography, hosts, ITS, molecular identification, parasitic plants

RESUMEN

La distribución geográfica de *Arceuthobium hondurense* y *A. nigrum* (Viscaceae) y de sus hospedadores en México y Centro América son inciertas debido a los problemas en su identificación. En este trabajo, se estudió la morfología, fenología, distribución y afinidades de hospedadores de estas dos especies de muérdagos enanos. Las mediciones morfológicas fueron hechas de poblaciones Mexicanas para ambas especies y se generaron y compararon secuencias de nr ITS. Aunque ligeras, existen diferencias interespecíficas en la morfología de las plantas, *A. hondurense* y *A. nigrum* se pueden distinguir por las dimensiones de las espigas estaminadas, flores y frutos. Nuestros datos indican que estas especies no se solapan en su distribución geográfica. *Arceuthobium hondurense* se distribuye desde el norte de Nicaragua hasta el norte de Oaxaca, México, mientras que *A. nigrum* se distribuye desde Veracruz hasta el norte de Durango, México. Aunque las dos especies florecen en el otoño, *A. hondurense* tiene su pico de floración en Septiembre y *A. nigrum* tiene su pico de floración en Octubre, extendiéndose hasta Enero en el Centro de México. El periodo de floración que fue reportado previamente para *A. nigrum* en la primavera no fue observado para esta especie. Se presenta información adicional sobre los hospedadores y sobre las diferencias moleculares entre estas especies de muérdago enano.

Palabras Clave: *Arceuthobium hondurense, Arceuthobium nigrum*, dwarf mistletoe, geography, hosts, ITS, molecular identification, parasitic plants

The genus *Arceuthobium* (Santalales: Viscaceae) consists of 42 species (Hawksworth & Wiens 1996) that are aerial parasites of Pinaceae or Cupressaceae. Many of the species, commonly known as dwarf mistletoes, are recognized as serious forest pathogens (Hawksworth & Wiens 1996; Mathiasen et al. 2008). Morphological characters consistent throughout the genus include small flowers produced on male and female plants, leaves reduced to squamate scales, and morphologically similar bi-colored fruits (Hawksworth & Wiens 1996). The genus has long been considered a taxonomically difficult group because of the extreme morphological reduction associated with the parasitic habit and the morphological similarities between species (Hawksworth & Wiens 1996). Factors that complicate classification and identification include a large amount of variation in morphology and geographic distributions as well as flowering periods that occasionally overlap. Two species that exemplify the problems associated with field identification of morphologically similar dwarf mistletoes occur in southern and central Mexico: *Arceuthobium hondurense* Hawksw. & Wiens (Honduran dwarf mistletoe) and *A. nigrum* Hawksw. & Wiens (black dwarf mistletoe).

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Arceuthobium hondurense was originally described from central Honduras (Hawksworth & Wiens 1970) and thought to be extremely rare, even on the verge of extinction due to rapid and extensive harvesting of its pine hosts (Hawksworth & Wiens 1972). However, Honduran dwarf mistletoe was later found to occur from northern Nicaragua, through much of Honduras into Chiapas, Mexico and as far north as central Oaxaca (Mathiasen et al. 2001; Mathiasen et al. 2002a; Mathiasen et al. 2003; Mathiasen et al. 2006; Mathiasen & Melgar 2006). Although it likely occurs in Guatemala, *A. hondurense* has never been confirmed there (Hawksworth & Wiens 1977; Mathiasen et al. 2003). Another dwarf mistletoe, originally described as *A. hawksworthii* Wiens and C.G. Shaw (Hawksworth's dwarf mistletoe), was recombined as a subspecies of *A. hondurense* (Mathiasen 2007). Therefore, *A. hondurense* presently consists of two subspecies: *A. hondurense* subsp. *hondurense* which occurs from Nicaragua north to Oaxaca, Mexico (Mathiasen et al. 2010) and *A. hondurense* subsp. *hawksworthii* (Wiens & C.G. Shaw) Mathiasen which is primarily distributed in the Mountain Pine Ridge area of Belize (Mathiasen 2007), but also has been reported from central Honduras (Mathiasen et al. 2002b).

Because plants of *Arceuthobium hondurense* subsp. *hondurense* (hereafter referred to as *A. hondurense*) are similar in size and color to those of *A. nigrum*, determining the geographic distribution of these species in southern Mexico has been difficult (Hawksworth & Wiens 1989, 1996; Mathiasen et al. 2001, 2002a, 2003, 2010). Although *A. nigrum* was thought to be distributed from northern Durango, Mexico into southern Mexico (Hawksworth & Wiens 1996), it is now thought to be distributed only as far south as central Mexico (Mathiasen et al. 2010). Further, both *A. hondurense* and *A. nigrum* produce red flowers that bloom in the fall. We have collected additional morphological data for *A. hondurense* and *A. nigrum* since 1998. Here we report our findings and discuss the distribution of these dwarf mistletoes in Mexico based on our field observations and morphological measurements. Because prior studies (Mathiasen et al. 2003; Nickrent et al. 2004) have successfully used ribosomal DNA (rDNA) sequence information to discriminate between *A. hondurense* and *A. nigrum*, we conducted additional analyses of the internal transcribed spacer (ITS) region for several populations of both species, particularly populations in central Mexico where these species may be sympatric (Nickrent et al. 2004). In addition, because *A. vaginatum* (Willd.) Presl subsp. *vaginatum* (Mexican dwarf mistletoe) is also morphologically similar to *A. hondurense* as well as *A. nigrum*, and often confused with them, we have provided information on how to distinguish these species from *A. vaginatum*. The primary objective of this study, however, was to provide additional data on how to discriminate *A. hondurense* from *A. nigrum*—and vice versa—and in so doing, better determine their geographic and host ranges. Morphological data and ITS sequences for *A. vaginatum* were taken from Hawksworth and Wiens (1996) and obtained from GenBank, respectively.

MATERIALS AND METHODS

Morphology and Phenology

To compare morphological characters we sampled 16 populations of *Arceuthobium hondurense* (two from Oaxaca, Mexico, one from Nicaragua, and 13 from previous work by Mathiasen (2007)) and 14 populations of *A. nigrum* from throughout its geographic range (Fig. 1). Plants were measured from the type locality for both mistletoe species (Hawksworth & Wiens 1965, 1970, 1977) (Fig. 1; locations 6 and 23). From each population, 10–20 male and 10–20 female plants were collected and the dominant shoot from each infection was used for morphological measurements. Characters measured were those used by Hawksworth and Wiens (1996) for taxonomic classification of *Arceuthobium*: height, basal diameter, third internode length and width, and color of male and female plants; mature fruit length, width, and color; seed length, width and color; length and width of staminate spikes; staminate flower diameters for 3- and 4-merous flowers; length and width of staminate flower petals; and, anther diameter and anther distance from the petal tip. Plants were measured within 24 hours after collection using a digital caliper and a Bausch and Lomb 7X hand lens equipped with a micrometer. Staminate spike and flower measurements were made during the peak of anthesis and fruit and seed measurements were made during the peak of seed dispersal. One-way analysis of variance (ANOVA) was used to examine the variance in the above characters for *A. hondurense* and *A. nigrum* and significant differences between means were determined using a Tukey's honestly significant difference (HSD) post-hoc test ($\alpha = 0.05$). All statistical analyses were performed using JMP 8.0.2 software (SAS Institute, Cary, NC).

FIG. 1. Approximate locations of populations sampled for *Arceuthobium hondurense* subsp. *hondurense* (open circles) in Honduras and Mexico and *A nigrum* (dark circles) in Mexico. Populations that are not numbered are locations reported in Hawksworth and Wiens (1996). Plant material from locations in bold were used to obtain nuclear ribosomal DNA internal transcribed spacer sequences for *A. hondurense* and *A. nigrum* (Fig. 2). *Arceuthobium hondurense*: HONDURAS. Department Cortes: **1** – Cusuco National Park; Department Lempira: **2** – Celaque National Park; Department Francisco Morazan: **3 – Lepaterique [RLM0136]**; **4** – La Estancia; **5** – Tatumbla; **6 – 22 km SE of Tegucigalpa on Pan American Hwy [RLM98107]**; **7** – 2 km S of Valle de Angeles; **8** – 7.5 km S of Valle de Angeles; Department El Paraiso: **9** – San Lucas. NICARAGUA. Nueva Segovia. **10** – Mozonte. MEXICO. **11** – Chiapas: San Cristobal de las Casas; **12** – Oxchuc; Oaxaca: **13 – 32 km E of Ixtlan [RLM0994]**; **14 – 15 km E of Oaxaca City [RLM0993]**; **15 – Suchixtepec [RLM0998]**; **16 – 21 km NE of Teotitlan [RLM1086]**.—*Arceuthobium nigrum*: MEXICO. Veracruz: **17 – Cofre de Perote [RLM0764]**; **18 – 3 km S of Sierra de Aqua [RLM1082]**; Puebla: **19** – Los Hermanos; **20** – Tetla de Ocampo; Hidalgo: **21** – Los Duraznos; **22** – Metepec; Durango: **23 – 50 km E of El Salto [RLM0778]**; **24 – 11 km E of El Salto [RLM0779]**; **25 – 3 km E of El Salto [RLM1105]**; **26 – 23 km N of Route 40 on road to San Miguel de Cruces [RLM0781]**; **27** – 102 km N of Route 40 on road to San Miguel de Cruces; **28** – Otinapa; **29** – 30 km W of Santiago Papasquiaro; **30** – 18 km W of Tepehuanes.

Because the times of flowering and seed dispersal for *Arceuthobium hondurense* and *A. nigrum* are poorly known (Hawksworth & Wiens 1996), additional observations of the phenology of these taxa were made during the spring and fall of 1999, 2003, 2005, 2007, 2008, and 2010 as well as during the early spring of 2011.

DNA Extraction and ITS Sequencing

Samples of DNA were obtained from five and six specimens, each representing a geographically separate population, of *Arceuthobium hondurense* and *A. nigrum*, respectively. Locality and voucher number for each specimen (bold print) are presented in Fig. 1. For each specimen, total DNA was extracted using the DNeasy™ Plant Mini Kit (Qiagen, Valencia, CA) according to the manufacturer's instructions. DNA purity and concentration were quantified for each sample using a NanoDrop ND-1000 (Thermo Fischer Scientific, Wilmington, DE). Full-length, ITS sequences (comprising ITS1, 5.8S rDNA gene, and ITS2) were PCR-amplified using the primer pair 18S 1830for and 26S 40rev (Nickrent et al. 2004). PCR amplifications were carried out in 25 μL reaction mixtures containing 12.5 μL of 2X AmpliTaq Gold® Master Mix (Applied Biosystems, Foster City, CA), 0.5 μL of each 20 μM primer, 11.25 μL nuclease-free water, and ~2–18 ng (0.25 μL of 8–78 ng/μL) of genomic DNA.

PCRs were performed in an Eppendorf Mastercycler® pro thermal cycler (Eppendorf, Westbury, NY) with the following cycling parameters: initial hold for 6 min. at 95°C; 5 cycles at 94°C for 30s, 55°C for 30s, and 72°C for 1 min.; 33 cycles at 94°C for 30s, 48°C for 30s, and 72°C for 1 min.; and, a final extension step of 72°C for 10 min. Blank reactions (i.e., minus genomic DNA) were run concomitantly to check for contamination of the reagents.

The size of each PCR product (bp) was checked separately by ultraviolet fluorescence after 1.2% agarose gel electrophoresis in 0.5x TAE buffer and staining with GelRed™ (Phenix Research Products, Candler, NC). Amplification products were purified directly from reactions using ExoSAP-IT (0.4 µL per µL of reaction product; USB Inc., Cleveland, OH) and normalized to 130 ng per sequencing reaction. Sequencing was carried out using a BigDye terminators DNA sequencing kit (Applied Biosystems), ABI 3730 DNA sequencer, and the above forward and reverse primers. PCR products were sequenced in both directions. Sequences were proofread and assembled in CodonCode Aligner (CodonCode Corporation, Dedham, MA). Boundaries to the 5′- and 3′-region of ITS1 and ITS2, respectively, were previously identified by Nickrent et al. (1994). ITS sequences for *A. hondurense* (n=5) and *A. nigrum* (n=6) produced in this study were deposited in GenBank.

Phylogenetic Analysis

ITS sequences for *Arceuthobium hondurense* and *A. nigrum* obtained in this study and from GenBank (*A. hondurense* AY2888263 and *A. nigrum* AY288271) as well as *A. vaginatum* subsp. *vaginatum* (AY288286 and AY288287) and *A. douglasii* Engelmann (L25687; outgroup) were included in the dataset. Sequences were aligned using ClustalX ver. 2 (Larkin et al. 2007) and visually edited as necessary in CodonCodon Aligner. Maximum Likelihood (ML) trees were constructed using PAUP* 4.0b10 (Swofford 2003). The DNA substitution model TIM2 and the parameter estimates for tree reconstruction were determined using the Akaike Information Criterion (AIC; Akaike 1974) as implemented in jModelTest 0.1.1 (Posada 2008). All nucleotides were included in the phylogenetic analysis; gaps were treated as missing characters. Heuristic searches were performed with 200 replicates of random sequence addition and tree bisection-reconnection (TBR) branch swapping. Branch support was evaluated using 1000 bootstrap replicates and 10 random additions of sequences per pseudo-replicate. Inter- and intraspecific genetic distances were also examined using Kimura's two-parameter model (K2P; Kimura 1980) for base substitution as implemented in PAUP*.

Bayesian analysis was also performed using MrBayes 3.1.2 (Huelsenbeck & Ronquist 2001). The best-fit model for DNA substitution was determined as described previously; however, Hasegawa-Kishino-Yano (HKY; Hasegawa et al. 1985) model and parameter estimates were determined using the Bayesian Information Criterion (BIC; Schwarz 1978). One cold and three heated Markov chain(s) were run, and samples were taken every 100 generations over 5.0×10^6 generations. The potential scale reduction factor (PSRF) for each of the model parameters was > 1.0 when the program was terminated. Stationarity was accessed by examining the average standard deviations of split frequencies and likelihood values. Burn-in value (10%) was determined using Tracer v1.5 (Rambaut & Drummond 2009). The remaining trees were used to calculate a 50% majority rule consensus tree and to determine the posterior probabilities.

RESULTS AND DISCUSSION

Arceuthobium hondurense

Our measurements of *Arceuthobium hondurense* indicate it forms larger plants than previously reported by Hawksworth and Wiens (1970, 1996); they reported plant heights averaged approximately 14 cm with a maximum height of 21 cm, but we measured plants (male and female combined) that averaged 22 cm. We found some male plants in Chiapas, Mexico that were over 65 cm in height (Table 1). The discrepancy in maximum heights is probably related to Hawksworth and Wiens only measuring specimens from central Honduras where plants were generally smaller than in southern Mexico (Mathiasen et al. 1999; Mathiasen 2007). The mean basal diameter of dominant shoots was the same as reported by Hawksworth and Wiens (1996); approximately 5 mm. However, we measured some shoots with basal diameters of nearly 13 mm, while Hawksworth and Wiens (1996) only reported a maximum of 9 mm for this character. The means and ranges for most of the remaining morphological characters were similar to those previously reported (Hawksworth & Wiens

Table 1. Morphological measurements for *Arceuthobium hondurense* and *A. nigrum*. Data are listed as mean (range) [n]. Means followed by different capital letters in the same row were significantly different using a Tukey's HSD post-hoc test (α = 0.05). Lower case letters in brackets indicate sample sizes already listed in the same column. Plant heights in cm and all other measurements in mm.

Character	A. hondurense	A. nigrum
Plant Height		
Male	24.9 A (11.5–66.4) [160 a]	24.3 A (10.3–53.5) [130 a]
Female	18.6 A (9.1–33.1) [a]	19.6 A (9.3–37.2) [a]
Basal Diameter		
Male	5.1 A (2.8–13.4) [a]	7.0 B (4.4–12.5) [a]
Female	5.4 A (2.8–12.8) [a]	7.8 B (4.1–13.1) [a]
Length of Third Internode		
Male	16.1 A (6.6–34.0) [a]	16.8 A (11.6–28.7) [a]
Female	13.8 A (6.3–32.0) [a]	16.5 B (11.8–31.8) [a]
Width of Third Internode		
Male	3.8 A (2.0–8.0) [a]	4.9 B (4.0–7.8) [a]
Female	4.0 A (2.0–10.0) [a]	5.5 B (4.4–9.6) [a]
Staminate Spike Length	14.3 A (6.1–17.9)[120 b]	20.6 B (8.1–33.3) [200 b]
Staminate Spike Width	1.7 A (1.3–2.4) [b]	2.9 B (2.4–3.3) [b]
Mean Flower Diameter		
3-merous	2.5 A (2.0–3.0) [80]	3.2 B (2.7–4.0) [100 c]
4-merous	3.1 A (2.8–3.4) [40]	4.8 B (3.6–5.4) [c]
Petal Length	1.3 A (1.0–1.6) [b]	1.7 B (1.3–2.3) [b]
Petal Width	1.2 A (0.8–1.4) [b]	1.4 B (0.8–1.9) [b]
Anther Diameter	0.5 A (0.4–0.6) [b]	0.8 B (0.5–1.1) [b]
Anther Distance from Tip	0.3 A (0.2–0.6) [b]	0.5 B (0.3–0.6) [b]
Fruit Length	5.3 A (5.0–6.0) [100 c]	6.9 B (5.2–8.8) [c]
Fruit Width	3.4 A (2.8–4.2) [c]	4.1 B (3.4–5.0) [c]
Seed Length	3.1 A (2.8–3.5) [c]	3.1 A (2.7–3.9) [c]
Seed Width	1.5 A (1.3–1.7) [c]	1.5 A (1.3–1.9) [c]

1970, 1996) with two exceptions: the fruits and petals. The means for each of these characters were greater than that found by Hawksworth and Wiens (1996). The means for male and female plant heights, the third internode length of male plants, and seed length and width were not significantly different, but the means of the remaining characters we measured (e.g., width of the third internode and staminate spike length and width) were significantly different between *A. hondurense* and *A. nigrum* (Table 1). Our measurements of 4-merous flower diameters of *A. hondurense* (n=40) were the first reported for this character.

An important and consistent character exhibited by *Arceuthobium hondurense* was the dark red surface of the adaxial side of petals reported by Hawksworth and Wiens (1970, 1996), which was characteristic of this species throughout its geographic range. Another characteristic of *A. hondurense* that we observed, and reported by Hawksworth and Wiens (1970, 1996), was that the lower nodes of older plants were often swollen and round, this was particularly evident on old, male plants. Hawksworth and Wiens (1970) indicated that the stigmas on female flowers and fruits of *A. hondurense* were exserted as much as 0.5 mm. While we observed this character on many female plants, we also observed many flowers and fruits without exerted stigmas, suggesting that this characteristic was polymorphic for *A. hondurense*. Similarly, the nectary of *A. hondurense* was occasionally three-lobed as reported by Hawksworth and Wiens (1996), but again this characteristic was inconsistent.

Arceuthobium hondurense flowered from late August to November with its peak flowering period in mid- or late-September, dispersing seed at approximately the same time. This is consistent with what Hawksworth and Wiens (1996) reported, except we found that in some years it flowered well into November, which they did not observe.

Previously, Mathiasen et al. (2003) listed the pines parasitized by *Arceuthobium hondurense* in Central America and Chiapas, Mexico. Our observations support their findings, except that *A. hondurense* also parasitized *Pinus teocote* Schiede ex Schlechtendal & Chamisso in central Oaxaca. Although we have only observed *A. hondurense* infecting this pine in one location north of Ixtlan (Fig. 1, location 13), the level of infection (> 90%) indicated *Pinus teocote* was a principal host. This population was misidentified as *A. vaginatum* subsp. *vaginatum* by Hawksworth and Wiens (1996), as our morphological and ITS analyses indicated this population was indeed *A. hondurense*. Mistletoe plants on *P. teocote* at this location were dark brown to black, similar in color to *A. vaginatum*, but male plants flowered in the fall producing dark red flowers. Large male plants at this locality also had swollen nodes and parasitized *P. tecunumanii* Eguiluz et J. P. Perry, a principal host of *A. hondurense* elsewhere in southern Mexico (Mathiasen et al. 2003). In addition, *A. hondurense* was found parasitizing *P. lawsonii* Roezl ex Gordon & Glendining in central and northern Oaxaca. Although Hawksworth and Wiens (1977, 1996) reported *A. hondurense* (but identified as *A. nigrum*) parasitizing *Pinus oaxacana* Mirov and *P. patula* Schiede ex Schlechtendal & Chamisso in Chiapas, we did not observe these host-mistletoe combinations during our field work in southern Mexico.

Arceuthobium nigrum

Arceuthobium nigrum is morphologically very similar to *A. hondurense*. Both species produced relatively large, dark brown to black plants on their pine hosts (Hawksworth & Wiens 1996). Male and female plants of *A. nigrum* averaged nearly 25 and 18 cm in height, respectively, but were not significantly larger than *A. hondurense* (Table 1). It is difficult to compare our results for plant heights with those of Hawksworth and Wiens (1996) because they only provided a range of heights for *A. nigrum* (15–35 cm, maximum = 45 cm). However, the largest plant we measured for *A. nigrum* was a male over 53 cm tall from Puebla, Mexico. We also found that the basal diameter of shoots averaged two-mm larger (7.6 mm) than that previously reported (5 mm, Hawksworth & Wiens 1996) with a maximum basal diameter nearly twice that described by Hawksworth and Wiens. Measurements of the third internode widths also indicated that *A. nigrum* produced thicker plants (about 5 mm) than what Hawksworth and Wiens reported (about 4 mm). The means for the basal diameters of male (7 mm) and female plants (7.8 mm) and third internode widths of *A. nigrum* were significantly greater than those for *A. hondurense* (Table 1). Furthermore, the mean length of the third internode of female plants of *A. nigrum* (16.5 mm) was significantly longer than those of *A. hondurense* (13.8 mm), but not the mean length of the third internode of male plants.

The only flower characteristics Hawksworth and Wiens reported for *Arceuthobium nigrum* was the diameter of 3-merous flowers (3.5 mm), which was slightly larger than the mean diameter for the 3-merous flowers we measured (3.2 mm). Our observations indicated that *A. nigrum* commonly produced 4-merous flowers also, thus, we sampled these flowers and found they averaged nearly 5 mm in diameter (Table 1). Collectively, the mean diameters of 3 and 4-merous flowers of *A. nigrum* were significantly larger than those of *A. hondurense*. Petal sizes were also relatively large for *A. nigrum* when compared to other dwarf mistletoes (Hawksworth & Wiens 1996). We found petals longer than 2 mm and nearly as wide, both significantly larger than those for *A. hondurense* (Table 1). Another key characteristic of *A. nigrum* flowers that was consistent throughout its geographic range, was that the adaxial surface of its petals was dark red. While this characteristic was easily observed, and is similar to flowers for *A. hondurense*, a review of the literature (Hawksworth & Wiens 1989, 1996) on *A. nigrum* revealed that the petal color, as a diagnostic character, had never been mentioned before. The reasons for this omission remain unclear.

Fruits of *Arceuthobium nigrum* were remarkably glaucous and large compared to other dwarf mistletoes. The mean fruit length was nearly 7 mm, which is what Hawksworth and Wiens reported. However, we found fruits 8.8 mm in length compared to 9.0 mm by Hawksworth and Wiens (1996). In contrast, the average width of fruits we examined was larger (4.1 mm) than that reported by Hawksworth and Wiens (3.5 mm). We measured seeds that were shorter, but wider on average than those examined by Hawksworth and Wiens (1996). The means for fruit length and width of *A. nigrum* were significantly larger than those of *A. hondurense*, however, the mean length and width of seeds were similar for both species (Table 1).

The phenology of *A. nigrum* requires additional observations as we were unable to confirm the incidence of two flowering periods—one in March–April and one in September–October—as reported previously by Hawksworth and Wiens (1989, 1996). We examined male plants of *A. nigrum* at several localities in mid- to late-March during 2003, 2005, and 2007 as well as in early April 2011 and never observed open flowers. Furthermore, staminate flowers did not appear to be approaching anthesis in late March or early April. Our field observations, however, indicated that it flowers beginning in mid-September and continued into November in Durango, Mexico, while in central Mexico, *A. nigrum* flowers in late-September and continued into at least January. Peak flowering was in early October in Durango; however, the peak flowering period in central Mexico is still poorly understood. Seed dispersal initiated in early September and peaked in mid-October continuing to mid-November in Durango and elsewhere in central Mexico.

Our field observations of pines infected by *Arceuthobium nigrum* in Mexico did not reveal any additional hosts. The principal hosts of *A. nigrum* in Durango were clearly *Pinus leiophylla* Schiede ex Schlechtendal & Chamisso, *P. lumholtzii* B. L. Robinson & Fernald, *P. teocote*, and *P. chihuahuana* Engelmann as reported by Hawksworth and Wiens (1996). This mistletoe also been reported to rarely infect *P. arizonica* Engelmann and *P. cooperi* Blanco in northern Mexico (Hawksworth & Wiens 1996), but we have not observed it on these infrequent hosts. In central Mexico its principal host was *P. teocote*. *Pinus patula* Schlechtendal & Chamisso was a secondary host at several locations in Hidalgo and Puebla. While we agree with the classification of *P. pseudostrobus* Lindley as an occasional host of *A. nigrum* (Hawksworth & Wiens 1996), we were unable to verify whether *P. montezumae* A. B. Lambert was also an occasional host. Moreover, we did not observe any *P. montezumae* at the location where Hawksworth and Wiens reported an infestation of *A. nigrum* in Hidalgo nor in Veracruz where we found large, mistletoe-free *P. montezumae* growing near *P. teocote* severely-infected with *A. nigrum*. Therefore, the susceptibility of *P. montezumae* to *A. nigrum* needs further study. Although Hawksworth and Wiens (1989, 1996) reported that both *P. lawsonii* and *P. oaxacana* Mirov were principal hosts of *A. nigrum*, this host susceptibility classification was based on infection of these pines by *A. hondurense* in Oaxaca and Chiapas, respectively (Mathiasen et al. 2003).

DNA Analyses

DNA sequence analysis demonstrated that *Arceuthobium hondurense*, *A. nigrum*, and *A. vaginatum* occurred in three well supported clades (Fig. 2). All samples identified morphologically as *A. hondurense* and *A. nigrum* yielded a 627 and 623 bp fragment, respectively, consisting of the 3′end of the 18S (4 bp), complete ITS1-5.8S-ITS2 sequence (604 and 600 bp), and the 5′end of the 26S (19 bp). Four of five sequences for *A. hondurense* were identical (mean K2P value= 0.0017); however, RLM 98107 differed by an A/G nucleotide change at positions 22 and 40 in ITS1. Similarly, ITS sequences for *A. nigrum* were nearly identical (mean K2P value= 0.0018); except for A/T nucleotide changes at position 508 in ITS2. The alignment for phylogenetic analyses consisted of 649 characters including those of *A. douglasii* and *A. vaginatum*. Of these characters, 574 were constant, 50 were parsimony-informative, and 25 were parsimony-uninformative. The combined, ML and Bayesian consensus tree supported three distinct clades (Fig. 2) with bootstrap values ≥98% and posterior probability values equal to 1.00, respectively. Each plant identified according to morphometric data as *A. hondurense* or *A. nigrum* formed a distinct clade with either *A. hondurense* (RLM 0136, Nickrent et al. 2004) or *A. nigrum* (DLN 2019, Nickrent et al. 2004). Sequences of *A. nigrum* differed from those of *A. hondurense* and *A. vaginatum* by approximately 43 nucleotides (mean nucleotide difference = 43.07, mean K2P value= 0.0775). Likewise, the mean number of nucleotide changes between *A. hondurense* and *A. vaginatum* was 13.0 (mean K2P value= 0.0224).

Nickrent et al. (2004) reported that *A. hondurense* may occur in Veracruz based on molecular data (GenBank accession no. L25693; voucher DLN 2018), but our results did not support this. Plants collected south of Sierra de Aqua (RLM 1083), the approximate location where Nickrent collected DLN 2018 (D. Nickrent, pers. comm.), were morphologically similar to those of *A. nigrum*. As suspected, the ITS sequences generated from RLM 1083 were identical to L25693 (data not shown). However, in a separate phylogenetic analysis (data not shown), these collections/sequences were unrelated to *A. nigrum* (AY288271) as well as GenBank accessions of *A. durangense* Hawksw. & Wiens, *A. gillii* Hawksw. & Wiens, *A. hondurense*, and *A. vaginatum*. Nickrent previously

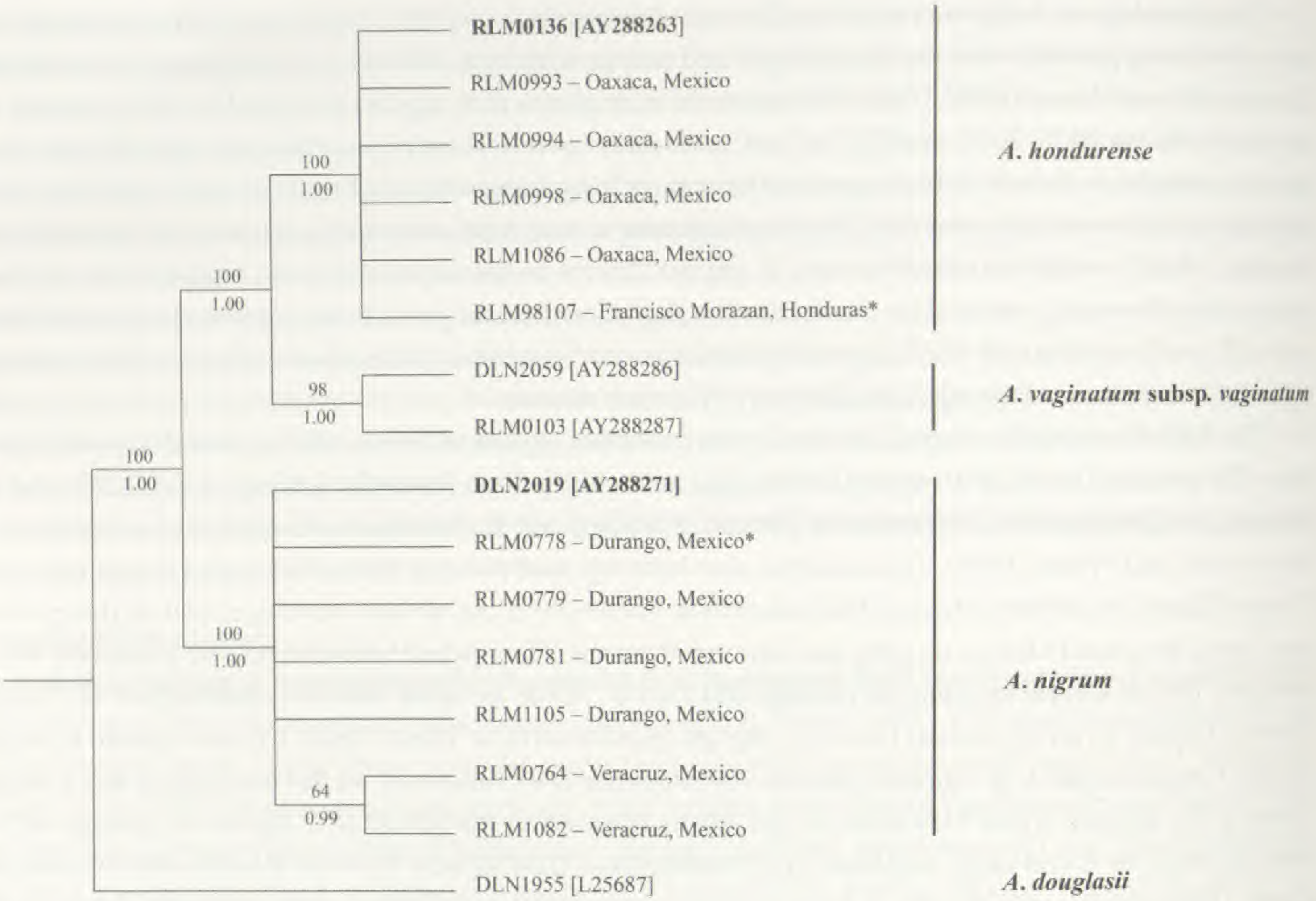

Fig. 2. Fifty-percent (50%) majority rule consensus tree based on maximum likelihood and Bayesian analyses using nuclear ITS sequences of *Arceuthobium nigrum, A. hondurense, A. vaginatum* subsp. *vaginatum,* and the outgroup taxon, *A. douglasii*. Representative sequences of *A. nigrum* and *A. hondurense* used in Nickrent et al. (2004) in bold. Sequences for *A. douglasii* and *A. vaginatum* ssp. *vaginatum* were obtained from GenBank ([ ] = accession number). Collector abbreviations are for Robert L. Mathiasen (RLM) and Daniel L. Nickrent (DLN) and precede assigned voucher numbers followed by locality (department/state – country; * = type locality). Numbers above branches indicate PAUP bootstrap values >60% (after 10^3 replicates), numbers below are Bayesian posterior probabilities >0.90 (after 5.0×10^6 generations).

Table 2. Principal morphological and physiological characteristics distinguishing *Arceuthobium hondurense, A. nigrum,* and *A. vaginatum* subsp. *vaginatum*. All measurements in mm and ranges in parentheses. Data for *A. vaginatum* from Hawksworth and Wiens (1996).

Character	A. hondurense	A. nigrum	A. vaginatum
Mean Basal Diameter [a]	5.3 (2.8–12.8)	7.4 (4.1–13.1)	7.0 (4–20)
Mean Width of Third Internode [a]	3.9 (2.0–8.0)	5.2 (4.0–9.6)	5.0 (2.8–8.5)
Swollen nodes at base of older plants	Yes	No	No
Staminate Spikes			
Secondary Branching	No	No	Yes
Mean Width	1.7 (1.3–2.4)	2.9 (2.4–3.3)	2.0 (1.5–2.5)
Mean Flower Diameter			
3-merous flowers	2.5 (2.0–3.0)	3.2 (2.7–4.0)	3.5 [b]
4-merous flowers	3.1 (2.8–3.4)	4.8 (3.6–5.4)	4.5 [b]
Red flowers	Yes	Yes	No
Mean Petal Length	1.3 (1.0–1.6)	1.7 (1.3–2.3)	1.6 [b]
Mean Petal Width	1.2 (0.8–1.4)	1.4 (0.8–1.9)	1.1 [b]
Mean Fruit Length	5.3 (5.2–6.0)	6.9 (5.2–8.8)	5.5 [b]
Mean Fruit Width	3.4 (3.1–4.2)	4.1 (3.4–5.0)	3.5 [b]
Anthesis	Aug–Nov	Sep–Jan	Mar–Apr
Seed Dispersal	Aug–Sep	Sep–Oct	Aug

[a] – Male and female plants combined.

[b] – No range provided in Hawksworth and Wiens (1996).

identified DLN 2018 (L25693) as either *A. vaginatum* (Nickrent et al. 1994) or *A. hondurense* (Nickrent et al. 2004). The species identity of this mistletoe (RLM 1083 and DLN 2018), therefore, remains unresolved and requires further study.

SUMMARY

Although *Arceuthobium hondurense*, *A. nigrum*, and *A. vaginatum* are morphologically similar and often difficult to distinguish from each other *in situ*, there are several diagnostic characteristics that can be used to identify them in central Mexico where they may be sympatric. Our results support the classification of these taxa as distinct species and the principal morphological and physiological characters that can be used to distinguish these species are summarized in Table 2. While the overall height of male and female plants and their color cannot be used to easily separate these species, *A. hondurense* is a more slender plant than both *A. nigrum* and *A. vaginatum*. It also has swollen, rounded nodes, particularly near the base of older plants. This characteristic is most evident on older, male plants. In contrast, *A. nigrum* and *A. vaginatum* lack swollen, rounded nodes near the base of plants.

Another key characteristic of *A. hondurense* that separates it from the other dwarf mistletoes is the width of its staminate spikes. While the length of staminate spikes often is too variable to be of any diagnostic value, the width of the staminate spikes of *A. hondurese* are thinner (mean 1.7 mm) compared to those of *A. nigrum* (2.9 mm) and *A. vaginatum* (2.0 mm). Furthermore, the staminate spikes of *A. nigrum* and *A. hondurense* generally do not form secondary branches, while those of *A. vaginatum* typically do.

Arceuthobium hondurense primarily forms 3-merous flowers, and occasionally 4-merous flowers, but *A. nigrum* and *A. vaginatum* commonly form both 3- and 4-merous flowers. Although the adaxial surface of petals of male flowers for *A. hondurense* and *A. nigrum* is distinctively dark red, the 3-merous flowers of *A. hondurense* are smaller (2.5 mm) on average than those of *A. nigrum* (3.5 mm). The color of male flower petals of *A. vaginatum*, however, is dark brown to green. While the fruits of both *A. hondurense* and *A. nigrum* are usually markedly glaucous, the fruits of *A. nigrum* are larger than those of *A. hondurense* as well as *A. vaginatum*. Additionally, *A. hondurense* and *A. nigrum* primarily flower from late August through September and October, but *A. vaginatum* flowers from March through April (Hawksworth & Wiens 1965, 1996). Additional observations of *A. nigrum* are still necessary to determine if it flowers in the spring as reported by Hawksworth and Wiens (1989, 1996). Our observations of *A. nigrum* over multiple seasons and years in Durango, Mexico, do not support a spring flowering period for *A. nigrum*. Furthermore, our analyses confirm that these species can be readily distinguished using ITS-rDNA sequences as previously demonstrated by Nickrent et al. (1994, 2004).

The host specificity of these mistletoes may help separate them, depending on the locality in Mexico. In Durango, *Arceuthobium nigrum* and *A. vaginatum* both parasitize *P. teocote*, but *P. teocote* is less susceptible to *A. vaginatum* (a secondary host) (Hawksworth & Wiens 1996). Moreover, *A. vaginatum* does not parasitize *P. leiophylla*, *P. lumholtzii*, nor *P. chihuahuana*, which are all highly susceptible to *A. nigrum*. In central Mexico, the principal host of *A. nigrum* is *P. teocote*, but *P. patula* is also infected by *A. vaginatum* there. Now that *A. hondurense* has been discovered severely infecting *P. teocote* in Oaxaca, Mexico, infection of this pine cannot be used to distinguish *A. nigrum* from *A. hondurense*, since these mistletoes both flower in the fall, have red flowers, and are similar in size and color. The width of internodes and staminate spikes, therefore, are likely the best characters for distinguishing between them. The size of 3-merous flowers, petals, and fruits will also assist in distinguishing *A. nigrum* (larger flowers and fruits) from *A. hondurense* (Table 2).

Based on our field observations and measurements of plant characteristics of the dwarf mistletoes in southern Mexico, we do not agree that *Arceuthobium nigrum* or *A. vaginatum* occur in Oaxaca or Chiapas. These species are primarily distributed along the Central Volcanic Cordillera of central Mexico and north into Durango. *Arceuthobium vaginatum* extends as far north as central Chihuahua in the Sierra Madre Occidental and as far north as southern Coahuila in the Sierra Madre Oriental (Hawksworth & Wiens 1996). However, the geographic distribution of *A. nigrum* is centered on the eastern side of the Central Cordillera and extends north into Durango (Fig. 1). *Arceuthobium vaginatum* is sympatric with *A. nigrum* in central Mexico (Hawksworth &

Wiens 1996) and since it also extends as far north as Chihuahua, it is probably sympatric with *A. nigrum* in Durango.

Honduran dwarf mistletoe, which was once thought to be near extinction (Hawksworth & Wiens 1972), is now known to be distributed from northern Nicaragua to northern Oaxaca, Mexico (Fig. 1). Our surveys in 2010 confirmed that *Arceuthobium hondurense* occurs in northern Oaxaca (Fig. 1, location 16), so we now know this species occurs almost to Veracruz and Puebla in central Mexico. Moreover, it has only been found in widely-scattered, small populations throughout its geographic range and therefore, should not be considered a common parasite of its pine hosts. It should also be noted that the reports of *A. nigrum* in Guatemala and El Salvador (Hawksworth & Wiens 1977, 1989, 1996) should be considered as reports of *A. hondurense*. In addition, since our results demonstrated that at least one of the populations of *A. vaginatum* from north-central Oaxaca was misidentified by Hawksworth and Wiens (1996) and is indeed *A. hondurense* (Fig. 1, location 13), we suspect the southern distribution of *A. vaginatum* only extends into Puebla and not Oaxaca. Further investigations, however, are warranted to assess whether *A. vaginatum* occurs in Oaxaca as several collections of this species have been made in the Sierra Juárez near Ixtlan. While all of these were classified as *A. vaginatum* by Hawksworth and Wiens (1996, page 370), we suspect these collections represent additional populations of *A. hondurense* in Oaxaca, but this needs to be confirmed.

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BOOK REVIEW

Alex George. 2011. **A Banksia Album: Two Hundred Years of Botanical Art.** (ISBN-13: 978-0-642-27739-8, pbk. flexbound). National Library of Australia, Canberra ACT 2600, Australia. (**Orders:** www.nla.gov.au/). $34.95, 128 pp., color throughout, 9¼" × 11¼".

This volume not only comes with a beautiful eye-catching cover, it captures the reader's attention with its introductory paragraph.

"The banksia illustrations chosen for this book are the work of botanical artists who are represented in the collections of the National Library of Australia. The images cover a period of nearly 240 years, beginning in 1770 with the art of Sydney Parkinson, who sailed on HM Bark *Endeavour* under Lieutenant James Cook, and ending in 2007 with two prints by Celia Rosser of *Banskia rosserae*, a species named in her honour. This introduction discusses the artists whose works appear in this publication."

The author provides a quick three page overview, entitled Biology and Ecology, also with three smaller pictures. This is extremely helpful for those of us who have never been fortunate enough to visit Australia. He also thoughtfully provides definitions of Type specimens, Species, Subspecies, and Variety. Occasionally, he adds additional helpful insights and comments

Page 15, entitled Banksia Album, lists the 29 species beautifully illustrated in the remainder of the volume.

Get comfortable, and be prepared to get lost in fascination of these species.—*Helen Jeude, Volunteer and Assistant Editor, Botanical Research Institute of Texas, 1700 University Dr., Fort Worth, Texas 76107-3400, U.S.A.*

TAXONOMIC HISTORY, REDISCOVERY, AND ASSESSMENT OF THREAT STATUS OF *STREBLUS ILICIFOLIUS* (MORACEAE) FROM INDIA

Bikarma Singh, Arun Chettri, Dibyendu Adhikari, and Saroj K. Barik[1]

Centre for Advanced Studies in Botany
School of Life Sciences
North - Eastern Hill University, Shillong 793 022, INDIA

ABSTRACT

Streblus ilicifolius (S. Vidal) Corner was reported first time in 1914 from Lushai Hills, the present day Mizoram state of India. For 96 years, this was the only known record for the species from India. In this paper, the rediscovery of *S. ilicifolius*—after a gap of nearly 100 years—is reported, and the report represents a state new record to the north-eastern state of Meghalaya. The collection history, taxonomic description with illustrations and distribution map, habitat characteristics, associated species, and threat status of the species are presented.

RESUMEN

Streblus ilicifolius (S. Vidal) Corner se citó por primera vez en 1914 de las Lushai Hills, actualmente estado de Mizoram de la India. Durante 96 años, este fue el único registro de la especie de la India. En este artículo se cita el redescubrimiento de *S. ilicifolius*—después de un intervalo de casi 100 años— y la cita es nueva para el estado nordestino de Meghalaya. Se presenta una historia de la colección, descripción taxonómica con ilustraciones y mapa de distribución, características del hábitat, especies asociadas, y estado de amenaza de la especies.

INTRODUCTION

The genus *Streblus* Lour. comprises 25 species (Mabberley 2008; Berg et al. 2006) distributed mostly in tropical and subtropical Asia (Haridasan & Rao 1987). In China, the genus is represented by seven species viz., *S. taxoides* (Roth) Kurz, *S. tonkinensis* (Dubard & Eberhardt) Corner, *S. asper* Lour., *S. indicus* (Bureau) Corner, *S. zeylanicus* (Thwaites) Kurz, *S. ilicifolius* (S. Vidal) Corner and S. *macrophyllus* Blume (Fu et al. 2003). There are four *Streblus* species in India viz., *S. asper*, *S. ilicifolius*, *S. zeylanicus*, and *S. indicus* (Haridasan & Rao 1987). Only two species viz., *S. asper* and *S. ilicifolius* were reported from north-eastern India by Kanjilal and Bor (1940). While *S. ilicifolius* was restricted only to one site in Lushai Hills, *S. asper* was reported to have more common occurrence in the former undivided province of Assam (Kanjilal & Bor 1940). Haridasan and Rao (1987) also reported the occurrence of *S. asper* from Baghmara in Garo Hills of Meghalaya.

Streblus ilicifolius (S.Vidal) Corner has not been collected and/or reported by any worker since its first report by U. Kanjilal in 1914 (ASSAM herbarium/Accession no. 28476, 28477 & 28478) from Lushai Hills in northeastern India under the name *Balanostreblus ilicifolia* Kurz. These accessions were renamed by G.K. Upadhaya in 2008 as *Streblus ilicifolius* (S. Vidal) Corner. The species has a very restricted occurrence, and is found only on calcareous habitat. The occurrence of *S. ilicifolius* in Meghalaya has been recorded and is reported for the first time, thereby extending the known distribution of the species in South-East Asia.

MATERIALS AND METHODS

During the floristic exploration of Nongtrai and its adjoining areas in Shella, Meghalaya, specimens of *Streblus ilicifolius* (Fig. 1A) were collected, processed, and housed in the ASSAM herbarium at Botanical Survey of India, Eastern Regional Circle, Shillong, Meghalaya. During the survey, the habitat conditions, associated species as well as biotic and abiotic pressures to which the species is exposed to were also recorded. Based on the population data, and habitat characteristics, the species was assessed for threat category following 2001 IUCN Red List Categories and Criteria version 3.1 (IUCN 2001) and Guidelines for Using the IUCN Red List Categories and Criteria (IUCN 2010).

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[1] Corresponding author: sarojkbarik@yahoo.com

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RESULTS

After critical observation of the newly collected specimens, and comparison with the existing herbarium specimens housed at ASSAM, and the original description, the identity of the species was confirmed as *Streblus ilicifolius* (S. Vidal) Corner. The location map and photographs of live and herbarium specimens of the species (Fig. 1) along with a line drawing (Fig. 2) are given.

TAXONOMIC TREATMENT

Streblus ilicifolius (S. Vidal) Corner, Gard. Bull. Singapore 19:227. 1962. *Taxotrophis ilicifolia* S. Vidal, Revis. Pl. Vasc. Filip. 249. 1886.

Taxotrophis obtusa Elmer, Leafl. Philipp. Bot. 5:813. 1913.
Taxotrophis triapiculata Gamble, Bull. Misc. Inform. Kew 1913. 188. 1913.
Taxotrophis aquifolioides W.C. Ko, Acta Phytotax. Sin. 8:353. 1963.
Balanostreblus ilicifolia Kurz, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 42:248. 1874.
Pseudotrophis laxiflora Warb., Bot. Jahrb. Syst. 13:295. 1891.

Bushy scandent spinous shrubs, 2.5–3 m tall, often gregarious in patches; dioecious; stems solitary, few branched, dark brown; bark grayish white, smooth, with latex; branchlets glabrous, divaricate or angular; spines straight, 1–2 cm long; stipules tapered, 0.4–0.5 cm long, caducous. Leaves mostly solitary, longer than broad; leaflets alternate, distichous, 1.4–5 cm long, 0.6–2.5 cm wide, elliptic to oblong-obovate, thickly leathery, the abaxial surface dark green, with cystoliths, the adaxial surface light green, glabrous and shiny, the margin loosely revolute, with 5 or more spiny teeth, the apex acute, blunt, with 2 or 3 spiny teeth, the base cuneate to decurrent; the midveins conspicuous on both sides and the abaxial surface prominent; the secondary veins pinnate, the abaxial surface inconspicuous, the adaxial surface slightly depressed; petioles 0.3–0.4 cm long, transversely verrucose. Male inflorescences axillary, cylindric catkin-like spikes, spicate, 0.5–1.2 cm; the bracts conspicuous, imbricate, margin dark. Female inflorescences shortly spicate, in pendent racemes, 2 to 6-flowered; the bracts minute. Male flowers: shortly pedicellate; perianth lobe 4, free, ± orbicular, margin inflexed and ciliate; pistillode 3.2-3.5 cm long, branched. Female flowers: perianth lobe 4, opposite, outer 2 smaller; ovary oblique, fleshy, glabrous. Fruits: drupes on brachyblasts, globose, 0.8-1.2 cm long, 0.8-1.1 cm wide, with persistent bracts, half enclosed by the persistent perianth lobes.

Habitat, Distribution, and Phenology.—The species was recorded at an elevation of 47.5 m a.s.l. in tropical forest of Phlangkaruh in Nongtrai area, Shella (Fig. 1). It grows in limestone areas, and on rocky substratum. The altitudinal distribution range of the species is 40–500 m a.s.l. The species is distributed in Meghalaya and Mizoram (Lushai Hills) in India, Bangladesh, China, Indonesia, Malaysia, Myanmar, Philippines, Thailand and Vietnam. The species flowers in March-April and fruits in May–June.

Voucher specimens: **INDIA. Meghalaya:** Nongtrai village in East Khasi Hills district, 25°11.171 N & 91°37.202 E, 30 Oct 2010, *Singh et al. 74965 & 74966* (ASSAM). Additional specimens examined: **INDIA. Mizoram:** Lushai Hills, Jul 1914, *Kanjilal 28478, 28476 & 28477* (ASSAM).

Threatened Status.—Not yet evaluated by IUCN. In spite of repeated search in the entire state of Meghalaya in 10 km × 10 km grids, only one population with 6 individuals of the species could be located in Nongtrai village. All the individuals in this locality were adults and were in fruiting stage. No seedling and sapling of the species was encountered, indicating poor regeneration of the species. One of the important features of the habitat of this species population was Karst topography. The main features of Karst topography are limestone terrain, and the absence of surface water flow. The species was classified from threat perspective based on population size, extent of occurrence, area of occupancy, and habitat quality (Table 1) following 2001 IUCN Red List Categories and Criteria version 3.1 (IUCN 2001). The species was classified as "Critically endangered" [CR A1. (a, b, c, d); B2. a, b (ii, iv, v); C2.a (i)].

DISCUSSION

With this new report of the species from Meghalaya, and rediscovery after nearly 100 years of its first report

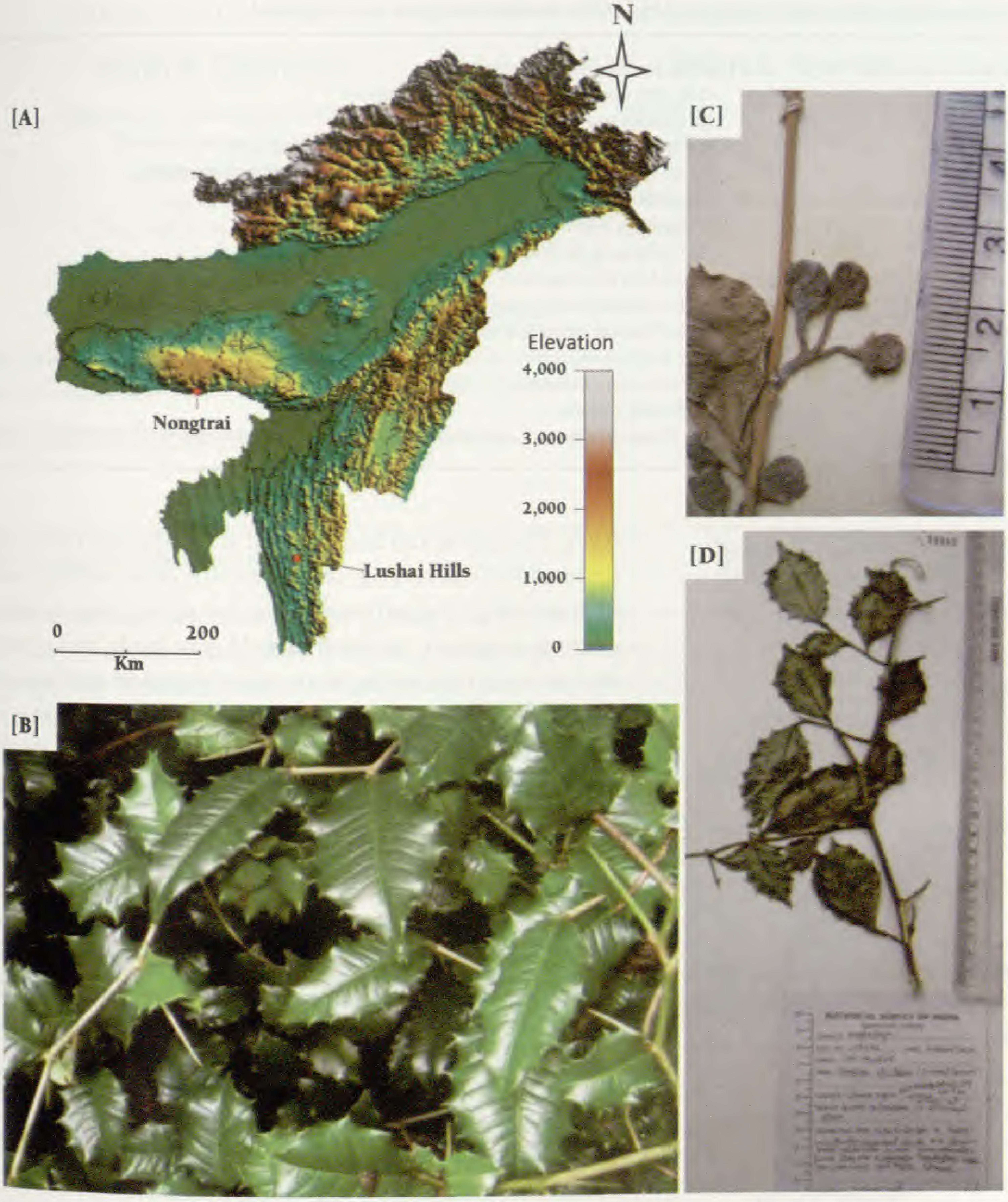

Fig. 1. A. **Map of northeastern India showing locations (●) of *Streblus ilicifolius*, B. Close view of the plant, C. Herbarium specimen with fruit, and D. Herbarium specimen with vegetative growth.**

from India, the existence of the species in the country is confirmed along with new extension of its geographical distribution area. The plants were growing in calcareous and moist under-canopy habitat. The associated species were *Breynia rhamnoides* Muell.-Arg., *Ficus hirta* Vahl, *Tetrameles nudiflora* R. Br., *Caryota urens* L., *Bauhinia purpurea* L., *Alstonia scholaris* (L.) R. Br., *Antidesma acuminatum* Wight, *Artocarpus heterophyllus* Lam., *Brassaiopsis glomerulata* (Blume) Regel, *Cayratia pedata* (Lam.) Juss. ex Gagnep., *Duabanga grandiflora* (Roxb. ex DC.) Walp.

The habitat of *S. ilicifolius* is increasingly exposed to disturbance due to forest clearance for large scale mining. Besides, small scale private limestone quarrying is also destroying the natural habitat of the species. In view of high intensity of disturbance to its natural habitat, and poor regeneration as observed in the field, the species might become extinct in the near future, unless adequate conservation measures for the species are

TABLE 1. Population data for *Streblus ilicifolius* used for classification of threatened categories of species as per IUCN (2010).

A. Population reduction	A1. ≥30% decline per generation
	(a) Direct observation: very less occurrences
	(b) Density per 10 m^2: 1 individual
	(c) Quality of habitat: disturbed, fragmented, karst topography
	(d) Exploitation: exposed to disturbance due to limestone mining
B. Geographic range	B2. Area of occupancy (AOO): < 10 km^2
	(a) Severely fragmented, 1 location
	(b) Continuing decline
	(ii) Area of occupancy: 100 m^2
	(IV) Number of locations: 1
	(v) Number of mature individuals: 6
C. Small population size and decline	
	Number of mature Individuals: <250
	C2. Continuing decline
	(a i) Number of mature individuals in each subpopulation: <50

taken. The species can be conserved in situ through habitat protection and by undertaking several ex situ conservation measures such as multiplying and introducing the species in the wild through micro-propagation, establishing field gene banks and conserving the species in the existing institutional botanical gardens. Considering the poor regeneration of the species in nature, there is a need to understand the reproductive biology and ecology of the species to ensure its perpetuation in natural as well as introduced habitats.

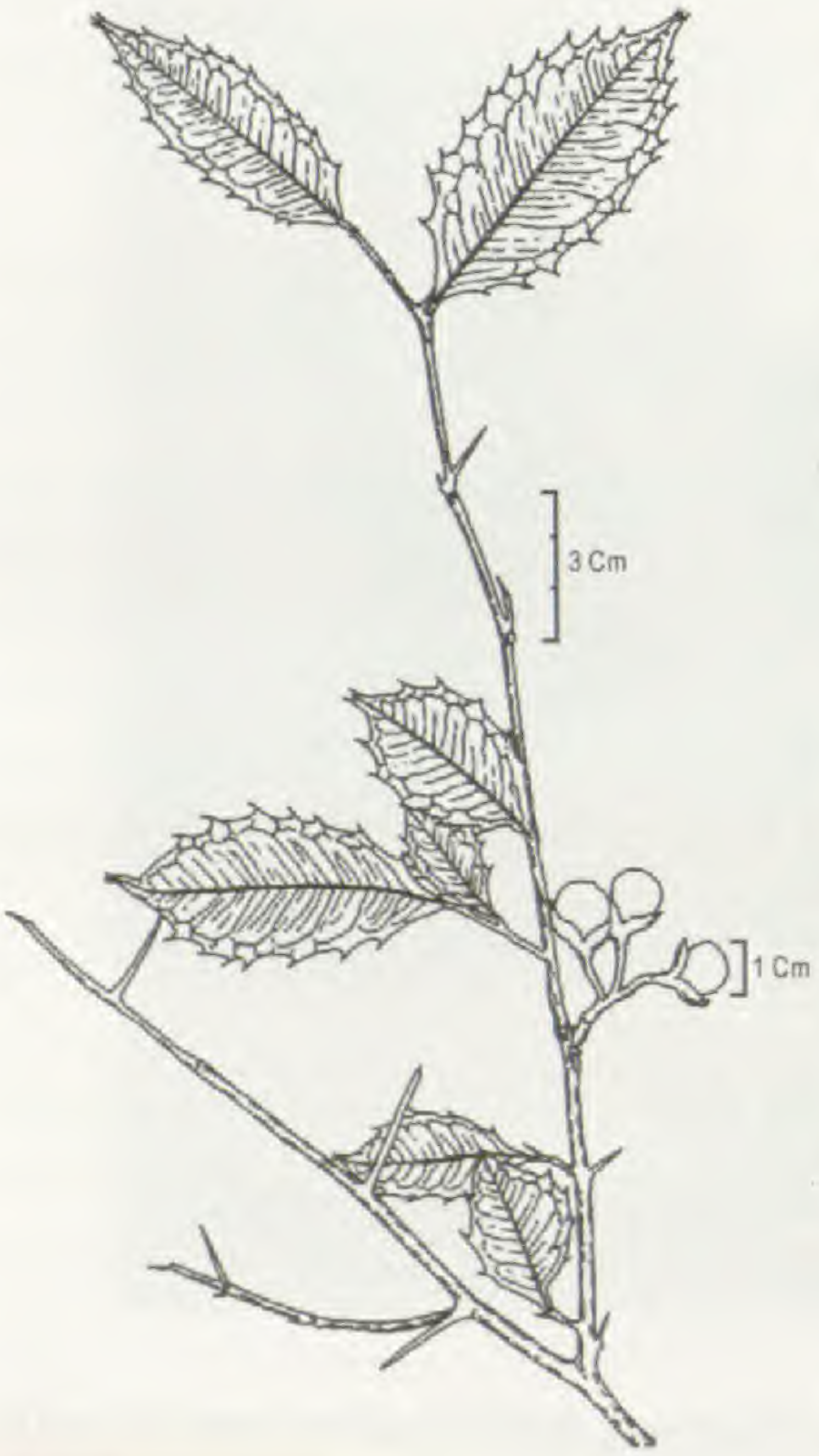

FIG. 2. Line drawing of *Streblus ilicifolius*.

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THREE NOTEWORTHY ADDITIONS TO THE ALABAMA FLORA

Alvin R. Diamond
Department of Biological Sciences &
Environmental Sciences
210L McCall Hall
Troy University
Troy, Alabama 36082, U.S.A.
Email: adiamond@troy.edu

Brian R. Keener
Department of Biological Sciences &
Environmental Sciences
Station 7
The University of West Alabama
Livingston, Alabama 35470, U.S.A.

ABSTRACT

Recent collections document three species of vascular plants as new to the Alabama flora: *Ligustrum quihoui*, *Kickxia elatine*, and *Poterium sanguisorba* subsp. *muricatum*.

KEY WORDS: Alabama, collections, new, noteworthy

RESUMEN

Recientes colecciones documentan tres especies de plantas vasculares como nuevas para la flora de Alabama: *Ligustrum quihoui*, *Kickxia elatine*, y *Poterium sanguisorba* subsp. *muricatum*.

Ligustrum quihoui Carrière (Oleaceae), Waxy Leaf Privet. *Ligustrum quihoui* is a medium-sized evergreen shrub native to China (Chang et al. 1996). In a recent paper, Nesom (2009) cited specimens from Arkansas, Mississippi, and Oklahoma and also noted its occurrence in several other southeastern states from apparent previous documentation. The two collections listed below are the first records documenting the presence of this species in Alabama. Even though both collections were from highly disturbed sites, this species has been known to inhabit more natural habitats in other states (Nesom 2009).

Voucher specimens: **ALABAMA. Sumter Co.:** 0.25 air mi NNE of Livingston, along North Street opposite of jct. with McConnell Street, roadside, margin of disturbed woodlands, 32.585833° -88.189444°, 25 Jul 2007, *Brian R. Keener 3775 with R. Mustain* (TROY, UWAL). **Montgomery Co.:** Herron Street at the railroad, disturbed woodland along the tracks, 32.375139° -86.328917°, 15 May 2011, *Alvin R. Diamond 22122* (TROY, UWAL).

Kickxia elatine (L.) Dumort. (Plantaginaceae), Sharpleaf Cancerwort. *Kickxia elatine* is a decumbent annual herb native to Eurasia (Fernandes 1972). It has long been known to be a naturalized element of the North American flora and has been documented to occur in several southeastern, northeastern, midwestern, and Pacific coast states (Pennell 1935; USDA, NRCS 2012). Prior to the ones listed below, the only known specimen from Alabama was collected on ballast ground in Mobile County by Charles Mohr (UNA; *C. Mohr s.n.*). That specimen is undated but was probably collected sometime in the late 1800s and was subsequently reported in Mohr's *Plant Life of Alabama* (1901). The following are the first collections of this species in Alabama in at least 110 years.

Voucher specimens: **ALABAMA. Marengo Co.:** 0.6 air mi SW of Demopolis, along S side of W Franklin Street (dirt road), in barren chalk areas of open field, 32.515302° -87.845843°, 16 Oct 2011; *Brian R. Keener 6779* (TROY, UWAL, VDB). **Marengo Co.:** 1.1 air mi SE of Demopolis, at jct. with E Pettus Street and Bailey Dr., 32.505841° -87.825028, 6 Jun 2012, *Brian R. Keener 7300* (TROY, UWAL, VDB).

Poterium sanguisorba L. subsp. **muricatum** Rouy & E.G. Camus (Rosaceae), Salad Burnet [=*Sanguisorba minor* Scop. subsp. *muricata* (Spach) Briq.]. Salad Burnet is a rosette forming perennial herb native across Eurasia and south to North Africa. Seven subspecies are recognized, with subsp. *muricatum* native to southern Europe (Royal Botanic Garden Edinburgh 2008). In North America it occurs from British Columbia, Montana, and Nebraska south to California and New Mexico in the west and from Ontario and Quebec south to Tennessee and North Carolina in the east (Fryer 2008; USDA, NRCS 2012). It is often a component of seed mixes for

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western rangelands, and is recommended for erosion control and as a wildlife food (Fryer 2008; USDA, NRCS 2002). In England, Salad Burnet is often associated with chalk grasslands (Graham & Hutchings 1988). The collection cited below is the first record documenting the presence of this species in Alabama.

Voucher specimen: **ALABAMA. Butler Co.:** Logging road 0.84 mi S of the Lowndes County line, cut-over limestone prairie, 31.949667° -86.762278°, 10 Jun 2011, *Alvin R. Diamond 22217 with W. Webb* (TROY, UWAL, VDB).

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A FIRST SPONTANEOUS RECORD OF *ACTINIDIA CHINENSIS* VAR. *DELICIOSA* (ACTINIDIACEAE) IN THE UNITED STATES FLORA

Brett E. Serviss
Department of Biology
Henderson State University
Arkadelphia, Arkansas 71999-0001, U.S.A.
servisb@hsu.edu

David H. Mason
State Survey Coordinator
Arkansas State Plant Board
Little Rock, Arkansas 72205, U.S.A.
david.mason@aspb.ar.gov

Troy L. Bray
Department of Biology
Henderson State University
Arkadelphia, Arkansas 71999-0001, U.S.A.
brayt@hsu.edu

ABSTRACT

Actinidia chinensis Planch. var. *deliciosa* (A. Chev.) A. Chev. (green kiwifruit) is here reported as new to the flora of Arkansas and the United States. Establishment of *A. chinensis* var. *deliciosa* at the Saline County site potentially occurred through the transport and subsequent introduction of one or more seeds to the site via a sewer pump station. Photographs of *Actinidia chinensis* var. *deliciosa*, along with a key to the three species of *Actinidia* currently known to occur outside of cultivation in the United States, are also included.

RESUMEN

Se cita aquí *Actinidia chinensis* Planch. var. *deliciosa* (A. Chev.) A. Chev. (kiwi verde) como nuevo para la flora de Arkansas y los Estados Unidos. El establecimiento de *A. chinensis* var. *deliciosa* en el condado de Saline County ocurrió potencialmente mediante el transporte e introducción subsecuente de una o más semillas a través de una depuradora. Se incluyen fotografías de *Actinidia chinensis* var. *deliciosa*, junto con una clave de las tres especies de *Actinidia* que se conocen actualmente fuera de cultivo en los Estados Unidos.

INTRODUCTION

In the United States flora, non-native plant species are continuously being documented and added, both at the regional and national levels (Whittemore 2004; Neves et al. 2009; Serviss 2009; Wunderlin et al. 2010; Peck & Serviss 2011). In some instances, subsequent to introduction, these species naturalize or occasionally even become invasive; therefore, it is extremely important to record first encounters with escaped populations and monitor new spontaneous occurrences of non–native species in order to evaluate their potential as invasive species (Neves et al. 2009; Yatskievych & Raveill 2001). Introduction of non-native plant species into the United States is often intentionally driven based on their potential as ornamentals or lucrative agronomic crops.

A case-in-point example would be the genus *Actinidia*. *Actinidia* is an Asiatic genus consisting of about 55 species of lianas, with its center of diversity in China (52 species, 44 of which are endemic) (Flora of China Editorial Committee 2007). Some species of *Actinidia* are important as ornamentals because of their showy and often colorful foliage and flowers, and a few species are important for their edible fruits, such as *A. arguta*, *A. chinensis*, and *A. kolomikta*. These represent the principle reasons why *Actinidia* species were introduced into the US.

Actinidia chinensis Planch. var. *deliciosa* (A. Chev.) A. Chev. (green kiwifruit, Chinese gooseberry) is the standard kiwi fruit of commerce and represents one of the few temperate fruit crop species to have been domesticated in the last 100 years (Ferguson 1999). The kiwifruit industry began in 1904 when seed collected from China were brought to New Zealand, and by 1970, the green kiwifruit had been developed into a production crop (Ferguson and Bollard 1990). At present, on an annual basis, over one million metric tons of kiwifruit are produced worldwide, most of which is grown in four countries: Italy, China, New Zealand, and Chile (World Kiwifruit Review 2009), and although only small amounts are produced commercially in the United States, the kiwifruit has become a popular commodity in this country (Ferguson 1999). *Actinidia chinensis* var. *deliciosa* has recently been recorded as spontaneous in a few European countries (Kasperek 2004; Essl & Stoehr 2006), so it is not surprising, based on its relative cold hardiness and seed viability, along with the popularity of its fruit as a food in this country (as it is in Europe), that *A. chinensis* var. *deliciosa* has also been documented outside of cultivation in the United States.

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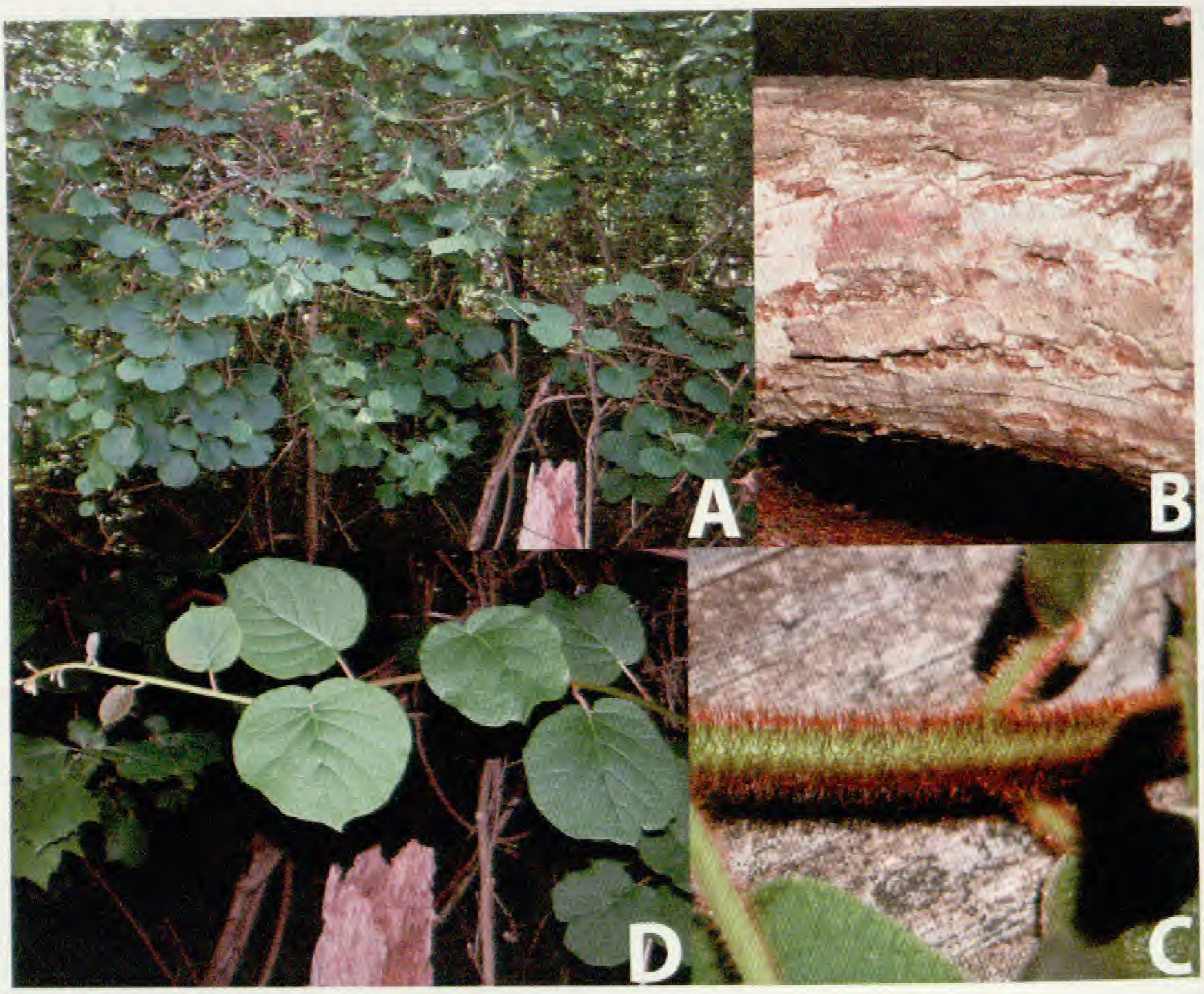

Fig. 1. Plant and habit of *A. chinensis* var. *deliciosa* (photographs are of spontaneous plant(s) from Saline County, Arkansas). **A.** Habit. **B.** Bark. **C.** Leaves and stem. **D.** Young stem and leaves showing dense indument of hispid trichomes.

Fig. 2. Herbarium specimens of *A. chinensis* var. *deliciosa* (specimens are from Saline County, Arkansas). **A.** Staminate flowers and leaves. **B.** Leaves and twining stem.

NEW SPECIES RECORD FOR THE CONTINENTAL UNITED STATES

Actinidia chinensis Planch. var. **deliciosa** (A. Chev.) A. Chev. (*A. deliciosa* (A. Chev.) Liang & Ferguson) (Actinidiaceae) (Fig. 1). Green kiwifruit is a large, deciduous liana that can climb by means of twining stems to a height of 10 meters or possibly more. It is native to China and Taiwan. *Actinidia chinensis* Planch. var. *deliciosa* is easy to distinguish from other vines in the eastern United States by the combination of the dense indument of large, red, reddish-brown, or whitish-tan, setose or hispid trichomes that cover the young stems and leaves, relatively thick, robust stems, and large (at maturity—up to 20 cm long), cordate-acuminate, pubescent, prominently-veined leaves. The large leaves and colorful new growth give the plant a tropical appearance. The voucher specimen below represents the first spontaneous record of *A. chinensis* var. *deliciosa* documented in the United States (Fig. 2).

Voucher specimen: **ARKANSAS. Saline Co.:** River Oak Drive, 1300 block, Benton, one or possibly two distinct clusters of stems, separated by about 2 m, remnant patch of mixed pine-hardwood, associates include *Callicarpa americana*, *Cornus florida*, *Fraxinus pennsylvanica*, *Liquidambar styraciflua*, *Pinus taeda*, *Platanus occidentalis*, *Quercus alba*, *Rhus copallina*, *Toxicodendron radicans*, and *Ulmus alata*, 5 May 2012, *B. Serviss 7423* (HEND).

Two clusters of stems, separated by about 2–3 meters, were observed at the site, but it was not determined whether or not each was a separate plant or a single, interconnected system of stems and roots. Both clusters of stems were present as large, multi-trunked, reproductive-age, staminate (*A. chinensis* has bisexual flowers but is functionally dioecious) lianas, growing on a wooded slope and up into and through the canopy to edge of woods. The immediate location of the *A. chinensis* var. *deliciosa* plant(s), while bordered by streets and residential areas, appears to be relatively undisturbed, with no evidence of a prior home site or areas of cultivation observed. However, a sewer pump station with associated cleanout valves is present at the site, which offers a potential explanation as to route of introduction of the *Actinidia* plant(s), which were rooted in close proximity to the cleanout valves. Introduction via seed may have occurred during routine cleaning of the sewer lines, or possibly even during an overflow event; subsequent seed germination and development resulting in the spontaneous plant(s).

In addition to *A. chinensis* var. *deliciosa*, two other species of *Actinidia*: 1. A. arguta (Siebold & Zucc.) Planch. ex Miq. (hardy kiwi, tara vine) and 2. *A. polygama* (Siebold and Zucc.) Maxim. (silver vine) have been documented outside of cultivation in Ohio and the northeastern United States (NRCS 1999; Mitchell 2000; Wilder & McCombs 2002; Haines 2011). See below for key to identification of these species (for a detailed treatment of *Actinidia*, including *A. chinensis* and its three varieties, see Flora of China Editorial Committee 2007).

KEY TO SPECIES OF *ACTINIDIA* IN THE CONTINENTAL UNITED STATES

1. One- to two-year-old branches (branchlets) densely strigose- to hispid-pubescent; fruits variously hispid-pubescent — **A. chinensis var. deliciosa**

1. One- to two-year-old branches (branchlets) glabrous, rarely finely tomentose-puberulent, but not strigose or hispid; fruits glabrous

  2. Pith of stems solid — **A. polygama**

  2. Pith of stems lamellate (made up of thin plates) — **A. arguta**

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PALLENIS MARITIMA (ASTERACEAE) NEW TO CALIFORNIA, WITH NOTES ON RECENT INTRODUCTIONS OF SALT-TOLERANT ORNAMENTAL PLANTS

Richard E. Riefner, Jr.
Research Associate
Rancho Santa Ana Botanic Garden
1500 North College Avenue
Claremont, California 91711-3157, U.S.A.
rriefner@earthlink.net

Werner Greuter
Herbarium Mediterraneum
c/o Orto Botanico
Via Lincoln 2/A
I-90121 Palermo, ITALY
w.greuter@bgbm.org

ABSTRACT

Pallenis maritima is a small cushion-forming subshrub known from the Western Mediterranean region, extending to S. Portugal along the Atlantic Coast. It is reported here for the first time for California, being documented for the first time as growing outside of cultivation in North America. In Orange County, southern California, it has naturalized along the immediate coast on rocky shores and sea cliffs mostly within the salt-spray zone. *Pallenis maritima* is cultivated in California and likely escaped from residential gardens, commercial landscapes, nurseries, or similar sources. We cite voucher specimens, describe the habitat, and comment on presumed mode of introduction. A review of the taxonomy and nomenclature of the *Asteriscus* alliance is provided. *Pallenis maritima* is one of a growing number of salt-tolerant ornamental plants that have become naturalized recently in southern California.

Key Words: *Pallenis maritima* (=*Asteriscus maritimus*), California, halophytes, non-native plants, ornamental horticulture, weeds

RESUMEN

Pallenis maritima es un pequeño subarbusto pulviniforme, conocido en la región Mediterránea occidental y a lo largo de la costa atlántica hasta el sur de Portugal. Se reporta aquí de California, siendo documentada por primera vez como creciendo de forma silvestre en América del Norte. En el Condado de Orange, al sur de California, se ha naturalizado en las costas rocosas y acantilados a lo largo de la costa colindante, sobre todo en la zona de niebla salina. *Pallenis maritima* se cultiva en California y es probable que provenga de jardines residenciales, servicios comerciales de diseño de jardines o fuentes similares. Se citan especímenes, se describe el hábitat y se comenta el probable modo de introducción. Se presenta una sinopsis de la taxonomía y la nomenclatura del complejo de *Asteriscus*. *Pallenis maritima* es una de las cada vez más numerosas plantas ornamentales tolerantes de la salinidad que se han naturalizado recientemente en el sur de California.

INTRODUCTION

Pallenis maritima (L.) Greuter was not reported for California in The Jepson Manual (Keil 2012a; Jepson Flora Project 2012), the Consortium of California Herbaria (2012), or other publications that address non-native species growing outside of cultivation in California (Hrusa et al. 2002; DiTomaso & Healy 2007; Dean et al. 2008; Roberts 2008). *Pallenis maritima* also was not included in the Flora of North America treatment of the Inuleae, nor has it been reported at all, outside of cultivation, for North America (Preston 2006; USDA, NRCS 2012).

In this paper, we provide the first documented records of *P. maritima* for California and North America, where it grows spontaneously outside of cultivation on rocky shores and sea cliffs in coastal Orange County, southern California. We provide voucher documentation, and review horticultural uses, seashore ecology, and apparent mode of introduction into the State. We also review the taxonomy and nomenclature of the species and its placement within the *Asteriscus* alliance, in view of the fact that it is still often referred to as *Asteriscus maritimus*.

Voucher specimens: **U.S.A. CALIFORNIA. Orange Co.:** City of Laguna Beach, Moss Cove, vicinity of Ocean Way and Ruby St., 33° 31' 32.569"N, 117° 46' 9.541"W, elev. ca. 2.5 m–3.5 m, large subshrub and scattered seedlings in rock crevices within the salt-spray zone, 2 Jan 2010, *Riefner 10-03* (RSA), same location, 25 Jun 2011, *Riefner 11-74* (PAL-Gr, RSA); City of Laguna Beach, Aliso Creek Beach, rocky shore and bluff between Aliso Beach Park and West St., 33° 30' 28.079"N, 117° 45' 12.265"W, elev. 4 m, uncommon, outcrops on ocean bluff, 1 Jul 2011, *Riefner 11-79* (RSA); City of Newport Beach, rocky beach between Shorecliff Rd. and Cameo Shores Rd., 33° 35' 6.465"N, 117° 51' 50.729"W, elev. ca. 1.5 m–3 m, locally common in rock crevices on sea cliff within the salt-spray zone and shale scree at the coastal strand, 1

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Jul 2011, *Riefner 11-86* (RSA); City of Dana Point, rocky shore between Mussel Cove and Salt Creek Beach, 33° 29' 4.444"N, 117° 44' 0.862"W, elev. ca. 2.5 m–5 m, subshrubs and seedlings in rock crevices at the edge of an ephemeral calcareous-saline seep on seashore cliff and among cobbles on the coastal strand, 25 May 2012, *Riefner 12-393* (RSA).

Pallenis maritima has long been known as *Asteriscus maritimus* (L.) Less., a name that has still some usage at present. As any given species can only bear one correct name once its taxonomic placement and limits are accepted, an overview of the historical background may be helpful to understand the disparity. That background is fairly intricate: the genus in which *P. maritima* has been placed through time, or to which it is currently assigned, has been given no fewer than eight different names: *Asteriscus* Mill., *Athalmum* Kuntze, *Bubonium* Hill, *Buphthalmum* L., *Nauplius* Cass., *Odontospermum* Sch. Bip., *Pallenis* Cass., and *Saulcya* Michon. For more details, see Greuter (1997).

Pallenis maritima belongs to a group of 15 Mediterranean and Macaronesian species, together forming a natural unit defined by morphology and chromosome number that has been called the *Asteriscus* alliance (Anderberg 1994; Francisco-Ortega et al. 1999; Goertzen et al. 2002). These species have been monographed by Wiklund (1983, 1985, 1987). Most are local, little known endemics of North Africa and the Atlantic Islands and need not be considered here. The three most widespread, however, were known to botanists even in pre-Linnaean times. They are the upright, annual, non-pungent *Asteriscus aquaticus* (L.) Less., the annual to biennial *Pallenis spinosa* (L.) Cass., characterised by pungent involucral bracts, and the perennial *P. maritima*, which is discussed in this paper.

These three species together formed the original genus *Asteriscus*, first described and named by Tournefort (1700). The name, he explained, means "little star" and refers to the star-like appearance of the "calyx" (involucrum) surrounding the "flower" (capitulum). The remarkably natural Tournefortian concept was maintained by Miller (1754) when he validated the generic name, but was lost when Linnaeus (1737) included *Asteriscus* in his own artificial new genus *Buphthalmum* (the name means "ox eye"). Linnaeus (1753) redefined *Buphthalmum* considerably, but did not succeed in making it more natural. Of the 11 *Buphthalmum* species he described and named over the years only two are left today, the remainder are currently placed in no fewer than seven different genera (Jarvis 2012).

Greuter (1997) summarized the post-Linnaean taxonomy, which is outlined here. Most 19th century authors essentially reverted to the Tournefortian generic concept of *Asteriscus*, but split it in two based on the obvious character of pungent vs. unarmed involucral bracts. That is, they left *Pallenis maritima* and *Asteriscus aquaticus* together, but separated *Pallenis spinosa*. The first to do so was Cassini (1822), who named the spiny plants *Pallenis* (after the borough Pallini E. of Athens—Fournier 1934–1940) and the unarmed ones *Nauplius* (perhaps, by analogy, after the Greek harbour, Nauplion). Subsequent authors accepted the division but took up the name *Asteriscus* for one of the genera—unfortunately not always for the same one. The problem was that *Asteriscus* had not been typified. A type was not designated until very late (Jeffrey 1982), and the monographer Wiklund (1985) refused to accept Jeffrey's choice of *A. aquaticus*.

Meanwhile Briquet (in Briquet & Cavillier 1917) had discovered profound micromorphological differences between the two unarmed species, placing them at least as far apart from each other as from their spiny relative. By consequence, he placed each of the three in a genus of its own. Wiklund (1985, 1987) went one step further, uniting the superficially dissimilar *P. maritima* and *P. spinosa* in one genus (her mis-typified "*Asteriscus*") while leaving *Asteriscus aquaticus* in the other (which she named *Nauplius*). Apart from her splitting off one deviating species as a monotypic genus *Ighermia* (Wiklund 1985), which has gained little acceptance, her taxonomic conclusions, with the nomenclature rectified, has been generally accepted (e.g., Greuter 2003, 2007; Greuter & Raab-Straube 2006–2009). That treatment, including the repatriation of *Ighermia* to *Asteriscus*, has received firm support by molecular studies (Goertzen et al. 2002).

Back then, to the initial question: which name, *Pallenis maritima* or *Asteriscus maritimus*, is correct? The answer, as so often: it depends. Accordingly, if one follows the concepts of Tournefort (1700), and wishes to recognize a single genus comprising the whole *Asteriscus* alliance, then *A. maritimus* is correct—a scientifically tenable if somewhat outmoded choice. However, if one honors the taxonomic progress made during the last 3+ centuries and maintain two genera, then *P. maritima* is the preferred choice.

Fig. 1. Photograph of *Pallenis maritima* growing at Moss Cove, Laguna Beach, California. The flower heads shown in the photograph are approximately 3.6–3.8 cm wide. The small white patches visible on the leaves and bracts in the lower left-hand corner are salt crystals formed from ocean sprays.

Pallenis maritima is a cushion-forming subshrub (a low, spreading woody perennial) that grows up to 40 cm tall and about 1 m wide. It is known from the Western Mediterranean region, extending to S. Portugal along the Atlantic Coast, with casual occurrences in Great Britain and N. France (Wiklund 1985). *Pallenis maritima* grows on sand dunes, cliffs, and rocky shores primarily along the coastline, and it frequently occurs within the salt-spray zone (Beckett 1993; Mucina 1997; NATURA 2003; Estrada et al. 2011). It is also found in dry grasslands of North Africa and Spain, and grows on limestone, clayey soils, including marl, and sandstone (Wiklund 1985).

In spring through early summer, *P. maritima* produces abundant golden-yellow flower heads up to 4 cm wide, with showy, finely toothed ray florets about as long as or longer than the involucre. The leaves and involucral bracts of *P. maritima* are narrowly obovate-spathulate, sparsely to densely villous, glandular, and somewhat folded. The receptacular scales contain oxalate crystals, and the achenes are irregularly four-sided to subcylindrical and densely strigose-hispid (see Wiklund 1985 for a detailed description). *Pallenis maritima* is known by the common names of gold coin, Mediterranean beach daisy, and sea daisy. A photograph is provided as Figure 1.

Horticultural Use

Pallenis maritima exhibits a high tolerance to severe water stress and highly saline irrigation water and therefore is useful for revegetation programs and xeroscape gardens (Rodriguez et al. 2005). Owing to these properties, it has been widely cultivated in Europe (Brickell 1996; Walters & Yeo 2000; Vogl-Lukasser & Vogl 2004). *Pallenis maritima* is also cultivated in California, where it is marketed by the nursery trade as a drought-tolerant plant for sandy soils and coastal gardens (Brenzel 2007; California Gardens 2012; San Marcos Growers 2012). Comments posted on Dave's Garden (2012) webpage confirm *P. maritima* is a hardy, drought-tolerant plant for central and southern California coastal gardens; Dave's Garden is an on-line forum where people share gardening advice and information about growing or purchasing ornamental plants. Casual observations by the senior author indicate *P. maritima* is often planted in street-side gardens in the coastal communities of Laguna Beach and Newport Beach, southern California.

Worldwide, escaped garden plants are one of the primary sources of non-native plant introductions, and California is no exception (Mack 2000; Reichard & White 2001; Bell et al. 2007). Although the mode of introduction of a species can be difficult to identify, documenting whether or not the plant is intentionally cultivated and sold commercially can be significant (Dehnen-Schmutz et al. 2005; Dean et al. 2008). Because *P. maritima* is known to be cultivated in our area, it likely escaped from residential gardens and commercial landscape plantings to become naturalized in seashore habitats along the southern California coast.

Salt Tolerance and Specialized Seashore Habitats

Halophytes grow naturally in saline environments and have evolved various mechanisms to cope with salinity where other plants cannot thrive (Breckle 2002; Parida & Das 2005). Tolerance to highly saline soils, exposure to salt spray, and periodic inundation are critical factors affecting vegetation and the establishment of non-native species in many habitats of coastal California (Barbour & De Jong 1977; Kuhn & Zedler 1997; Grewell et al. 2007; Pickart & Barbour 2007). Therefore, knowing whether or not a non-native plant is tolerant of saline conditions can have important implications regarding its potential invasive spread and the habitats it might colonize when introduced to a new region.

Pallenis maritima was not identified as a halophyte in the databases of Aronson (1989), Menzel and Lieth (2003), or Yensen (2012). Experimental data, however, indicate it is tolerant of high salinity levels, with electrical conductivity measurements ranging from 1.25 to 12.61 dS/m-1 during 150 days of treatment (Rodriguez et al. 2005). For Aronson (1989), the minimum criterion required for a plant to be classified as a halophyte is a salinity level with an electrical conductivity of at least 7–8 dS/m-1 during significant portions or all of the plant's life cycle. More recently, however, halophyte classification has become more demanding, and the threshold of salinity tolerance for a plant to qualify as halophyte has been raised to 20 dS/m-1 (≈ 200 mM NaCl) (Flowers & Colmer 2008). For comparison, the salt concentration of seawater is approximately equivalent to 50 dS/m-1 (≈ 500 mM NaCl). See Grigore et al. (2010) for a review of the history and evolving concepts that define halophytes versus other salt-tolerant plants.

Rodriguez et al. (2005) also reported that salt-treated *P. maritima* plants accumulate high Na+ and Cl- levels in leaves, and to a lesser extent stems and roots, which demonstrates the presence of an ion inclusion mechanism and osmotic adjustment that maintains leaf tugor in response to salt stress. The preferential accumulation of either Na+ and/or Cl– may account, in part, for salt tolerance (Nieman et al. 1988; Gibbs et al. 1989; Boursier & Läuchli 1990). Accordingly, *P. maritima* is a salt-tolerant species and should be considered for inclusion in future revisions of the world-wide halophyte database.

In Orange County, southern California, *P. maritima* grows on rocky shores or sea cliffs, often within the salt-spray zone and in habitats periodically inundated during storm surge. At one location, it also grows at the edge of an ephemeral calcareous-saline seep. The known distribution of *P. maritima* in southern California is depicted in Figure 2.

Laboratory analysis using saturated extracts of soil samples taken within the root zone of *P. maritima* at each naturalized population indicate the substrate is slightly to moderately alkaline (7.5–8.1 pH), slightly to strongly saline (6.5–34.7 dS/m-1), and slightly to highly calcareous. In addition, the micro-habitat of these rocky seashore environments is barren or covered with sparse vegetation, often with documented halophytes such as *Cakile maritima* Scop., *Carpobrotus chilensis* (Molina) N.E. Br., *Distichlis spicata* (L.) Greene, *Extriplex californica* (Moq.) E.H. Zacharias (syn., *Atriplex californica* Moq.), and *Limonium perezii* (Stapf) Hubb. Therefore, *P. maritima* functions as a halophyte in coastal southern California, and the habitats it occupies here are similar to its seashore environment along the Mediterranean Sea.

FIG. 2. Known distribution of *Pallenis maritima* in southern California; a solid circle (●) identifies the location of naturalized populations.

Invasive Weed Status

There is always some concern about the possible invasiveness of new non-native plants that become established in natural ecosystems. *Pallenis maritima* is cited as a "casual alien or weed" for Great Britain and is listed as a "potential weed introduction" in Australia, but is not known to be invasive anywhere around the world (GCW 2012; ISSG 2012; PIER 2012; Randall 2007, 2012; Weeds Australia 2012).

Wiklund (1985) noted that *P. maritima* plants kept in isolation produce viable seed, pointing to autogamous or apomictic reproduction. Additionally, in 2003 a gardener in Huntington Beach, coastal Orange County, California, posted a comment on-line indicating that *P. maritima* may become slightly invasive (Dave's

Garden 2012). Accordingly, *P. maritima* possesses reproductive and physiological traits that enable it to escape cultivation and become established in seashore environments. We do not know if it will become a pest plant in North America, but it is expected to expand its range and establish elsewhere in coastal southern California.

CONCLUSIONS

Ornamental horticulture promotes invasions in many ways, and the tradition of selecting and distributing showy species purely for aesthetic reasons remains an important pathway of dispersal (Dehnen-Schmutz & Touza 2008). Aesthetically-pleasing and easy-to-grow plants often become popular with gardeners, and thereby frequently become available for sale in large numbers of nurseries and in expanding horticultural markets. Market availability drives prices, so the more often a species is offered for sale, purchased, and planted, the greater its chance to escape cultivation and find suitable natural habitats (Lockwood et al. 2005; Dehnen-Schmutz & Touza 2008). In addition, biological characteristics that make a plant interesting and easy to grow for gardeners, such as climatic suitability, long blooming period, quick propagation, hardiness, and drought-tolerance, may also enhance the successful establishment of escaped plants in new regions and start an invasion process (Mack 2000; Dehnen-Schmutz et al. 2005; Anderson et al. 2006). We believe salt-tolerance in ornamentals, especially those selected and marketed for coastal gardens, contributes to their ability to successfully escape cultivation and become established in unintended habitats.

Pallenis maritima is one of a growing number of salt-tolerant, hardy, and attractive ornamental plants that have naturalized recently in southern California. Others include *Lagunaria patersonia* (Andrews) G. Don (Malvaceae), *Plecostachys serpyllifolia* (P.J. Bergius) Hilliard & B.L. Burtt (Asteraceae), and several species of *Limonium* (Plumbaginaceae) (Hill 2012; Keil 2012b; Preston 2012). *Plecostachys serpyllifolia* and several *Limonium* taxa are highly invasive species (Riefner & Nesom 2009; BAEDN 2012).

Halophytes are receiving substantial attention from botanists and agriculturists as potential fodder crops, food plants, biofuel sources, turf grasses, ornamentals, sand dune stabilizers, and redeemers of salt-affected land, among others (Glenn et al. 1999; Barrett-Lennard et al. 2003; Rozema & Flowers 2008; Yensen 2008). As greater numbers of salt-tolerant plants become cultivated, and as the horticultural trade continues to meet consumers' demands for hardy and attractive plants for coastal gardens, we can expect to find other non-native halophytes naturalized along the California coast.

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BOOK NOTICES

Adam Cross. 2012. **Aldrovanda. The Waterwheel Plant.** (ISBN-13: 978-1-9087870-4-0, hbk.). Redfern Natural History Productions, 61 Lake Drive, Hamworthy, Poole, Dorset BH15 4LR, England, UK. (**Orders:** www.redfernnaturalhistory.com, sales@redfernnaturalhistory.com, inside UK 01202 686585, outside UK +44 1202 686585). £34.99, 248 pp., 91 figures (b/w and color), 6" × 9".

From the Publisher: The first comprehensive monograph of *Aldrovanda*, the rare and extraordinary carnivorous "Waterwheel Plant." This incredible carnivore, known for trapping aquatic prey between jaw-like lobes that dramatically snap shut when triggered, is related to the famous Venus Flytrap and employs one of the fastest movement responses known in the plant kingdom. Not only arthropods are caught in its deadly jaws, but even small vertebrates including tadpoles and fish fry.

Representing over four years of study and research, this long-awaited work presents a pioneering and uniquely detailed treatment of all aspects of the botanical history, ecology, evolutionary history, distribution and cultivation of this novel plant. The text also addresses the pressing need for integrated conservation and management initiatives.

Review forthcoming!

Robert Lee Riffle, Paul Craft, and Scott Zona. 2012. **The Encyclopedia of Cultivated Palms, Second Edition.** (ISBN-13: 978-1-609469-205-1, hbk.). Timber Press, Inc., The Haseltine Building, 133 S.W. Second Avenue, Suite 450, Portland, Oregon 97204-3527, U.S.A. (**Orders:** www.timberpress.com, 800-327-5680). $59.95, 517 pp., 950 color plattes, 8½" × 11".

From the Publisher: "This essential reference, now completely revised and updated, describes more than 900 species of palms that can be grown in climates ranging from tropical to temperate. With new species, current taxonomy, plant characteristics, cultural requirements such as cold hardiness and water needs, and uses in the landscape as well as Indoors, this is the definitive resource on this economically and horticulturally important plant group."

"Winner of an American Horticultural Society Book Award in 2004, it also provides history, ethnobotany, and biology, along with seed germination notes and extensive lists of palms for specific landscape situations."

"The magnificent new edition includes an expanded discussion of palm health as well as information on gardens with important palm collections that are open to the public. Generously illustrated with more than 730 new photos for a total of nearly 1000, this volume is useful both as an identification guide and as a practical handbook."

Palm lovers have surely discovered this fantastic palm book by now. But this book is not just for palm experts; gardeners, botanists, and taxonomists will also surely find this a useful reference. Aside from the center piece of 950 colorful plates, the section on Palm Descriptions A to Z is filled with botany, taxonomy, and horticultural information. Each genus/species has a phonetic pronunciation guide. I like this and you will too. With this, you too, can roll these Latin names off your tongue in no time and sound like an expert.

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VASCULAR FLORA AND PLANT COMMUNITIES OF DEAD HORSE KNOB (RUCKER'S KNOB), MADISON COUNTY, KENTUCKY

Ralph L. Thompson

Berea College Herbarium
Berea College, Biology Program
Berea, Kentucky 40404-2121, U.S.A.
ralph_thompson@berea.edu

Derick B. Poindexter

University of North Carolina Herbarium
University of North Carolina, Biology Dept.
Chapel Hill, North Carolina 27599-3280, U.S.A.
poindexter@unc.edu

J. Richard Abbott

Missouri Botanical Garden
P.O. Box 299
Saint Louis, Missouri 63166-0299, U.S.A.
richard.abbott@mobot.org

ABSTRACT

A descriptive floristic study was conducted during the growing seasons of 2010–2011 and spring 2012 at Dead Horse Knob (Rucker's Knob), an isolated 2.6 ha steep eroded hill with a 312 m conical summit in southern Madison County, Berea, Kentucky. This Dead Horse Knob survey is the first comprehensive flora of a solitary knob in the Knobs Region of east-central Kentucky. The knob is comprised of four residual and colluvial soils from weathering of Devonian black shales. Dry-Mesic Oak-Hickory Forest with interspersed planted pines is the major forest type. Plant communities have been altered through the anthropogenic effects of excessive land use, livestock disturbances, and the presence of naturalized invasive species. The vascular flora is comprised of 291 species (this total includes infraspecific taxa), in 191 genera from 67 families, which consists of two Monilophytes, five Gymnosperms, and 284 Angiosperms (71 Monocots; 213 "Dicots"). One hundred and sixteen species (39.9% of the total flora) were exotic and 52 were invasive, with *Lonicera maackii* as the most detrimental.

RESUMEN

Un estudio florístico descriptivo que se llevó a cabo durante las temporadas de crecimiento de 2010–2011 y la primavera de 2012 en Dead Horse Knob (Rucker's Knob), una colina aislada de 2,6 ha , empinada y erosionada con una cumbre cónica de 312 m en el sur del condado de Madison, en Berea, Kentucky. Este estudio de Dead Horse Knob es la primera flora exhaustiva de un "knob" o loma aislada en la Región de Lomitas del centro-este de Kentucky. El "knob" está compuesto de cuatro suelos residuales y coluviales del desgaste de la pizarra arcillosa negra del Devónico. El tipo principal de bosque es el Seco-Mésico de *Quercus-Carya* con *Pinus* sembrados intercalados. Las comunidades vegetales han sido alteradas por los efectos antropogénicos del uso excesivo de la tierra, perturbaciones del ganado y la presencia de especies invasoras naturalizadas. La flora vascular comprende 291 especies (un total que incluye los taxa infraespecíficos), de 191 géneros y 67 familias, que consiste en dos Monilofitas, cinco Gimnospermas y 284 Angiospermas (71 monocotiledóneas, 213 "dicotiledóneas"). Ciento dieciséis especies (39,9% de la flora total) eran exóticas y 52 eran invasoras, con *Lonicera maackii* como la más perjudicial.

Key Words: Dead Horse Knob, Rucker's Knob, *Lonicera maackii*, invasives, vascular flora, Kentucky

INTRODUCTION

Dead Horse Knob (or Rucker's Knob), hereafter DHK or "knob," is an isolated 2.6 ha steep hill in east-central Kentucky, 1.6 km north of the Berea Ridge in southern Madison County (Fig. 1). DHK is between 37.582° and 37.584° latitude, and -84.298°and -84.300° longitude within the zoned Berea city limits. Elevations in the immediate vicinity range from nearly level terrain at 297 m on the western foot slope of DHK to 312 m at the eroded, cone-shaped summit (Weir 1967). It is surrounded by 270 ha of agricultural field and pasture farmland of the Berea College Farm that is managed through Berea College (Thompson et al. 2008).

DHK is located within the Knobs Physiographic Region, an area of remnant low peaks derived from the erosion of the Cumberland Plateau of the Appalachian Mountain highlands. These low scattered hills form a mountain chain of Devonian black shale in a 5957 km^2, horseshoe-shaped belt, 15–25 km wide, interspersed between the limestone Ordovician Outer Bluegrass Region, Mississippian Plateau, and Cumberland Plateau of central Kentucky (Burroughs 1926; Newell 1981).

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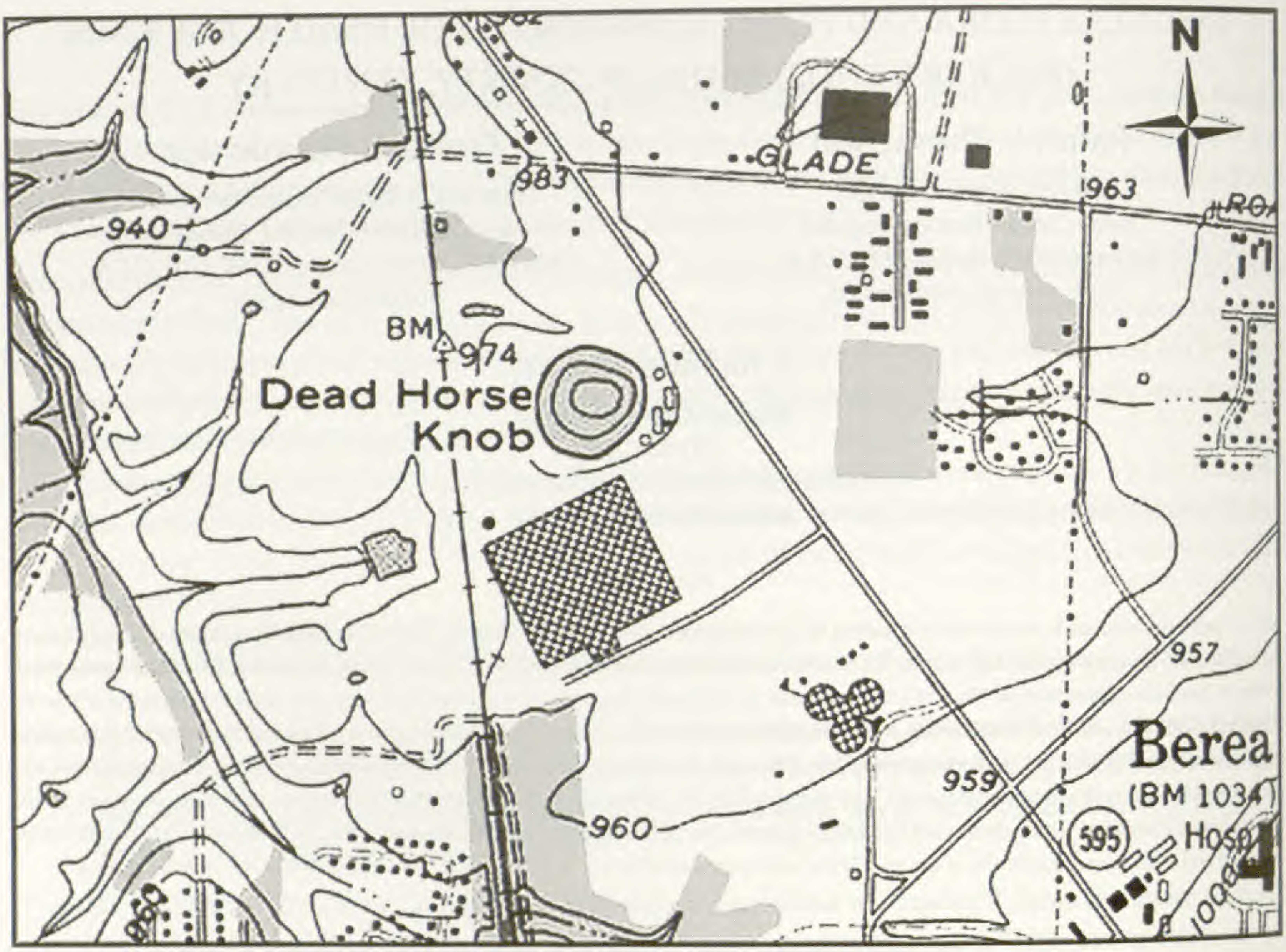

Fig. 1. Dead Horse Knob (DHK), Madison County, Kentucky. Map is modified from the Berea Quadrangle 7.5-minute topographic series (Map scale 1:24,000), 1970, photo-revised 1979, U.S. Geological Survey, Washington, DC. DHK geology and environs are entirely Devonian New Albany Shale (Weir 1967).

This survey is the first comprehensive flora from an individual peak in the Knobs Region of south-central Kentucky and provides additional information to augment the rich natural history of southern Madison County (e.g., Grossman & Pittillo 1962; Jones & Thompson 1986; Wade & Thompson 1990; Thompson & Fleming 2004; Thompson 2005; Thompson 2008). Furthermore, DHK serves as an area of historic and cultural importance due to a small private Revolutionary War cemetery at the summit and the remnants of an old clay pit area at the westernmost foot slope, which was used in the past for the brick and tile industry of Berea College.

The objectives of our descriptive study were to: 1) document the vascular plants growing at DHK through collection of representative voucher specimens for deposit in the Berea College Herbarium (BEREA); 2) discuss the present effects of invasive species and livestock disturbance on the native flora and forest vegetation; 3) designate plant communities and describe plant habitats with characteristic associated species; and 4) increase our understanding of vascular plant diversity in preparation of a future publication of the Madison County flora. Additionally, all of these objectives provide a reference baseline for future comparative studies and potential land management decisions.

THE STUDY AREA

History

Pullins-Rucker Cemetery.—Dead Horse Knob on topographic maps by Weir (1967) was historically known as Rucker's Knob to acknowledge two pioneer families who initially colonized and farmed the immediate surrounding land. A unique feature at the knob summit is an abandoned small private cemetery, the Pullins-

Rucker Cemetery. Descendants of the Pullins and Rucker families intermarried and used the graveyard as a burial ground for their relatives. The cemetery dates from Revolutionary War times, with the interment of Loftus Pullins, Jr. (1764–1841), a Revolutionary War soldier with the Virginia Militia who served in the regiment of Colonel Sampson Matthew under General George Washington at the Battle of Yorktown in 1781. After his Revolutionary War service, Loftus Pullins, Jr. received a small pension in Kentucky, and he moved to southern Madison County with his family in 1787 (E.T. Pullins, pers. comm. 2010). His grandson, Alva Pullins, Jr., married Alma Rucker, a descendant of Jeremiah Rucker, Jr. and Susan Ann Morton, owners of the land that encompassed Rucker's Knob in the 1860s. One of their sons, John Morton Rucker, farmed the land until it was sold to Joseph and Sallie Coyle in 1888.

On September 27, 1898, Berea College acquired "the Jeremiah Rucker Place" of 15.8 ha from the Coyle family including the knob, which then became known as "Rucker's Knob" (S. Wilson, pers. comm. 2011). Among the few markers in the Pullins-Rucker Cemetery, only Loftus Pullins, Jr. (1764–1841), Celia Pullins (1775–1841), Samuel Pullins (1807–1832), James Pullins (1794–1854), and Susan A. (Morton) Rucker (1815–1855), are identified. The Daughters of the American Revolution placed an additional marble commemorative marker on the Loftus Pullins grave site on November 8, 1981 (E.T. Pullins, pers. comm. 2010).

Brick and Tile Yard.—Another significant historic feature of Dead Horse Knob was the presence of gray clay from weathered New Albany Shale in the vicinity of the western foot slope. This clay was excavated from a group of shallow pits that were used for brick and tile making by Berea College workers in the early 1900s. These obliterated clay cavities range from 1.0–2.0 m in depth and now lie in the concave flatlands contiguous to the western foot slope of Rucker's Knob (Foerste 1906).

During the 19th century, Berea College building campaigns needed great quantities of bricks for college buildings and as a labor industry for many male students (Boyce 2006). In 1901, Berea College created a large Brick and Tile Yard adjacent to the western side of Rucker's Knob where bricks were hand-made by students. In 1902, a brick machine and kiln increased the operation to a high capacity of several thousand bricks per day. By 1906, because of higher production needs, the brickyard industry created up to 25,000 bricks per day from four kilns with excess bricks shipped to other regional cities by a switch line of the Louisville & Nashville Railroad. The Berea College Brick and Tile Yard operation at Rucker's Knob was closed down in January 1911 (Boyce 2006). Among college buildings constructed with the red bricks from the clay pits at Rucker's Knob, were the Edwards Building (Men's Industrial Building/College Square) in 1902–1903, the Phelps Stokes Chapel (Main Chapel) during 1903–1906, and the Frost Building (originally Carnegie Library) in 1904–1907 (Boyce 2006).

Physiography

Fenneman (1938) classified the physiographic region comprising Dead Horse Knob as the Kentucky Knobs Region within the Interior Low Plateaus Physiographic Province. Braun (1950) described the southern Kentucky Knobs Border Area of the Interior Low Plateaus from Berea to Frenchburg to be included within the Hill Section of the Norman Uplands. Quarterman and Powell (1978) designated this hilly region as the Knobstone Escarpment of the Interior Low Plateaus. Keys et al. (1995) classified the ecological unit, which would include DHK, into the Eastern Knobs Transitional Subsection of the Interior Low Plateau, Highland Rim Section of the Eastern Broadleaf Forest Province.

Based on the most recent classification per Woods et al. (2002), the knobs of southern Madison County are located entirely within the 400 million-year-old Knobs-Norman Upland Ecoregion of the Interior Plateau Physiographic Province. These Uplands are interspersed among the western and eastern Outer Bluegrass Ecoregion, the southern Hills of the Bluegrass Ecoregion, the northeastern Cumberland Plateau Ecoregion, and the Northern Forested Plateau Escarpment of the Western Alleghany Plateau (Woods et al. 2002). The rugged terrain of the Knobs is characterized by colluvial and residual shale, limestone, and sandstone slopes with the higher ridgetops often capped by vertical conglomeratic sandstone cliffs inclining down steep V-shaped hills and ridges into broad U-shaped valleys. These landscapes are subsequently drained by numerous dissected intermittent first order and flowing second order streams. In the Knobs Region, vast open agriculture and pasture lands adjoin and surround the moderately hilly terrain (Woods et al. 2002).

Geology

The Knobs-Norman Uplands are underlain by Silurian, Devonian, Mississippian, and Pennsylvanian-aged sedimentary bedrock (Woods et al. 2002). At DHK, the bedrock is entirely underlain by the New Albany Shale Formation of the Middle and Upper Devonian System (Weir 1967). To the north and west of DHK, the Knobs-Norman Uplands intergrade into the Outer Bluegrass Ecoregion. The Outer Bluegrass is characterized by broad rolling hills consisting of Upper Ordovician limestone bedrock on open, flatland topography dissected by shallow, narrow streams (Woods et al. 2002).

The New Albany shale of southern Madison County consists of carbonaceous, black shale about 24 to 30 m thick containing sparsely crystalline pyrite and concretions of fine-grained calcitic and iron-rich or phosphatic material. When weathered, this black shale is typically brownish-black to yellowish-brown often with a few thin seams (2.5–4.0 cm)of yellowish-green shales, which locally form abundant chips and plates on outcrops (Campbell 1946). Megafossils are scarce and are mainly comprised of small brachiopods, fish plates, plant parts, and spores (Campbell 1946). In the vicinity of DHK, basal content is evident where shale rests concordantly above the Middle Devonian Boyle Dolomite.

Although the DHK summit is only 312 m above sea level, it is unique in being the only solitary, isolated knob to be separate from other higher elevated peaks of the Berea College Forest (BCF). Within the adjacent BCF in southern Madison County, higher knob summits range from Welch Mountain (383 m), West Pinnacle or Barton Knob (453 m), East Pinnacle (458 m), Robe Mountain (465 m), and Pinnacle Knob (487 m) to Bear Mountain (504 m), the highest point in Madison County (Weir 1967; Weir et al. 1971). Within the city of Berea proper on the Devonian black shale Berea Ridge, elevations vary from 267 m at Silver Creek to 316 m on the Berea College campus to 324 m in the Dogwood Heights subdivision (Thompson et al. 2008).

Forest Vegetation

Deciduous forest vegetation of southern Madison County mainly consists of Oak-Hickory Forest (Küchler 1964; Woods et al. 2002; Thompson 2008). Braun (1950) classified some forest vegetation of more separated hills in the Knobs Region as examples of Oak-Hickory communities within the Western Mesophytic Forest Region, a transitional mosaic of Oak-Hickory Forest and Mixed Mesophytic Forest. Evans (1991) characterized vegetation in the Knobs Region as Acidic Sub-Xeric Forest based on topographic moisture, slope aspect, and dominant forest vegetation consisting of Oak-Hickory components with a poorly-developed understory and sparse herbaceous cover.

In the oil-bearing Devonian black shale Knobs Region, Wharton (1945) described five upland forest types: oak, oak-pine, chestnut oak-scarlet oak, white oak, and mixed mesophytic, while Muller and McComb (1986) reported white oak, chestnut oak, scarlet oak, and mesophytic hardwoods forest types in their study of upland forests of the Knobs Region. Vegetation studies in the Knobs Region have emphasized the correlation of forest types with soils, site moisture characters, slope position, topographic aspect, and physiognomy over time (Wharton 1945; Braun 1950; Fedders 1983; Muller & McComb 1986; Woods et al. 2002; Thompson 2008). Dry-Mesic Oak-Hickory Forest is the major vegetation, albeit altered, of DHK from the knob summit down to interspersed planted pines stands of upper slopes, middle slopes, lower slopes, and foot slopes at the boundary, with the perimeter being grassland pasture habitat.

Soils

As mapped by the Web Soil Survey (Soil Survey Staff 2012) from Newton et al. (1973), the 2.6 ha of DHK is comprised of four major forest soil series (Fig. 2). The knob residual and colluvial soils belong to the Coyler-Weikert-Captina Association. These series are characteristically shallow, moderately well-drained, acid in reaction (4.5–5.0 pH) from the summit down all steep slope aspects to foot slopes (Newton et al. 1973).

Coyler shaley silt loam (CoF) comprises the shallow soils of 0.8 ha (of the total 2.6 ha DHK site), for 31.6% of the area on the summit and upper western-trending slopes. Coyler soils are clayey-skeletal residuum weathered from New Albany Shale on steep 12 to 50 percent slopes. This soil is very strongly acidic in reaction, excessively well-drained, channery silt clay loam from 0 to 51.0 cm to the shale bedrock. The soil profile of the A surface horizon is 0 to 12.7 cm deep, brown, friable, fine granular channery shaley silt loam with small black

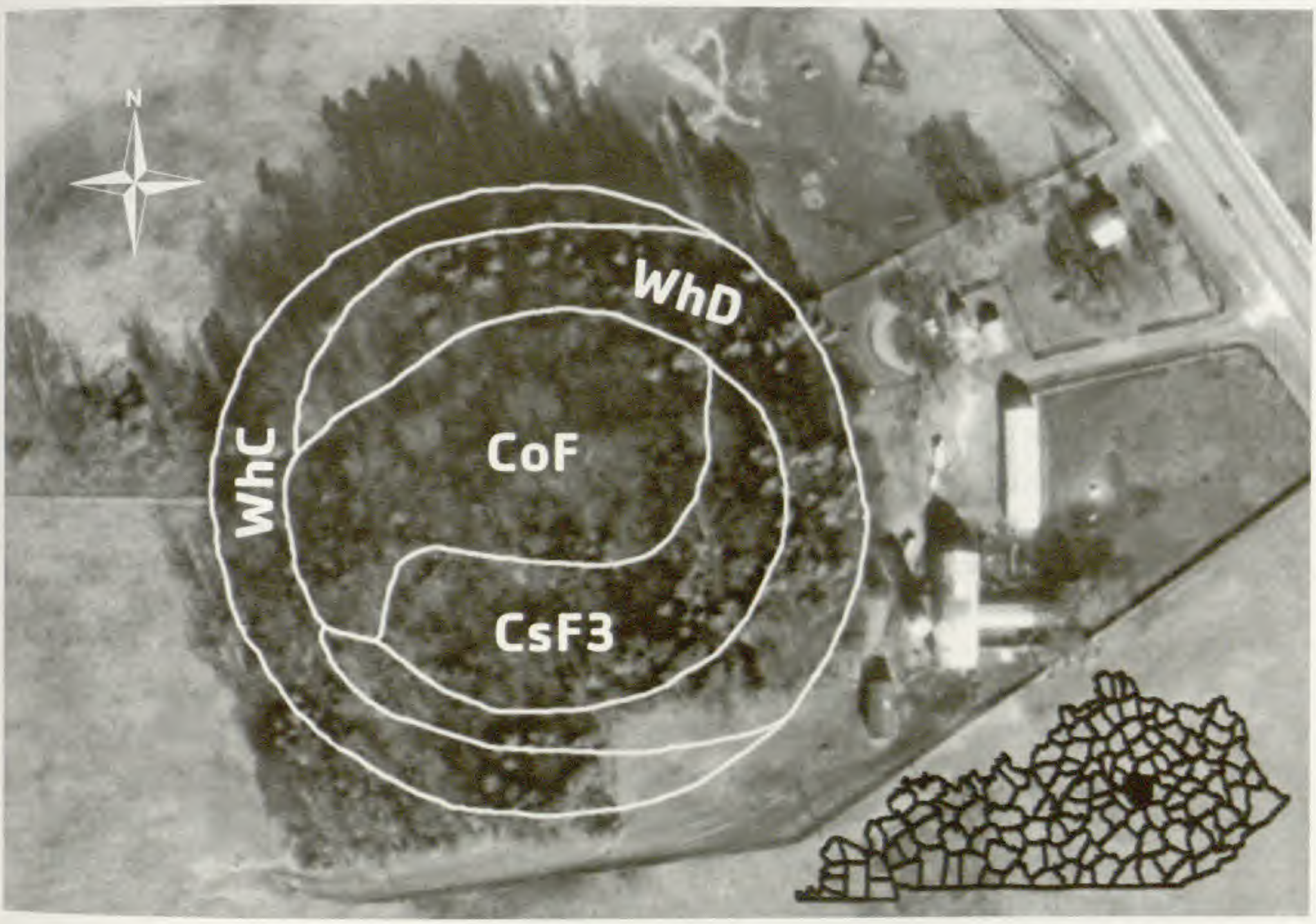

Fig. 2. Soils of Dead Horse Knob, Madison County, Kentucky. Map unit symbol, unit name, slope and area percentages adapted from Soil Survey Staff (2012): CoF (Colyer shaley silt loam, 12–50% slopes, 0.81 ha, area 31.6%); CsF3 (Colyer shaley silty clay loam, 12–50% slopes, severely eroded; 0.57 ha, area 21.8%); WhC (Whitley silt loam, 6 to 12% slopes; 0.45 ha, area 16.8%); and WhD (Whitley silt loam, 12 to 20% slopes; 0.77 ha, area 29.8%).

shale fragments; the B horizon varies from 12.7–38.1 cm deep, yellowish-brown, friable to firm, very heavy channery silty clay with 35 percent black shale fragments; the C horizon is 38.1–50.8 in depth, brown heavy silty clay with 75 percent highly weathered black shale layers down to the unweathered hard, brittle, black shale bedrock of the R horizon (Newton et al. 1973; Fig. 2).

The highly eroded Coyler shaley silty clay loam (CsF3) is the principal soil of another 0.6 ha, for 21.8% of the area, on southern and eastern upper and middle 12 to 50 percent slopes. Coyler shaley silty clay loams are different in composition from CoF in having the top brown surface layer lost through erosion and a surface layer of exposed yellowish-brown silty clay loam present (Newton et al. 1973; Fig. 2).

Whitley silt loam soils (WhC) comprise the deep soils of a circular, crescent-shaped band of 0.5 ha, for 16.8% of the site, on the southern and western middle slopes, lower slopes, and foot slopes. Whitley silt loam is fine-silty colluvium derived from weathered New Albany Shale on 6 to 12 percent slopes. This weathered soil is very strongly acid, deep, well-drained, silt loam to gravelly silty clay loam from 0 to 122 cm to shale bedrock. The soil profile is an A horizon from 0–23 cm deep, dark yellowish-brown, friable granular silt loam; the B horizon ranges from 23–91.4 cm deep, brown to yellowish-brown, moderate to fine and medium blocky heavy silt loam with a few, small black concretions; and the C horizon ranges is 91.4–122 cm in depth of yellowish-brown silty clay loam with fine, distinct light, brownish gray clay mottles with an abrupt smooth boundary. The R horizon beyond 122 cm consists of highly fissured black shale bedrock (Newton et al. 1973; Fig. 2).

Whitley silt loam (WhD) soils are in colluvial areas totaling 0.7 ha, for 29.8% of the area, at the base of 12 to 20 percent foot slopes at the northern and eastern aspects and part of the southern mid-slope. The WhD soil profile is similar to the WhC soils but differs in a 7.6 cm thick yellowish-brown silt loam surface layer intermixed with clayey subsoil material (Newton et al. 1973; Fig. 2).

Climate

The continental climate of Kentucky has warm to hot summers, mild to cold winter temperatures, and generally abundant moisture during all seasons (Trewartha & Horn 1980). Kentucky climatic data for 1971–2000 were obtained from the Berea College Weather Station-150619 (Midwest Climate Center 2011). Mean length of the growing season is 194 days. Median first frost is October 22 and the median last frost occurs April 10. Mean annual precipitation is 120.2 cm with the highest in May at 13.4 cm and the lowest in October at 7.8 cm. Mean annual snowfall approximates 29.7 cm. Mean annual temperature of Berea is 13.6°C with January the coldest month at 1.5°C and August the warmest month at 24.3°C (Midwest Climate Center 2011).

METHODS AND MATERIALS

Vascular plants at DHK were collected from 26 field trips during the growing seasons of 2010 (11 trips), 2011 (10 trips) and spring 2012 (5 trips). A complete voucher specimen set is deposited at the Berea College Herbarium (BEREA) and a partial duplicate set is filed at the University of North Carolina-Chapel Hill Herbarium (NCU). In the annotated species list, the following data are assigned for each taxon: origin (native vs. exotic), invasive plant pest status, Madison County distribution records, relative abundance, habitat(s) of occurrence, and collection number(s).

Gleason and Cronquist (1991), Jones (2005), and Weakley (2011) were the primary manuals consulted for taxon identification. Madison County records were determined based on Campbell and Medley (2012), Clark and Weckman (2008), USDA, NRCS (2012), and from herbarium searches of BEREA and Eastern Kentucky University Herbarium (EKY). A relative abundance value was assessed for each taxon utilizing the definitions of Thompson (2007). Each taxon was assigned a single comprehensive value inclusive for all plant community habitats.

Nomenclature follows Weakley (2011), with two exceptions mentioned later. Assigned exotic status was also based on Weakley (2011), except where origin was dubious and the species are considered invasive in Kentucky (e.g., *Chenopodium album*, *Dysphania ambrosioides*). Invasive pest plant status is from the current list from the Kentucky Exotic Plant Pest Council (KY-EPPC 2012).

Plant communities were delineated through field reconnaissance and sampling data of characteristic associated and/or dominant species in conjunction with physical factors (general topography, slope aspect, moisture regimes, soil types, geology) and anthropogenic influences (livestock disturbance, invasive plant impact, farming practices).

Diameter at Breast Height (DBH) measurements were made on selected canopy trees with Haglöf Swedish Mantax Black Calipers® and transverse core samples for age determination of the largest pine species using a Haglöf Swedish Increment Borer®.

RESULTS AND DISCUSSION

Taxonomic Summary

The vascular flora of Dead Horse Knob consists of 291 species (this total includes infraspecific taxa) in 191 genera from 67 families (Table 1). The flora includes two Monilophytes (0.69%), five Gymnosperms (1.72%), and 284 Angiosperms (97.59%), comprised of 71 Monocots (24.40%) and 213 "Dicots" (73.20%), the latter including eudicots and the paraphyletic grade of "basal angiosperms." The six largest families in species are the Poaceae (43), Asteraceae (39), Cyperaceae (17), Brassicaceae (15), Fabaceae (15), and Rosaceae (13). *Carex* is the largest genus with 15 taxa, followed by *Quercus* with 8 taxa. The 116 exotic taxa (39.86% of the total flora) are all Angiosperms (27 Monocots and 89 "Dicots"). Pyšek (1998) reported that the Poaceae, Asteraceae, Fabaceae, and Brassicaceae are the four families that accounted for the greatest percentage of exotic species in local floras from 26 regions in a worldwide survey, and indeed, the DHK flora follows the same trend, as the four families with the most naturalized species are Poaceae (24), Asteraceae (13), Brassicaceae (12), and Fabaceae (11). No state-listed rare, endangered, or threatened species according to the Kentucky State Nature Preserves Commission list (KSNPC 2010) are present.

Table 1. Taxonomic distribution of vascular plants of the Dead Horse Knob, Kentucky.

Clade	Families	Genera	Taxa*	Native	Exotic	Percent of Total Flora
Monilophytes	2	2	2	2	0	0.69
Gymnosperms	2	2	5	5	0	1.72
Angiosperms	63	187	284	168	116	97.59
Monocots	9	40	71	44	27	24.40
"Dicots"	54	147	213	124	89	73.20
Totals:	67	191	291	175	116	100.00

*Note: The number of taxa is equal to the number of species.

Madison County Records

Nine taxa (3.09% of the total flora) are new county distribution records for Madison County based on map data from Campbell and Medley (2012), Clark and Weckman (2008), USDA, NRCS (2012). The USDA, NRCS (2012) map distributions for Kentucky counties were mainly from atlas map data provided by Campbell and Medley (2006).

1. *Carex gravida* L.H. Bailey.—Campbell and Medley (2012) map Heavy Sedge for Campbell County (*Naczi CGE 45, 06 June 1996*, KNK) and Trigg County (*Thompson and Poindexter 04-412, 08 May 2004*, BEREA) from Thompson and Poindexter (2006). This sedge is not listed for Kentucky by the USDA, NRCS (2012).

2. *Carex umbellata* Schkuhr ex Willd.—Campbell and Medley (2012) list 26 counties for Parasol Sedge and remark that it is often overlooked in scattered, dry open woods. We found several populations on the dry western lower slope and foot slope in a mixed *Juniperus virginiana* var. *virginiana* and *Pinus echinata* stand.

3. *Carex texensis* (Torr. ex L.H. Bailey) L.H. Bailey.—Campbell and Medley (2012) record the Texas Sedge for 14 counties with our specimen listed for Madison County. Our collection was rare under *Pinus echinata* on a western lower-slope.

4. *Crataegus macrosperma* Ashe.—Clark and Weckman (2008) record 12 counties for the Fanleaf Hawthorn mostly from eastern Kentucky, while Campbell and Medley (2012) confirm it from seven counties. The USDA, NCRS (2012) lists only Harlan and Letcher counties.

5. *Galium divaricatum* Pourr. ex Lam.—Campbell and Medley (2012) catalog Lamarck's Bedstraw for Campbell, Estill, and Powell Counties. USDA, NRCS (2012) record Campbell and Estill Counties, from records in Campbell and Medley (2006). Medley (1993) does not list *G. divaricatum* for Kentucky.

6. *Malus baccata* (L.) Borkh.—The complexity of Siberian Crabapple cultivars is discussed in Clark and Weckman (2008), but the taxon is not mapped. Campbell and Medley (2012) record Siberian Crabapple for Fayette, Floyd, and Jefferson Counties. The USDA, NRCS (2012) map Fayette and Floyd Counties. Our documented taxon appeared to be spontaneous, rather than planted, from a single fertile tree on the eastern aspect near the knob crest. Jones (2005) notes that the flowering crabapples, especially *M. baccata*, may occasionally escape in Kentucky.

7. *Malus prunifolia* (Willd.) Borkh.—Although the Chinese Plum-leaf Crabapple tends to escape and become locally established from cultivation (Campbell and Medley 2012), neither Clark and Weckman (2008) nor Campbell and Medley (2012) map Chinese Crabapple for Kentucky. Gleason and Cronquist (1991) corroborate that Chinese and Siberian Crabapples occasionally escape from cultivation. Several uneven-age specimens of this crabapple (including fruiting and flowering material) were documented from the western foot slope, so even if it might originally have been planted in the area, it is now clearly naturalized.

8. *Quercus phellos* L.—Willow Oak is documented from 22 counties according to Campbell and Medley (2012) and from 19 Kentucky counties by the USDA, NRCS (2012). A single, mature individual at DHK is present, although its origin is not clear. Given the long history of human presence in the area, this tree may be derived from a local source, or it may be a natural volunteered tree.

9. *Ranunculus bulbosus* L.—The naturalized Bulbous Buttercup is confirmed for 10 Kentucky counties in Campbell and Medley (2012) and also is listed for 10 counties by the USDA, NRCS (2012).

Invasive Plants

Fifty-two of the exotic species from Dead Horse Knob are considered naturalized invasive plant pests for Kentucky (KY-EPPC 2012). Based on our intensive observations, the most deleterious species on the peak appear to be the Old World woody plants: *Ailanthus altissima*, *Celastrus orbiculatus*, *Elaeagnus umbellata*, *Euonymus alatus*, *E. fortunei*, *Ligustrum obtusifolium* var. *obtusifolium Lonicera japonica*, *L. maackii*, and *Rosa multiflora*, all of which were deliberately introduced to the United States as ornamentals. Reichard and White (2001) discussed the role of ornamental horticulture in the spread of invasive plant introductions in the United States. Major horticultural sources of naturalized and invasive taxa include plant nurseries, landscaping enterprises, botanical gardens and arboreta, city and state parks, individual gardeners and farmers, and soil erosion control measures by state and governments agencies (Reichard & White 2001). We have no means of determining if any of these taxa were deliberately introduced at DHK, but there is no disputing that these ornamental taxa are now naturalized invasives having a profound impact on the vegetation in the area.

These same woody invasive taxa were the most significant woody plant pests in a comprehensive vascular plant survey of the Berea College Forest (Thompson 2008). At the knob, all nine of these invasive woody plants clearly meet the criteria of being "novel, invasive colonizers," i.e., the true invaders *sensu* Davis and Thompson (2000), aggressively expanding their geographical range and constituting a severe impact on the natural native flora and vegetation. Without doubt, the most aggressive invasive species with the greatest deleterious impact on the total vegetation and native plants of the knob is *Lonicera maackii*. This omnipresent species comprises a dense understory cover throughout all slope aspects of the Dry-Mesic Oak-Hickory Forest. Reichard and Hamilton (1997) noted that invasive woody plants are frequently more capable of vegetative reproduction than native woody plants in North America, but it is not clear how much, if at all, *L. maackii* spreads vegetatively at DHK. While it certainly regenerates readily when cut back, the clumps are of uneven sizes and ages, do not appear to be connected via rhizomes, and fruit copiously, which indicate that *L. maackii* may be spreading primarily by seed.

Invasive herbaceous plants with significant impact on the native flora and vegetation of the Dry-Mesic Oak-Hickory Forest include *Alliaria petiolata*, *Commelina communis*, *Microstegium vimineum*, *Persicaria longiseta*, *Schedonorus arundinaceus*, and *Stellaria media*, among several others. *Stellaria media* in the spring, *Commelina communis* and *Persicaria longiseta* (in the summer) and *Microstegium vimineum* (in the fall) are especially abundant throughout the entire knob forested habitats.

Plant Communities

Plant communities are defined as an assemblage of associated species with a definite floristic composition and a uniform physiognomy under rather consistent habitat conditions as detectable through field reconnaissance and sampling data (Thompson & Jones 2010). The DHK study area is completely bisected by a four-wired electric fence from the eastern foot slope aspect to the knob summit down through the western aspect foot slope. This nearly equivalent division of the study area into southern and northern halves was useful for delineating southern, western, northern, and eastern slope aspect habitats. The circular knob perimeter is surrounded by barbed wire fences where all foot slope aspects adjoin nearly level agricultural grassland pasture. We define essentially two community types here: a highly altered Dry-Mesic Oak-Hickory Forest Community comprised of five specific habitats and a heavily disturbed Culturally-Derived Ruderal Community composed of two habitats.

Dry-Mesic Oak-Hickory Forest Community

The major vegetation of the knob is a substantially human-influenced second and third growth stand of Dry-Mesic Oak-Hickory from the knob summit with mixed oaks and hickory down to upper, middle, and lower slopes where oaks and hickories are intermixed with planted pines on all four directional slope aspects. Indicator oak and hickory and other characteristic hardwoods in varying quantities are typically found in all size-age classes from seedlings, saplings, pole-size, and mature trees. Three interplanted pine species, *Pinus echinata*, *P. strobus*, and *P. taeda*, are mainly mature-sized trees that exhibit little to no seedling recruitment. We estimated the occurrence of these pine stand plantings at approximately 22% of the total canopy cover of the forested knob, which included the entire study area and other communities/habitats described below.

Herbaceous and woody vegetation development has been considerably disturbed by livestock and by the severe influences of naturalized woody invasive plants. The overall effects on the flora and vegetation from cattle grazing, browsing, and trampling activities are currently more evident on the fenced northern half of the knob; nevertheless, the southern half has also been affected in species richness (number of plant species) and species diversity (types of plant species). The Dry-Mesic Oak Community is described from four slope aspect-delineated habitats: Knob Summit, Southern and Eastern Aspects, and Northern and Eastern Aspects, and a seasonal Western Foot Slope Seep.

1. Knob Summit.—Soils are mostly Coyler shaley silt loams at the DHK mountain crest (Fig. 2). Vegetation is comprised of Dry-Mesic Oak-Hickory Forest without planted pines. This dry, open-canopied knob summit habitat is typified by a sparse native herb layer, a very dense nearly impenetrable *Lonicera maackii* understory shrub layer and some tree seedlings and saplings in a canopy overstory of mature *Quercus* and *Carya* species. Important indicator trees are *Carya ovata*, *C. glabra*, *Quercus alba*, *Q. falcata*, *Q. stellata*, and a hardwood mixture of *Acer rubrum* var. *rubrum*, *Fraxinus americana*, *Nyssa sylvatica*, *Prunus serotina* var. *serotina*, *Quercus velutina*, and *Robinia pseudoacacia*. The two largest *Quercus alba* at the knob crest are 100.3 and 102.5 cm DBH, while the two largest *Q. stellata* are 103.1 and 105.8 cm DBH.

Besides *Lonicera maackii*, other naturalized woody plants include *Euonymus alatus*, *E. fortunei*, *Ligustrum obtusifolium* var. *obtusifolium*, and a single *Pyrus calleryana*. *Symphoricarpos orbiculatus* and *Rubus pensilvanicus* are typical native shrubs. The preeminent woody vines are *Lonicera japonica* and *Toxicodendron radicans* var. *negundo*. Characteristic native woody vines are *Parthenocissus quinquefolia*, *Smilax bona-nox*, *S. glauca*, and *Vitis vulpina*.

The herbaceous layer of the knob summit is sparse mainly due to the deleterious effects of *Lonicera maackii* and the dry topographic-moisture gradient from high insolation. The abundant exotic annual *Stellaria media* forms a nearly continuous spring ground cover. Important native graminoids are *Agrostis perennans*, *Carex blanda*, *C. glaucodea*, *C. swanii*, *Danthonia spicata*, *Dichanthelium acuminatum* var. *fasciculatum*, and *Sphenopholis intermedia*. Among the few native dicot herbaceous species are *Cardamine concatenata*, *Corydalis flava*, *Erigeron annuus*, *Galium aparine*, *Oxalis violacea*, *Paronychia canadensis*, *Penstemon brevisepalus*, *Phytolacca americana*, and *Potentilla simplex*.

At the Knob Summit during May 2011, Thompson and Poindexter (2011) conducted a quantitative floristic study of species richness within the Pullins-Rucker Cemetery after the removal of *Lonicera maackii* and other understory shrubs and tree saplings from a 30 × 15 m area with a chain saw and hand clippers. In September 2011, frequency data were determined through a 20 × 12 m test cemetery macroplot with thirty (1 × 1 m^2) quadrats randomly placed after *Lonicera maackii* removal. Likewise, frequency data were gathered through a reference macroplot in an adjacent *L. maackii* thicket using the same parameters (Thompson & Poindexter 2011).

Species richness in the 30 cemetery test quadrats contained 51 different species with nine additional taxa recorded outside the quadrats for a total of 60 taxa within the test macroplot. In order of decreasing frequency, taxa with 50% or greater frequency across the quadrats, were *Phytolacca americana*, *Oxalis stricta*, *Solanum ptychanthum*, *Erechtites hieraciifolius*, *Persicaria longiseta*, and *Ailanthus altissima* (Thompson & Poindexter 2011).

Twenty-one species were documented in the 30 quadrats of the reference *Lonicera maackii* macroplot, and only *L. maackii* and *L. japonica* had 50% or greater frequency (Thompson & Poindexter 2011).

A field trip in October 2011 after the September 2011 inventory within the cemetery macroplot revealed the additional presence of *Ageratina altissima*, *Clematis virginiana*, and *Symphyotrichum lateriflorum* for a total of 63 taxa. In March 2012, the cemetery macroplot was dominated by a thick cover of *Stellaria media* with intermixed *Lamium purpureum*, *Cardamine hirsuta*, *Galium aparine*, and *Taraxacum officinale* in order of relative abundance with several volunteer and resprouted *Lonicera maackii* seedlings and a few *Ailanthus altissima*, *Celastrus orbiculatus*, and *L. japonica* sprouts. During the monthly surveys in March through June 2012, 32 more species were discovered within the cemetery macroplot for an overall 95volunteering taxa. These new additions consisted of *Ambrosia trifida* var. *trifida*, *Anthoxanthum odoratum*, *Aralia spinosa*, *Arctium minus*, *Cardamine hirsuta*, *Carex swanii*, *Cerastium glomeratum*, *Cirsium discolor*, *C. vulgare*, *Corydalis flava*, *Daucus carota*, *Dichanthelium acuminatum* var. *fasciculatum*, *Erigeron philadelphicus*, *Galium aparine*, *Holcus lanatus*, *Juglans nigra*, *Juncus effusus* ssp. *solutus*, *J. tenuis*, *Lactuca serriola*, *Leersia virginica*, *Lepidium virginicum*, *Morus rubra*, *Packera glabella*, *Poa pratensis* ssp. *pratensis*, *Ranunculus abortivus*, *Rumex obtusifolius*, *Sanicula canadensis* var. *canadensis*, *Schedonorus arundinaceus*, *Solidago altissuma* var. *altissima*, *Torilis arvensis*, *Ulmus rubra*, and *Verbascum thapsus*.

These 95 species within the cemetery test macroplot comprised a noteworthy 32.65% of the total DHK species richness after additional collections from October 2011 and monthly collections during March-June 2012. Among these individuals, 10 of the colonizing herbaceous species were found only in the cemetery macroplot and nowhere else: *Acalypha rhomboidea*, *Ageratina altissima*, *Chamaesyce maculata*, *Cirsium discolor*, *Commelina diffusa*, *Conoclinum coelestinum*, *Eclipta prostrata*, *Eupatorium serotinum*, *Packera glabella*, and *Passiflora incarnata*. Most of the 60 species prior to the October 2011 collection were also observed during the 2012 trips.

A majority of the herbaceous species colonizing the cemetery macroplot are annuals and biennials from seeds and fruit propagules in the existing seed bank and from light, wind-carried diaspores of the seed rain (e.g., members of the Asteraceae). Most of these early successional annuals are not expected to persist as secondary succession continues in time with the presence of *Lonicera maackii* (Thompson & Poindexter 2011).

The plot sampling data from September 2011 revealed that a high density of *Lonicera maackii* was significantly correlated with lowered species richness of both exotic and native annual and perennial herbs, shrubs, and tree seedlings. Much greater species richness was evident in the cleared cemetery macroplot. The cemetery macroplot is being reinvaded by *L. maackii* and as predicted, it will result in a corresponding decrease in species richness and species diversity and comprise another thicket in a relatively short period of time without significant control measures (Thompson & Poindexter 2011).

2. *Southern and Western Aspects*.—The forested southern slope aspect from the summit down to foot slope is primarily composed of Coyler shaley silty clay loam soil, while the western slope aspect adjoining the summit inclining to foot slope is comprised mostly of Whitley silty clay loam (Fig. 2). The canopy composition on the drier southern and western slopes consists of Dry-Mesic Oak-Hickory Forest comparable to that at the knob summit with the addition of the interplanted *Pinus echinata*, *P. strobus*, and *P. taeda*, a few more native and exotic shrubs, and several more herbaceous species.

Most pines are mature canopy trees with some recruitment of Eastern White Pine seedlings and saplings evident, but no regeneration from Shortleaf Pine and Loblolly Pine. A few *Pinus virginiana* scattered throughout the southern and western slopes have sparse regeneration along with *Juniperus virginiana* var. *virginiana*. The three intermixed pine plantations were planted in 1962, according to information from the individual who supervised the plantings (C.L. Gentry, pers. comm. 2012). Most pines were planted on the southern, western, and northern middle slopes to lower slopes. Representative pine tree ages were confirmed by eight core samples on the southern aspect from four *Pinus strobus* and four *P. taeda*. The sample cores of the largest *Pinus strobus* of the southern aspect ranged from 47–49 yr old (41.5–55.0 cm DBH). Similarly, cores from the four largest *Pinus taeda* were 48–49 yr old (44.9–49.5 cm DBH). *Juniperus virginiana* var. *virginiana* is the most important coniferous indicator species among the oaks and hickories on the more open southwestern aspects. The largest *Quercus falcata* have DBHs of 103.3 and 105.8 cm. *Quercus imbricaria* is also an important additional species of the southern and western slopes with the two largest 66.7 and 77.0 cm DBH. Other characteristic trees are *Acer rubrum* var. *rubrum*, *Diospyros virginiana*, *Fraxinus americana*, *Nyssa sylvatica*, *Prunus serotina* var. *serotina*, *Robinia pseudoacacia*, and *Sassafras albidum*. *Lonicera maackii* is less prevalent on the drier southern and western slopes than the mesic northern and eastern aspects. Subcanopy trees and other shrubs of varying abundances are *Amelanchier arborea*, *Cornus florida*, *Frangula caroliniana*, *Ilex opaca*, *Rhus copallinum* var. *latifolia*, *R. glabra*, *Rosa multiflora*, *Rubus pensilvanicus*, *Vaccinium stamineum*, and *Viburnum rafinesquianum*. *Symphoricarpos orbiculatus* is the most widespread native shrub. Important woody vines include *Campsis radicans*, *Lonicera japonica*, *Parthenocissus quinquefolia*, *Smilax bona-nox*, *S. glauca*, and the ubiquitous *Toxicodendron radicans* var. *negundo*.

Characteristic native herbs on the southern and western slopes down to the foot slopes adjoining the fence line and the grassland pasture are *Agrostis perennans*, *Andropogon virginicus* var. *virginicus*, *Carex leavenworthii*, *C. swanii*, *C. texensis*, *C. umbellata*, *Chimaphila maculata*, *Danthonia spicata*, *Dichanthelium acuminatum* var. *fasciculatum*, *Elymus virginicus* var. *virginicus*, *Juncus tenuis*, *Panicum anceps*, *Paronychia fastigiata*, *Penstemon brevisepalus*, *Phytolacca americana*, *Potentilla simplex*, *Sisyrinchium angustifolium*, and *Symphyotrichum dumosum* var. *dumosum*. *Tipularia discolor*, the only orchid species present, and *Polygonatum biflorum* var. *biflorum* are scarce at the western-trending middle slope.

3. *Northern and Eastern Aspects.*—The soil at the upper northern slope from the knob summit habitat is mostly Colyer shaley silt loam and on the lower slope to foot slope is Whitley silt loam soil. The eastern aspect is comprised of Coyler shaley silt loam that adjoins the summit and intergrades into the Whitley silt loam soils (Fig. 2). The canopy vegetation of the northern and eastern aspect slopes also consists of Dry-Mesic Oak-Hickory Forest interspersed with mixed pine plantings, as in the case of the southern and western-trending aspects (Fig. 2). Pine regeneration here is basically non-existent. A significant, marked difference between the mesic northern and eastern slope aspects is the presence of greater species richness of the herbaceous and woody plants than the southern and western slopes, although mature canopy trees tend to be smaller-sized. The higher native and exotic species richness of the northern and eastern topographic aspects is related to greater canopy shade, more available soil moisture, and deeper soils.

At DHK, slope aspect differences result in greater vegetation diversity and richness on the northern and eastern aspects but larger trees on the southern and western aspects. These data are congruent with recent slope aspect data from an Appalachian watershed study in West Virginia by Desta et el. (2004). More pronounced cattle grazing and trampling on the northern and eastern aspects have also influenced the presence of more abundant exotic herbs and shrubs than on the southern and western aspects with lesser livestock impact.

Major canopy trees are mainly those mentioned above for the Oak-Hickory knob crest and southern and western aspects. The largest trees of this area are *Acer rubrum* var. *rubrum* (74.1 cm DBH), *Prunus serotina* (87.4 cm), and *Robinia pseudoacacia* (91.2 cm). Other mature trees include *Acer negundo* var. *negundo*, *A. saccharum*, *Ailanthus altissima*, *Aralia spinosa*, *Celtis occidentalis*, *Fraxinus pennsylvanica*, *Morus rubra*, *Ulmus americana* var. *americana*, and *U. rubra*. A few *Quercus montana* are located on the northern mid-slope and *Liquidambar styraciflua* is present on the eastern lower slope.

Naturalized woody shrubs on the northern and eastern slopes are *Elaeagnus umbellata* var. *parviflora*, *Ligustrum obtusifolium* var. *obtusifolium*, *Lonicera maackii*, and *Rosa multiflora*, with the invasive woody vines, *Celastrus orbiculatus*, *Euonymus fortunei*, and *Lonicera japonica*. A marked difference is the lesser abundance of *Lonicera maackii* due to browsing and trampling by livestock on the fenced northern half of the knob. Characteristic native shrubs include *Rubus pensilvanicus*, *Sambucus canadensis*, and *Symphoricarpos orbiculatus*. *Toxicodendron radicans* var. *negundo* is the predominant native woody vine with fewer *Campsis radicans*, *Clematis virginiana*, *Parthenocissus quinquefolia*, *Smilax rotundifolia*, and *Vitis vulpina*. A few clumps of *Phoradendron leucarpum* ssp. *leucarpum* are found in three *Prunus serotina* var. *serotina* trees and a single *Gleditsia triacanthos* on the northern upper slope.

The herbaceous layer on the mesic northern and eastern aspects predictably has a high species richness and species diversity. *Carex amphibola*, *C. blanda*, and *C. grisea* are important sedges on the rich leaf mold soil litter layer. *Asplenium platyneuron* is scarce on the northern and northeast-trending mid-slopes. Other characteristic native herbs of various abundance are *Bidens bipinnata*, *Dichanthelium clandestinum*, *Elymus villosus*, *Erigeron annuus*, *Galium aparine*, *Paronychia canadensis*, *Phytolacca americana*, *Pilea pumila*, *Sanicula canadensis* var. *canadensis*, and *Symphyotrichum lateriflorum* var. *lateriflorum*. Invasive exotic herbs forming a significant seasonal groundcover include vast amounts of *Commelina communis*, *Microstegium vimineum*, *Persicaria longiseta*, and *Stellaria media*.

4. Western Foot Slope Seep.—A small, seasonal seep habitat exists at a convex western foot slope near the area of the old clay pits formerly used for brick-making by Berea College (Fig. 2). The clay soil of the seep is comprised of eroded shaley Whitley silt loam. The few woody species at the seep edge include *Acer negundo* var. *negundo*, *Aralia spinosa*, *Clematis virginiana*, *Fraxinus pennsylvanica*, *Rubus pensilvanicus*, and *Sambucus canadensis*. The seasonal wetland habitat supports several graminoids, i.e., Cyperaceae, Juncaceae, and Poaceae. Indicator wetland sedges and rushes are *Carex annectans*, *C. frankii*, *C. lurida*, *C. tribuloides* var. *tribuloides*, *C. vulpinoidea*, *Cyperus strigosus*, and *Juncus effusus* ssp. *solutus*. Wetland grasses include *Agrostis gigantea*, *Echinochloa muricata* var. *muricata*, *Leersia virginica*, and *Phalaris arundinacea*. Other wetland plants include *Ambrosia trifida* var. *trifida*, *Commelina communis*, *Diodia virginiana*, *Hypericum mutilum* var. *mutilum*, *Persicaria longiseta*, *P. pennsylvanica*, and *P. punctata*.

Culturally-Derived Ruderal Communities

Two anthropogenic-derived communities are directly and indirectly influenced by activities of Berea College farm workers and disturbances caused by their livestock. In the case of the Berea College Farm agricultural enterprise, farm workers typically sow pasture and grain crops, mow pastureland, harvest hay and ensilage, and maintain Black Angus cattle and Kiko Spanish Cross goats, not to mention other undocumented historic events. These human and animal activities have resulted in significant influences on the composition of the native flora and vegetation below the junction bordering the Dry-Mesic Oak-Hickory Forest. Moreover, a significant impact on species richness and species diversity of native herbaceous plants in the Culturally-Derived Community is the consequence of the naturalized herbaceous plants now classified as invasive plant pests by the KY-EPPC (2012).

1. Southern Foot Slope Pasture and Feedlot.—A culturally-derived or ruderal habitat is present within a 0.17 ha triangular-shaped area lying between the circular southern lower slope and foot slope and a barbed wire fence border. Whitley silt loam is the predominant soil here (Fig. 2). This ruderal area serves as year-around livestock pasture and as a winter and spring feedlot. Tractor track paths from hay distribution and nearby crop cultivation create bare ground, which also influences plant colonization. Cattle continually create bare ground from disturbances through grazing, feeding on hay, manure deposition, and heavy ground trampling throughout the year.

Plant coverage is highly correlated with the seasonal patterns and respective phenology of the plant species and the highest species richness at DHK exists in this ruderal habitat. The surface ground area ranges from a mosaic of scattered bare to sparsely-vegetated to fully vegetated during the late summer and fall growing season, which have the greatest growth of weedy herbs. The floristic composition and coverage are dominated by a rich assemblage of many native and naturalized annual and perennial ruderal weedy species with very few woody taxa.

Important families with the largest number of exotic species from the southern foot slope pasture and feedlot, in descending order by number of species, are the Poaceae, Asteraceae, Brassicaceae, Fabaceae, Caryophyllaceae, and Polygonaceae. Naturalized grasses in the livestock-disturbed pasture and feedlot habitat include *Anthoxanthum odoratum*, *Dactylis glomerata*, *Digitaria ischaemum*, *D. sanguinalis*, *Echinochloa crus-galli* var. *crus-galli*, *Eleusine indica*, *Eragrostis cilianensis*, *Holcus lanatus*, *Poa annua*, *P. pratensis* ssp. *pratensis*, *Schedonorus arundinaceus*, *Setaria faberi*, *S. pumila* ssp. *pumila*, and *Sorghum halepense*, among other taxa. *Juncus tenuis* and *Plantago rugelii* are important native perennials of cattle paths and tractor tracks. Exotic dicots fluctuating in seasonal abundance include *Barbarea vulgaris*, *Cerastium fontanum* var. *vulgare*, *Cichorium intybus*, *Kummerowia striata*, *Plantago lanceolata*, *Persicaria longiseta*, *P. maculata*, *Ranunculus bulbosus*, *Rumex obtusifolius*, *Sonchus asper*, *Stellaria media*, *Trifolium campestre*, *T. dubium*, *T. pratense*, *T. repens*, *Veronica arvensis*, *V. persica* ssp. *persica*, and *Vicia sativa* ssp. *nigra*. Coarse rank-scented dicot weeds typical of feedlots and barnyards are *Abutilon theophrasti*, *Ambrosia artemisiifolia*, *Amaranthus hybridus*, *A. spinosus*, *Anthemis cotula*, *Chenopodium album*, *Datura stramonium*, *Dysphania ambrosioides*, *Matricaria discoidea*, *Sisymbrium officinale*, *Solanum* *ptychanthum*, and *Xanthium strumarium*. Consistent with the information provided here, Daehler (1998) found that over-represented families among agricultural weeds tended to be mostly herbaceous annuals represented within the Asteraceae, Fabaceae, and Poaceae. Typically, these three families are characterized by rapid reproduction, abiotically dispersed diaspores, and adaptation to disturbed habitats.

2. *Perimeter Foot Slope Grassland Pasture*.—The open grassy pasture habitat is a narrow band between the fenced boundary and the circular eastern, northern, and western foot slope borders. Whitley silt loam is the predominant soil series (Fig. 2). Many of the notable weedy exotic and native annuals present in the southern pasture and feedlot are also established here. Herbaceous perennials constitute the major plant species of this grassy livestock grazing land with several grasses and legumes planted by Berea College Farm workers. The perimeter grassy pasture is predominately a thick cover of the introduced and now invasive Tall Fescue, *Schedonorus arundinaceus*. Other graminoids naturalized through agricultural sowing are *Dactylis glomerata*, *Phalaris arundinacea*, *Phleum pratense* ssp. *pratense*, and *Poa pratensis* ssp. *pratensis*. Perennials interspersed among Tall Fescue include other graminoids, *Paspalum laeve* var. *laeve*, *Setaria parviflora*, *Tridens flavus*, and the perennial forbs, *Plantago lanceolata*, *P. rugelii*, *Rumex crispus* ssp. *crispus*, *Solidago altissima* var. *altissima*, *Symphyotrichum dumosum* var. *dumosum*, *S. pilosum* var. *pilosum*, *Taraxacum officinale*, *Trifolium pratense*, *T. repens*, *Verbena urticifolia*, *Vernonia gigantea*, and *Viola sororia* var. *sororia*.

ANNOTATED PLANT LIST

An asterisk (*) before a scientific name signifies a naturalized exotic taxon. A double asterisk (**) before a scientific name designates a Kentucky invasive pest plant listed by the Kentucky Invasive Exotic Plant Pest Council (KY-EPPC 2012). A superscript circle (°) denotes a Madison County distribution record.

Nomenclature and taxonomic concepts for plant families and respective taxa follow Weakley (2011), with the exceptions of *Phoradendron leucarpum* ssp. *leucarpum*, which follows a recent nomenclatural correction (Abbott and Thompson 2011), and *Penstemon brevisepalus* (D. Estes, *in litt.*). Families are organized within the categories: MONILOPHYTES, GYMNOSPERMS, and ANGIOSPERMS, with angiosperms separated into MONOCOTS and "DICOTS," the latter a non-monophyletic assemblage that includes eudicots and the Lauraceae, a member of the paraphyletic basal grade of "primitive angiosperms."

Scientific names are followed by a common name, a relative abundance value, habitat designation, and voucher collection number(s), which concludes each taxon entry. Relative abundance is defined as follows: R (Rare)—1–4 plants or colonies, very difficult to find in one or two locations; S (Scarce)—5–10 plants or colonies, difficult to find; I (Infrequent)—11–30 plants or colonies, scattered; O (Occasional)—31–100 plants or colonies, widely scattered; F (Frequent)—101–1000 plants or colonies, easily found; and, A (Abundant)—greater than 1000 plants or colonies, a diagnostic indicator or dominant species.

The four *Dry-Mesic Oak-Hickory Forest Community* habitats are abbreviated as: KS=Knob Summit (includes cemetery macroplot); N-E=Northern and Eastern Aspects, S-W=Southern and Western Aspects; and WS=Western Foot Slope Seep. The two *Culturally-Derived Ruderal Community* habitats are condensed as: GP=Perimeter Foot Slope Grassland Pasture and PF=Southern Foot Slope Pasture and Feedlot. All habitats are listed alphabetically by abbreviation. Voucher specimen(s) are in an italicized *year-number* (e.g., *10-828*; *11-610*) format.

MONILOPHYTES

ASPLENIACEAE

Asplenium platyneuron (L.) B.S.P., Ebony Spleenwort. S; N-E.*10-828*

OPHIOGLOSSACEAE

Sceptridium dissectum (Spreng.) Lyon, Dissected Grape Fern. R.; KS. *11-610*

GYMNOSPERMS

CUPRESSACEAE

Juniperus virginiana L. var. *virginiana*, Eastern Red Cedar. F; S-W. *10-904*

PINACEAE

Pinus echinata P. Miller, Shortleaf Pine. O; S-W. *10-430*

Pinus strobus L., Eastern White Pine. O; N-E, S-W. *10-19*

Pinus taeda L., Loblolly Pine. O; N-E, S-W. *10-152*

Pinus virginiana P. Miller, Virginia Pine. I; S-W. *10-827*

ANGIOSPERMS: MONOCOTS

ALLIACEAE

**Allium vineale* L., Field Garlic. O; GP, PF, S-E. *10-411*

COMMELINACEAE

***Commelina communis* L., Asiatic Dayflower. A; KS, WS. *10-427; 11-650*

**Commelina diffusa* Burm. f., Creeping Dayflower. S; KS. *11-652*

CYPERACEAE

Carex amphibola Steud., Eastern Narrow-leaf Sedge. F; N-E. *10-253*

Carex annectens (E.P. Bickn.) E.P. Bickn., Yellow-fruited Sedge. O; PS, S-E. *10-409*

Carex blanda Dewey, Eastern Woodland Sedge. A; KS, N-E, S-W. *10-354; 12-366*

Carex frankii Kunth, Frank's Sedge. O; WS. *10-864*

Carex glaucodea Tuckerm. ex Olney, Blue Sedge. O; N-E. *10-405*

°*Carex gravida* L.H. Bailey, Heavy Sedge. R; S-W. *10-230; 10-352*

Carex grisea Wahlenb., Inflated Narrow-leaved Sedge. I; N-E. *10-353*

Carex leavenworthii Dewey, Leavenworth's Sedge. O; GP, S-W. *10-351, 11-118*

Carex lurida Wahlenb., Yellow-green Sedge. O; WS. *10-419*

Carex normalis Mack., Greater Straw Sedge. I; GP, S-W. *10-406*

Carex swanii (Fern.) Mack., Swan's Sedge. F; KS, S-W. *11-453; 12-365*

°*Carex texensis* (Torrey ex L.H. Bailey) L.H. Bailey, Texas Sedge. S; S-W. *10-248*

Carex tribuloides Wahlenb. var. *tribuloides*, Blunt Broom Sedge. O; WS. *10-829*

°*Carex umbellata* Schkuhr ex Willd., Parasol Sedge. F; KS, S-W. *11-120*

Carex vulpinoidea Michx., Fox Sedge. O; WS. *10-420*

Cyperus echinatus (L.) A.W. Wood, Globe Flatsedge. I; GP, PF. *10-899; 11-468*

Cyperus strigosus L., False Nutsedge. O; GP, KS, WS. *10-936; 11-651*

IRIDACEAE

Sisyrinchium angustifolium P. Miller, Narrowleaf Blue-eyed Grass. I; S-W. *10-238*

JUNCACEAE

Juncus effusus L. ssp. *solutus* (Fern. & Wieg.) Hämet-Ajto, Soft Rush. I; KS, WS. *12-838*

Juncus tenuis Willd., Slender Path Rush. F; PF, S-W, WS. *10-434*

ORCHIDACEAE

Tipularia discolor (Pursh) Nuttall, Cranefly Orchid. S; S-W. *10-18; 11-536*

POACEAE

**Agrostis gigantea* Roth, Redtop. O; GP, WS. *10-830*

Agrostis perennans (Walter) Tuckerm., Autumn Bent. F; KS, S-W. *10-891*

Andropogon virginicus L. var. *virginicus*, Old-field Broomsedge. O; S-W. *10-1067*

**Anthoxanthum odoratum* L., Sweet Vernal Grass. O; KS, PF. *11-107; 12-149*

**Bromus commutatus* Schrad., Meadow Brome. F; PF. *10-347*

Coleataenia anceps Michx. ssp. *anceps*, Beaked Panic-grass. O; GP, PF. *10-851*

**Dactylis glomerata* L., Orchard Grass. O; PF, GP. *10-190*

Danthonia spicata (L.) P. Beauv ex Roem. & J.A. Schult., Poverty Oat Grass. A; KS, S-E. *10-412*

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *fasciculatum* (Torr.) Freckmann, Western Panic Grass. A; KS, S-W. *10-843; 12-710*

Dichanthelium clandestinum (L.) Gould, Deer-tongue Panic Grass. I; N-E. *10-896*

**Digitaria ischaemum* (Schreb.) Muhl., Smooth Crabgrass. F; KS, PF. *11-612*

**Digitaria sanguinalis* (L.) Scop., Hairy Crabgrass. A; KS, PF. *11-644*

***Echinochloa crus-galli* (L.) P. Beauv. var. *crus-galli*, Common Barnyard-grass. O; KS, PF. *11-637*

Echinochloa muricata (P. Beauv.) Fernald var. *muricata*, Rough Barnyard-grass. I; WS. *10-933*

***Eleusine indica* (L.) Gaertn., Goose-grass. O; PF. *10-886*

**Elymus repens* (L.) Gould, Quackgrass. S; PF. *10-838*

Elymus villosus Muhl. ex Willd., Hairy Wild-rye. I; N-E. *10-859*

Elymus virginicus L. var. *virginicus*, Virginia Wild-rye. S; S-W. *10-813*

***Eragrostis cilianensis* (All.) Vignolo ex Janch., Strong-scented Lovegrass. O; PF. *10-927*

Eragrostis pectinacea (Michx.) Nees ex Steud., Tufted Lovegrass. O; PF. *10-930*

***Holcus lanatus* L., Common Velvet Grass. O; GP, KS, PF. *10-348; 12-408*

Hordeum pusillum L., Little Barley. O; PF, S-W. *10-349*

Leersia virginica Willd., White Cutgrass. F; KS, WS. *10-863; 12-711*

***Lolium perenne* L. var. *aristatum* Willd. Italian Rye-grass. I; PF. *10-431*

***Microstegium vimineum* (Trin.) A. Camas, Nepalese Browntop. A; KS, N-E, S-W, WS. *10-941*

Muhlenbergia schreberi J.F. Gmel., Nimblewell Muhly. O; GP, N-E. *10-1055*

Panicum dichotomiflorum Michx., var. *dichotomiflorum*, Fall Panic-grass. O; KS, PE. *11-636*

Paspalum laeve Michx. var. *laeve*, Field Bead-grass. A; GP. *10-928*

**Phalaris arundinacea* L., Reed Canary-grass. I; GP, WS. *10-340*

**Phleum pratense* L. ssp. *pratense*, Timothy. O; GP. *10-417*

***Poa annua* L., Annual Bluegrass. A; PF. *10-154*

***Poa compressa* L., Canada Bluegrass. F; GP. *11-455*

***Poa pratensis* L. ssp. *pratensis*, Kentucky Bluegrass. A; GP, KS, PF. *10-191; 11-456; 12-147*

**Poa trivialis* L. ssp. *trivialis*, Rough Bluegrass. I; N-E. *10-438*

***Schedonorus arundinaceus* (Schreb.) Dumort, Tall Fescue. A; GP, KS, PF. *10-187; 12-407*

**Secale cereale* L., Cereal Rye. R; PF. *11-159*

***Setaria faberi* R.A.W. Herrm., Nodding Foxtail. O; KS, PF. *10-841; 11-643*

Setaria parviflora (Poir.) Kerguélen, Knotroot Foxtail. O; GP. *11-540*

**Setaria pumila* (Poir.) Roem. & Schlult. ssp. *pumila*, Yellow Foxtail. O; KS, PF. *10-1044; 11-620*

***Sorghum halepense* (L.) Pers., Johnson Grass. O; GP, PF. *10-843*

Sphenopholis intermedia (Rydb.) Rydb. Slender Wedgegrass. O; KS, S-W. *10-242*

Tridens flavus (L.) A.S. Hitchc., Purpletop Tridens. O; GP, PF. *10-883*

**Triticum aestivum* L., Common Wheat. R; PF. *11-158*

RUSCACEAE

Polygonatum biflorum (Walter) Elliott var. *biflorum*, Smooth Solomon's-seal. I; S-W. *11-119*

SMILACACEAE

Smilax bona-nox L., Saw Greenbrier. O; KS, N-E, S-W. *10-1056*

Smilax glauca Walter, Glaucous Catbrier. F; KS, N-E, S-W. *10-918*

Smilax rotundifolia L., Common Roundleaf Greenbrier. I; N-E. *10-1045*

ANGIOSPERMS: "DICOTS" (including Lauraceae, a "basal angiosperm")

ADOXACEAE

Sambucus canadensis L., Common Elderberry. I; KS, N-E, WS. *10-402*

Viburnum rafinesquianum J.A. Schult., Downy Arrow-wood. R; S-W. *10-944*

ALTINGIACEAE

Liquidambar styraciflua L., Sweetgum. R; N-E. *10-856*

AMARANTHACEAE

**Amaranthus hybridus* L., Smooth Amaranth. F; PF. *11-649*

**Amaranthus spinosus* L., Spiny Amaranth. O; PF. *11-539*

***Chenopodium album* L., Lamb's Quarters. O; PF. 10-251

**_Dysphania ambrosioides_ (L.) Mosyakin & Clements, Mexican Tea. F, PF. _10-922_

ANACARDIACEAE

Rhus copallinum L. var. _latifolia_ Engler, Eastern Winged Sumac. I; S-W. _10-814_
Rhus glabra L., Smooth Sumac. R; S-W. _10-1065_
Toxicodendron radicans (L.) Kuntze var. _negundo_ (Greene) Reveal, Midwestern Poison Ivy. A; KS, N-E, S-W. _10-220_

APIACEAE

Chaerophyllum tainturieri Hooker var. _tainturieri_, Southern Chervil. O; N-E, PF. _10-196_
**_Conium maculatum_ L., Poison Hemlock. I; KS, PF. _10-410; 12-364_
**_Daucus carota_ L., Queen-Anne's-lace. F; GP, KS, PF. _10-840; 12-405_
Sanicula canadensis L. var. _canadensis_, Black Snakeroot. O; KS, N-E, S-W. _12-718_
*_Torilis arvensis_ (Hudson) Link, Field Hedge Parsley. R; KS, PF. _12-410; 12-724_

APOCYNACEAE

Apocynum cannabinum L., Indian Hemp. S; S-W. _10-819_
Cyanchum laeve (Michx.) Pers., Honeyvine. I; N-E. _11-469_

AQUIFOLIACEAE

Ilex opaca Aiton var. _opaca_, American Holly. I; N-E, S-W. _10-815_

ARALIACEAE

Aralia spinosa L., Spiny Aralia. R; KS, N-E, WS. _10-818; 12-154_

ASTERACEAE

Achillea millefolium L., Common Yarrow. O; GP, PF. _10-250; 12-723_
Ageratina altissima (L.) R.M. King & H. Robinson, White Snakeroot. R; KS. _11-679_
Ambrosia artemisiifolia L., Annual Ragweed. A; GP, KS, PF. _11-611_
Ambrosia trifida L. var. _trifida_, Great Ragweed. O; KS, PF, WS. _11-622; 12-712_
*_Anthemis cotula_ L., Mayweed. F; GP,PF. _12-721_
**_Arctium minus_ Bernh., Common Burdock. I; KS, N-E, PF. _10-852; 12-355_
Bidens bipinnata L., Spanish Needles. F; KS, N-E, S-W. _11-618_
Bidens frondosa L., Devil's Beggar-ticks. O; KS, WS. _11-641_
Bidens polylepis S.F. Blake, Ozark Tickseed-sunflower. I; GP. _10-920; 10-1061_
**_Carduus nutans_ L., Nodding Musk Thistle. I; KS, PF. _10-424; 12-354_
**_Cichorium intybus_ L., Chicory. F; GP, PF. _11-525_
Cirsium discolor (Muhl. ex Willd) Spreng, Glaucous Field Thistle. R; KS. _12-353_
*_Cirsium vulgare_ (Savi) Tenore, Bull Thistle. R; KS, PF. _11-544; 12-352_
Conoclinum coelestinum (L.) DC., Blue Mistflower. R; KS. _11-653_
Conyza canadensis (L.) Cronquist var. _canadensis_, Common Horseweed. O; GP, KS, PF. _11-616_
Coreopsis tinctoria Nutt. var. _tinctoria_, Golden Tickseed. S; PF. _11-470; 12-726_
*_Eclipta prostrata_ (L.) L., Yerba-de-Tago. R; KS. _11-529_
Elephanotopus carolinianus Raeusch., Carolina Elephant's-foot. I; GP, KS, PF. _10-901_
Erechtites hieraciifolius (L.) Raf. ex DC., Fireweed. F; KS, PF. _10-932; 11-645_
Erigeron annuus (L.) Pers., Annual Daisy Fleabane. F; KS, N-E, S-W. _10-441_
Erigeron philadelphicus L. var. _philadelphicus_, Philadelphia Fleabane. O; GP. _11-112_
Eupatorium serotinum Michx., Late flowering Eupatorium. O; KS. _11-676_
*_Galinsoga quadriradiata_ Ruiz & Pavón, Common Peruvian Daisy. O; KS, PF. _10-440; 11-647_
Gamochaeta purpurea (L.) Cabrera, Spoonleaf Purple Everlasting. S, PF. _12-361_
Lactuca canadensis L., Wild Canada Lettuce. I; N-E. _10-812_
*_Lactuca serriola_ L., Prickly Lettuce. O; KS, PF. _11-531; 12-409_
**_Leucanthemum vulgare_ Lam., Oxeye Daisy. I; GP. _10-233_
*_Matricaria discoidea_ DC., Pineapple-weed. I; PF. _11-121; 12-363_
Packera glabella (Poir.) C. Jeffery, Yellowtop. R; KS. _12-156_
Solidago altissima L. var. _altissima_, Tall Goldenrod. A; KS, GP, PF. _10-1060; 12-713_
*_Sonchus asper_ (L.) Hill, Spinyleaf Sow-thistle. O; KS, PF. _10-415_
Symphyotrichum dumosum (L.) G.L. Nesom var. _dumosum_, Bushy Aster. O; S-W. _10-1068_
Symphyotrichum lateriflorum (Willd.) G.L. Nesom var. _lateriflorum_, Calico Aster. F; KS, N-E, S-W. _10-1069; 11-675_
Symphyotrichum pilosum (Willd.) G.L. Nesom var. _pilosum_, White Old-field Aster. I; GP. _10-1064_
*_Taraxacum officinale_ G.H. Weber ex Wiggers, Common Dandelion. O; GP, KS, PF. _11-678; 12-17_
*_Tragopogon dubius_ Scop., Yellow Salsify. S; GP. _10-339_
Verbesina alternifolia (L.) Britton ex Kearney, Common Crownbeard. R; KS. _11-642_
Vernonia gigantea (Walter) Trelease, Tall Ironweed. I; GP, KS, PF. _10-939; 11-646_
Xanthium strumarium L. var. _canadense_ (P. Miller) Torr. & A. Gray, Rough Cocklebur. F; PF, WS. _10-919_

BIGNONIACEAE

Campsis radicans (L.) Seem. ex Bureau, Trumpet Creeper. O; N-E, S-W. _10-842_

BORAGINACEAE

**_Buglossoides arvensis_ (L.) I.M. Johnston ssp. _arvensis_, Corn Gromwell. S; PF. _11-64_
Myosotis macrosperma Engelm., Large-seeded Forget-me-Not. I; PF. _11-105_

BRASSICACEAE

**_Alliaria petiolata_ (M. Bieb.) Cavara & Grande, Garlic Mustard. F; S-W. _10-146; 10-198_
*_Arabidopsis thaliana_ (L.) Heynh., Mouse-ear Cress. I; PF. _11-55_
**_Barbarea vulgaris_ R. Brown, Yellow Rocket. I; GP, PF. _11-53_
*_Capsella bursa-pastoris_ (L.) Medik., Shepherd's Purse. O; PF. _11-49_
Cardamine concatenata (Michx.) O. Schwartz., Cutleaf Toothwort. S; KS. _11-51_
*_Cardamine hirsuta_ L., Hairy Bittercress. A; GP, KS, PF. _11-36; 12-13_
*_Draba verna_ L., Whitlow-grass. F; PF. _10-25_
*_Erysimum repandum_ L., Treacle Wallflower. O; PF. _11-48_
*_Lepidium campestre_ (L.) R. Brown, Common Fieldcress. O; PF. _11-115_
Lepidium virginicum L. var. _virginicum_, Virginia Pepperweed. O; GP, KS, PF. _10-422; 12-350_
**_Microthlaspi perfoliatum_ (L.) F.K. Mey., Perfoliate Pennycress. I; PF. _11-33_
Planodes virginicum (L.) Greene, Virginia Winged Rockcress. O; GP, PF. _10-134; 11-35_
*_Sisymbrium officinale_ (L.) Scop., Hedge Mustard. O; PF. _11-465; 12-146_
*_Thlaspi alliaceum_ L., Garlic Pennycress. S; PF. _11-31_
*_Thlaspi arvense_ L., Field Pennycress. O; GP, PF. _10-137; 11-114_

CAMPANULACEAE

Lobelia inflata L., Indian Tobacco. O; KS, PF, S-W. _10-810; 11-639_
Triodanis perfoliata (L.) Nieuwl., Venus' Looking Glass. I; PF. _10-236_

CANNABINACEAE

Celtis occidentalis L., Northern Hackberry. F; KS, N-E, S-W. _10-394; 12-841_

CAPRIFOLIACEAE

**Lonicera japonica* Thunb., Japanese Honeysuckle. A; KS, N-E, S-W. *10-223*

**Lonicera maackii* (Rupr.) Herder, Amur Honeysuckle. A; KS, N-E, S-W. *11-677; 12-358*

Symphoricarpos orbiculatus Moench, Indian Currant. A; KS, N-E, S-W. *10-1047*

CARYOPHYLLACEAE

**Arenaria serpyllifolia* L., Thymeleaf Sandwort. O; PF. *11-160*

Cerastium fontanum Baumg. ssp. *vulgare* (Hartman) Greuter & Burdet., Common Mouse-ear Chickweed. F; GP, PF. *10-396*

Cerastium glomeratum Thuill., Sticky Mouse-ear Chickweed. F; KS, PF, S-W. *10-206; 12-411*

**Dianthus armeria* L. ssp. *armeria*, Deptford Pink. S; PF. *10-882*

Paronychia canadensis (L.) A.W. Wood, Smooth Forked Chickweed. F; N-E, S-W. *11-464*

Paronychia fastigiata (Raf.) Fernald, Hairy Forked Chickweed. O; N-E, S-W. *10-946*

Silene latifolia Poiret, White Campion. S; PF. *10-245; 10-246*

**Stellaria media* (L.) Villars, Common Chickweed. A; KS, N-E, S-W. *11-59; 12-356*

CELASTRACEAE

**Celastrus orbiculatus* Thunb., Oriental Bittersweet. F; KS, N-E, S-W. *10-805; 12-715*

**Euonymus alatus* (Thunb.) Sieb., Winged Burning Bush. I; N-E, S-W. *10-439*

**Euonymus fortunei* (Turcz.) Hand.-Mazz., Wintercreeper. A; KS, N-E, S-W. *10-1049; 12-18*

CONVOLVULACEAE

**Ipomoea hederacea* Jacq., Ivy-leaf Morning-glory. O; PF. *10-879*

Ipomoea lacunosa L., White Morning-glory. O; PF. *11-625*

**Ipomoea purpurea* (L.) Roth, Common Morning-glory. I; PF. *10-916*

CORNACEAE

Cornus drummondii C.A. Meyer, Roughleaf Dogwood. R; N-E. *10-820*

Cornus florida L., Flowering Dogwood. O; KS, N-E, S-W. *10-150; 10-1037*

EBENACEAE

Diospyros virginiana L., American Persimmon. O; KS, N-E, S-W. *10-398*

ELAEAGNACEAE

**Elaeagnus umbellata* Thunb. var. *parviflora* (Wall. ex Royle) C.K. Schneid., Autumn Olive. O; N-E, S-W. *10-429*

ERICACEAE

Chimaphila maculata (L.) Pursh, Spotted Wintergreen. I; S-W. *10-823*

Vaccinium stamineum L., Deerberry. R; S-W. *11-116*

EUPHORBIACEAE

Acalypha rhombiodea Raf., Rhomboic Copperleaf. S; KS. *11-627*

Euphorbia maculata L., Spotted Spurge. S; KS. *11-640*

Euphorbia nutans Lag., Small Eyebane Spurge. O; PF. *11-530*

FABACEAE

Desmodium paniculatum (L.) DC., Panicled Tick-trefoil. O GP, PF. *10-925*

Desmodium perplexum Schubert, Dillenius' Tick-trefoil. I; PF, S-W. *10-1063*

Gleditsia triacanthos L., Honey Locust. I; KS, N-E, S-W. *11-458*

**Kummerowia striata* (Thunb.) Schindl., Japanese Lespedeza. A; GP, PF. *10-934*

**Lespedeza cuneata* (Dum.-Cours.) G. Don, Sericea Lespedeza. O; GP. *10-1058*

**Medicago lupulina* L., Black Medick. S; PF. *11-156*

**Melilotus officinalis* (L.) Pallas, Yellow Sweetclover. O; PF. *11-163*

Robinia pseudoacacia L., Black Locust. F; KS, N-E, S-W. *10-195; 11-452*

**Securigera varia* (L.) Lassen, Crown Vetch.O; PF. *11-162*

Trifolium campestre Schreb., Pinnate Hop-clover. F; GP, PF. *10-247*

Trifolium dubium Sibth., Low Hop-clover. A; PF. *11-106*

Trifolium pratense L., Red Clover. A; GP, PF. *10-254*

Trifolium repens L., White Clover. A; GP, PF. *10-414*

Vicia sativa L. ssp. *nigra* (L.) Ehrh., Common Vetch. O; PF. *11-56*

Vicia villosa Roth ssp. *varia* (Host) Corbière, Winter Vetch. O; PF. *10-335*

FAGACEAE

Quercus alba L., White Oak. A; KS, N-E, S-W. *10-1034*

Quercus falcata Michx., Southern Red Oak. F; KS, N-E, S-W. *10-400*

Quercus imbricaria Michx., Shingle Oak. F; N-E, S-W. *10-1050*

Quercus montana Willd., Chestnut Oak. I; N-E. *10-1046*

Quercus palustris Muenchh., Pin Oak. R; S-W. *10-948*

°*Quercus phellos* L., Willow Oak. R; S-W. *10-1036*

Quercus stellata Wangenh., Post Oak. F; KS, N-E, S-W. *10-1043*

Quercus velutina Lam., Black Oak. F; KS, N-E, S-W. *10-1041*

FUMARIACEAE

Corydalis flava (Raf.) DC., Pale Corydalis. F; KS, N-E. *10-143; 12-14*

GERANIACEAE

Geranium carolinianum L., Carolina Crane's-bill. F; GP, PF. *10-197*

Geranium dissectum L., Cutleaf Crane's-bill. I; KS, PF. *11-108; 12-359*

HYPERICACEAE

Hypericum mutilum L. var. *mutilum*, Dwarf St. John's-wort. I; WS. *10-862*

Hypericum punctatum Lam., Spotted St. John's-wort. I; S-W. *10-806*

JUGLANDACEAE

Carya cordiformis (Wangenh.) K. Koch, Bitternut Hickory. R; N-E. *10-1038*

Carya glabra (P. Miller) Sweet, Pignut Hickory. F; KS, N-E, S-W. *10-915*

Carya ovata (P. Miller) K. Koch, Shagbark Hickory. F; KS, N-E, S-W. *10-816*

Juglans nigra L., Black Walnut. I; KS, N-E. *10-870*

LAMIACEAE

**Glechoma hederacea* L., Ground-ivy. A; GP, N-E. *10-232*

Hedeoma pulegioides (L.) Pers., American Pennyroyal. O; PF. *10-938*

**Lamium amplexicaule* L. var. *amplexicaule*, Henbit Dead-nettle. F; PF. *11-32*

Lamium purpureum L., Purple Dead-nettle. F; KS, N-E, PF. *11-54; 12-16*

Prunella vulgaris L. var. *lanceolata* (Bart.) Fernald, American Self-heal. S; GP, PF. *10-897*

LAURACEAE

Sassafras albidum (Nuttall) Nees, Sassafras. F; KS, N-E, S-W. *10-441*

MALVACEAE

Abutilon theophrasti Medik., Indian Velvetleaf. O; PF. *10-949*

Sida spinosa L., Prickly Sida. F; PF. *11-624*

MORACEAE

Morus alba L., White Mulberry. R; N-E. *11-631*

Morus rubra L., Red Mulberry. I; KS, N-E, S-E. *10-421; 12-840*

NYSSACEAE

Nyssa sylvatica Marshall, Black gum. F; KS, N-E, S-W. *10-403*

OLEACEAE

Fraxinus americana L., White Ash. O; KS, N-E, S-W. *10-1062; 12-720*

Fraxinus pennsylvanica Marshall, Green Ash. I; N-E, WS. *11-467*

Ligustrum obtusifolium Sieb. & Zucc. var. *obtusifolium*, Border Privet. O; KS, N-E, S-W. *10-333*

OXALIDACEAE

Oxalis dillenii Jacq., Southern Yellow Wood-sorrel. F; N-E, PF, S-W. 10-202; 11-528

Oxalis stricta L., Common Yellow Wood-sorrel. A; KS, N-E, S-W. 10-903; 11-628

Oxalis violacea L, Violet Wood-sorrel. O; KS. 10-148

PASSIFLORACEAE

Passiflora incarnata L., Maypops. R; KS. 11-617

Passiflora lutea L. var. glabriflora Fernald, Yellow Passion-flower. R; KS. 11-463

PHYTOLACCACEAE

Phytolacca americana L., Common Pokeweed. A; KS, N-E, PF, S-W. 10-868

PLANTAGINACEAE

Penstemon brevisepalus Pennell, Appalachian Beard-tongue. O; KS, N-E, S-W. 10-342

*Plantago lanceolata L., English Plantain. F; GP, PF. 10-885

Plantago rugelii Decne., Rugel's Plantain. F; GP, PF. 10-811

*Veronica arvensis L., Corn Speedwell. A; GP, PF. 10-212

*Veronica peregrina L. ssp. peregrina, Common Purslane speedwell. F; PF. 11-47

*Veronica persica Poiret, Bird's-eye Speedwell. I; GP. 11-37

POLYGONACEAE

**Persicaria longiseta (de Bruijn) Kitagawa, Asiatic Smartweed. A; KS, N-E, PF, S-W, WS. 10-839

**Persicaria maculosa S.F. Gray, Spotted Lady's-thumb. I; PF. 10-878

Persicaria pensylvanica (L.) M. Gómez, Pennsylvania Smartweed. O; PF, WS. 10-926

Persicaria punctata (Elliott) Small, Dotted Smartweed. F; KS, PF, WS. 10-895

*Polygonum aviculare L., Common Knotweed. O; PF. 11-537

Polygonum erectum L., Erect Knotweed. S; PF. 10-1042

**Rumex acetosella L., Red Sheep Sorrel. O; PF, S-W. 10-213

*Rumex crispus L. ssp. crispus, Curly Dock. O; GP, PF. 10-252

*Rumex obtusifolius L., Bitter Dock. O; GP, KS, PF. 11-538; 12-719

RANUNCULACEAE

Clematis virginiana L., Virgin's-bower. O; KS, N-E. 11-674; 12-716

Ranunculus abortivus L., Kidneyleaf Buttercup. F; GP, KS, PF. 10-140; 12-15

°**Ranunculus bulbosus L., Bulbous Buttercup. A; GP, KS, PF. 11-454; 12-412

RHAMNACEAE

Frangula caroliniana (Walter) A. Gray, Carolina Buckthorn. O; S-W. 10-1039

ROSACEAE

Amelanchier arborea (Michx. f.) Fernald, Common Serviceberry. S; S-W. 10-1040

Crataegus crus-galli L., Cockspur Hawthorn. R; S-W. 10-850

°Crataegus macrosperma Ashe, Fanleaf Hawthorn. R; N-E. 10-1057; 12-152

Geum canadense Jacq., White Avens. O; N-E. 10-825

°*Malus baccata (L.) Borkh., Siberian Crab-apple. R; N-E. 10-1051; 11-61

°*Malus prunifolia (Willd.) Borkh., Plum-leaf Chinese Crab-apple. R; S-W. 10-1070; 11-62

**Potentilla indica (Andr.) T. Wolf, Indian Strawberry. A; N-E, PF. 10-249

**Potentilla recta L., Sulphur Cinquefoil. I; PF. 11-164

Potentilla simplex L., Old-field Cinquefoil. O; KS, S-W. 10-20

Prunus serotina Ehrh. var. serotina, Wild Black Cherry. F; KS, N-E, S-W. 11-117; 12-151

*Pyrus calleryana Decne., Bradford Pear. S; KS. 10-1035

**Rosa multiflora Thunb. ex Murr., Multiflora Rose. O; N-E, S-W. 10-209

Rubus pensilvanicus Poiret, Pennsylvanica Blackberry. F; KS, N-E, S-W, WS. 12-360

RUBIACEAE

Diodia virginiana L., Virginia Buttonweed. R; WS. 11-535

Galium aparine L., Cleavers. A; KS, N-E, S-W. 10-144; 12-404

°*Galium divaricatum Pourr. ex Lam., Lamarck's Bedstraw. R; PF. 10-393

**Galium pedemontanum (Bellardi) Ehrend., Piedmont Bedstraw. A; GP, PF. 10-341

SAPINDACEAE

Acer negundo L. var. negundo, Box-elder Maple. S; N-E, WS. 10-900

Acer rubrum L. var. rubrum, Red Maple. F; KS, N-E, S-W. 10-404

Acer saccharum Marshall, Sugar Maple. F; KS, N-E. 10-192

SCROPHULARIACEAE

*Verbascum blattaria L., Moth Mullein. I; PF. 10-884

*Verbascum thapsus L., Common Woolly Mullein. I; KS, PF. 11-460; 12-834

SIMAROUBACEAE

**Ailanthus altissima (P. Miller) Swingle, Tree-of-Heaven. F; KS, N-E, S-W. 10-822

SOLANACEAE

*Datura stramomium L., Jimson-weed. O; PF. 10-950; 12-722

Physalis angulata L. var. angulata, Smooth Ground-cherry. S; PF. 10-1048

Solanum carolinense L. var. carolinense, Bull-nettle. O; KS, PF. 10-935

Solanum ptychanthum Dunal, American Black Nightshade. O; KS, PF. 11-615

ULMACEAE

Ulmus americana L. var. americana, American Elm. I; N-E, 10-1052

Ulmus rubra Muhl., Slippery Red Elm. O; KS, N-E, S-W. 10-803; 12-406

URTICACEAE

Pilea pumila (L.) A. Gray, Clearweed. F; N-E, WS. 10-887

VERBENACEAE

Verbena urticifolia L., White Vervain.O; GP, KS, PF. 11-614; 12-725

VIOLACEAE

*Viola arvensis Murr., European Field-pansy. F; PF. 11-113; 12-148

Viola bicolor Pursh, Wild Field-pansy. O; PF, S-W. 10-203; 11-47

Viola sororia Willd. var. sororia, Common Blue Violet. F; GP, N-E, PF. 10-135

VISCACEAE

Phoradendron leucarpum (Raf.) Reveal & M.C. Johnston. ssp. leucarpum, American Mistletoe. S; N-E. 10-1071 (hemiparasitic on Prunus serotina var. serotina); 11-457 (hemiparasitic on Gleditsia triacanthos)

VITACEAE

Parthenocissus quinquefolia (L.) Planchon, Virginia-creeper. F; KS, N-E, S-W. 10-343

Vitis vulpina L., Frost Grape. O; KS, N-E, S-W. 10-1053

CONCLUSIONS

With ties back to the Revolutionary War and even the bricks that make up part of the historic Berea College campus, Dead Horse Knob could be carefully managed in the years to come. Our study of the vascular flora and altered plant habitats of Dead Horse Knob documents a heavily invaded modern landscape and provides a reference baseline for future comparative studies and data for potential land management decisions. The general trends supported by our data include:

1. The DHK has a high species richness for such a small site. The largest families in terms of taxa are the Poaceae, Asteraceae, Cyperaceae, Fabaceae, and Brassicaceae. Although the order of the families varies from site to site, this same trend is supported by other floristic surveys of anthropogenically-influenced areas in southern Madison County (e.g., Wade & Thompson 1990; Thompson & Fleming 2004; Thompson 2005; Thompson 2008). Directly correlated to this species richness trend, most exotics found in this study (116; 39.9% of the total flora) are members of the Asteraceae, Brassicaceae, Fabaceae, and Poaceae.

2. Fifty-two of the exotic taxa (17.9% of the total number of species) are also Kentucky-listed invasive plant pests. Woody Old World invasive taxa are the most influential in the Dry-Mesic Oak-Hickory Community, and invasive Eurasian herbaceous taxa are most important in the Culturally-Derived Communities.

3. The Asian shrub, *Lonicera maackii*, has the most detrimental impact overall on the native forest flora and vegetation and natural secondary succession. Although species composition and species richness of native forest herbs, shrubs, and trees are also affected by other woody invasives such as *Ailanthus altissima*, *Celastrus orbiculatus*, *Eleaegnus umbellatus*, *Euonymus fortunei*, *Ligustrum obtusifulium* var. *obtusifolium*, *Lonicera japonica*, and *Rosa multiflora*, the omnipresent *Lonicera maackii* will continue to dominate the shrubby understory over time through seed recruitment, succession adaptations, shade tolerance, and allelopathy without repeated anthropogenic control and management measures.

4. Ninety-five (32.65%) or nearly one-third of the total DHK flora have volunteered or colonized the 20× 12 m cemetery macroplot after *Lonicera maackii* removal in 2011. Most are annuals and biennials derived from seeds and fruit propagules within the existing seed bank within the macroplot and from light wind-transported diaspores through seed rain from the immediate environs.

5. The major plant community, Dry-Mesic Oak-Hickory Forest, can be delineated into four habitats and exhibits heterogeneity in species richness and relative abundance of the existing flora, related to topography, slope aspect, and historic land usage. Higher-insolated southern and western aspects habitats are drier, hotter, and sunnier. These areas exhibit less diversity, though some species are restricted to these conditions. Habitats on the mesic, shaded, northern and eastern slope aspects display greater species richness mainly as a result of a more growth conducive environment.

6. In addition to the human-mediated introduction of invasive exotics, historic and ongoing anthropogenic influences on vegetation structure include clearing the land (whether for a cemetery, brick-making, farming, or timber-harvest), planting pines, and introduction of cattle and goats. Livestock disturbances from grazing, browsing, and trampling on all four directional aspects of the knob continues to impact species composition of native herbs and woody plants in the Dry-Mesic Oak-Hickory Forest, as well as in the non-forested areas.

7. Culturally-Derived or Ruderal Communities are created and maintained through anthropogenic disturbances, primarily related to livestock trampling and grazing and agricultural farming practices. These two habitats support the highest ruderal weedy flora and are dominated by exotic and native annuals and perennials, especially within the Poaceae, Fabaceae, and Asteraceae.

8. Woody and herbaceous invasive plant colonizers at Dead Horse Knob are expected to continue to severely influence litter decomposition, disturb soil nutrient cycles, disrupt nitrogen-fixation, compete for resources, replace native flora and vegetation, change patterns of seedling germination, reproduction, and regeneration, and alter overall natural secondary plant succession. What this means for the native vegetation at the knob will only be known with certainty in the decades to come, but without active control of the exotics it certainly seems likely that the invasives will continue to increase in abundance, out competing the natives and reducing overall species diversity and species richness. This current study provides a reference baseline for future comparative work.

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BOOK NOTICES

Michael H. Graham, Joan Parker, and Paul K. Dayton (eds). 2011. **The Essential Naturalist.** (ISBN-13: 978-0-226-305790-7, pbk.). The University of Chicago Press, Chicago, Illinois 60637, U.S.A. (**Orders:** www.press.uchicago.edu). $39.00, 552 pp., 4 halftones, 18 line drawings, 39 tables, 6" × 9".

From the Publisher: "Like nearly every area of scholarly inquiry today, the biological sciences are broken into increasingly narrow fields and subfields, its practitioners divided into ecologists, evolutionary biologists, taxonomists, paleontologists, and much more. But all these splintered pieces have their origins in the larger field of natural history—and in this era where climate change and relentless population growth are irrevocably altering the world around us, perhaps it's time to step back and take a new, fresh look at the larger picture.

"*The Essential Naturalist* offers exactly that: a wide-ranging, eclectic collection of writings from more than eight centuries of observations of the natural world, from Leeuwenhoek to E.O. Wilson, from von Humboldt to Rachel Carson. Featuring commentaries by practicing scientists that offer personal accounts of the importance of the long tradition of natural history writing to their current research, the volume serves simultaneously as an overview of the field's long history and as an inspirational starting point for new explorations, for trained scientists and amateur enthusiasts alike."

Just reading the Table of Contents will make you want to have this book in your personal library. *The Essential Naturalist* is broken into five broad subject areas: 1) Inspiration, 2) Exploration, 3) Initiation, 4) Intuition, and 5) Unification. Robert T. Paine, University of Washington, Seattle, writes in his introduction "A Foundation Built by Giants" that "the attraction of humans to nature is clear and ubiquitous." Paine goes on to define Natural History as the systematic study of natural organisms through observations. I like this definition. For sure, one cannot underestimate the power of personal observation in science. It is the foundation and most powerful tool of any naturalist!—*Barney Lipscomb, Botanical Research Institute of Texas, 1700 University Dr., Fort Worth, Texas 76107-3400, U.S.A.*

VASCULAR PLANTS OF THE YAZOO-MISSISSIPPI DELTA, LOESS BLUFFS, AND NORTH CENTRAL PLATEAU IN GRENADA COUNTY, MISSISSIPPI

Michael Wayne Morris
Department of Biological and Environmental Sciences
Troy University
Troy, Alabama 36082, U.S.A.
mwmorris@troy.edu

John R. MacDonald
Mississippi Entomological Museum
Mississippi State University
Mississippi State, Mississippi 39762, U.S.A.
arcasimperialis@aol.com

ABSTRACT

Floristic studies conducted in Grenada County, Mississippi, primarily from 1986 to 1987, and from 1993 to 1996, have resulted in the documentation of 1,129 species of vascular plants representing 529 genera in 153 families. The following categories of vascular plants were cataloged: Lycophytes, 3 species; Equisetophytes, 2 species; Polypodiophytes, 23 species; Gymnosperms, 4 species; Angiosperms, 1,097 species. A complete listing of these 1,131 taxa, which includes two additional infraspecific taxa, is presented along with information on habitats, relative species abundance, land usage, topography, soils of the three physiographic regions included in the study area, rare plants, and exotic vascular plant species in Grenada County.

RESUMEN

Los estudios florísticos llevados a cabo en el condado de Grenada, Mississippi, primariamente de 1986 a 1987, y de 1993 a 1996, han dado como resultado la documentación de 1,129 especies de plantas vasculares que representan 529 géneros de 153 familias. Se catalogaron las siguientes categorías de plantas vasculares: Lycophytas, 3 especies; Equisetophytas, 2 especies; Polypodiophytas, 23 especies; Gimnospermas, 4 especies; Angiospermas, 1,097 especies. Se presenta un listado completo de estos 1,131 taxa, que incluye dos taxa infraespecíficos adicionales, junto con información sobre los hábitats, abundancia relativa de especies, uso del territorio, topografía, suelos de las tres regiones fisiográficas incluidas en el área de estudio, plantas raras, y especies de plantas vasculares exóticas en el condado de Grenada.

INTRODUCTION

Located in north central Mississippi about 160 km north of Jackson, MS, and about 160 km south of Memphis, TN, Grenada County includes parts of three physiographic regions (Fig. 1): the nearly flat alluvial plain in the western part of the county known as the Yazoo-Mississippi Delta (or Delta); the Loess Bluffs, a long north-south line of hills arising abruptly at the eastern edge of the Delta; and the North Central Plateau, an ancient, eroded plateau in the eastern part of the county (Lowe 1921). The Yalobusha River, a major tributary of the Yazoo River, forms a floodplain as it flows from east to west through each physiographic region. In addition, in order to prevent flooding and erosion and for recreational purposes, the Yalobusha River was dammed in the central part of the county to create Grenada Lake. It should be noted that the Yazoo-Mississippi Delta is not the true delta of the Mississippi River, which is located approximately 560 km farther south (Carter et al. 1990).

Three different forest regions of the Deciduous Forest Formation (Braun 1950) are present in Grenada County, largely corresponding with the physiographic regions within the area. The Delta is a part of the Mississippi Alluvial Plain of the Southeastern Evergreen Forest Region. Although mapped in this region, much of the Delta not used for agricultural purposes is covered with bottomland deciduous hardwood forests, marshes, and swamp forests; pines are absent as native species as are most broad-leaved evergreen species. The Loess Bluffs are located in the Mississippi Embayment Section of the Western Mesophytic Forest Region and are characterized by nutrient-rich hardwood forests in deep ravines and on bluffs and by providing a cool, moist microclimate that supports vascular plant species characteristic of the Appalachian Mountains and more northern latitudes, as well as regional endemic and calciphilic species. The North Central Plateau is included in the Gulf Slope Section of the Oak-Pine Forest Region. Plant communities here are indicative of much of the Inner Gulf Coastal Plain of the southeastern United States and range from acidic, well-drained oak-pine woods to localized bog and spring branch habitats supporting plants with both northern and southern affinities.

Concerning the topography of Grenada County, low points of approximately 39.4 m (130 ft) above sea

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level are located in the Yazoo-Mississippi Delta; a hill in the North Central Plateau of the southeastern part of the study area rises approximately 163.6 m (540 ft) above sea level. The two extremes of elevation give a total relief of 124.2 m (410 ft).

Soils of the Delta Region are primarily of the Alligator-Forestdale association (Thomas & Bowen 1967). These soils are silty or clayey and generally poorly drained. The silty soils were washed down from the nearby Loess Bluffs and deposited in this area by the Yalobusha River and large streams and creeks. The clayey soils formed in alluvium of the Mississippi River. Soil reaction is usually moderately acid to circumneutral.

The Loess Bluffs are in a nearly level to very steep area where the silty soils are derived from loess. The mantle of loess is about 9.1 m (30 ft) thick at its extreme western edge in Grenada County, but it thins progressively toward the east (Thomas & Bowen 1967). Soil associations of the Loess Bluff Region are Memphis, Memphis-Guin, Memphis-Loring, and Providence-Loring-Ruston, which are silty, sandy, or gravelly, well-drained soils that are generally circumneutral to moderately acid.

The main soil associations of the North Central Plateau are Ruston-Cuthbert-Providence, Tippah-Boswell-Dulac, and Ruston-Providence (Thomas & Bowen 1967). These are sandy, silty, or clayey soils that usually have a strongly acid reaction; they are poorly to well-drained. On some of the ridges, a thin layer of loess remains, but geologic erosion has removed the loess from the side slopes.

Fig. 1. Location of Grenada County, Mississippi.

Agriculture plays an important role in the economy of Grenada County. As a result, many of the level Areas that are not poorly drained have been cleared and are now present as cultivated fields or pastures. The bottomlands along the Yalobusha River and one of its major tributaries, the Batupan Bogue, are now almost entirely under cultivation; but they were originally timbered with many species of oaks and hickories among other hardwoods (Hilgard 1860). Crops grown include cotton, soybeans, corn, rice, wheat, and other grains.

The lumber industry contributes to the economy of Grenada County. Pine monocultures frequently replace upland oak-hickory or pine-oak-hickory forests in areas that have been clearcut in the eastern part of the county. This practice generally reduces overall biodiversity and sets up conditions for uncontrolled plant diseases and increased erosion, and also creates corridors for the spread of invasive plant species.

Since the settlement of the area, the formation of Grenada Lake, and because of agricultural practices and the lumber industry, much of the natural vegetation has been drastically altered. However, areas of minimal disturbance where native species are the predominant flora still remain in the county, especially sites that are either poorly drained or too steep to be subject to mass deforestation.

One of the first vegetational surveys conducted in northern Mississippi only included areas north or south of Grenada County (Harper 1913). Since that time, very little intensive field work has been car-ried out within and adjacent to Grenada County. Therefore, prior to our studies, the flora was poorly known. The second author conducted a floristic survey of Camp McCain, a military training area within Grenada County that the first author did not have permission to inventory.

MATERIALS AND METHODS

Collecting trips were made by the first author at regular intervals from March 1986 to November 1987, and by the second author from 1993-1996. Voucher specimens of each vascular plant species encountered were prepared using standard herbarium techniques for deposit in the Institute of Botanical Exploration (IBE), and other herbaria.

Manuals and guides consulted in the determination of species and for current nomenclature include the following: Clewell (1985), Correll & Johnston (1970), FNA (1993+), Godfrey (1988), Godrey & Wooten (1979, 1981), Radford et al. (1968), Steyermark (1963), Weakley (2011), Wofford (1989), and Wunderlin (1998). Works on the flora of Mississippi that have some bearing on the vascular plants of Grenada County are: Bryson (1984), Bryson & Carter (1994), Bryson & Morris (1988, 1992), Bryson et al. (1994), Evans (1978), Gunn et al. (1980), Jones (1974a, 1974b, 1975a, 1975b, 1976a, 1976b), Jones et al. (1969), Lowe (1921), Morris (1989), Morris et al. (1993), Morris (1997), Pullen et al. (1968), and Sorrie & Leonard (1999). Nomenclature primarily follows Weakley (2011). Standardized abbreviations for authority names are from The International Plant Names Index (2012).

RESULTS AND DISCUSSION

Field work conducted mostly in 1986–1987 (Morris 1987) and in 1993–1996 has resulted in the documentation of 1,129 species of vascular plants. Two additional infraspecific taxa were also documented for a total 1,131 taxa. The major families are: Poaceae, 140 species; Asteraceae, 132 species; Cyperaceae, 107 species; and Fabaceae, 83 species. Many of the most noteworthy taxa, including the first documented Mississippi populations of *Equisetum arvense* L., *Dryopteris ×australis* (Wherry) Small, and *Cyperus lancastriensis* Porter in A. Gray, were previously reported from Grenada County by the author (Morris 1988, Morris & Bryson 1986). The additional collections of *Aristida ramosissima* Engelm. ex A. Gray and *Lepidium densiflorum* Schrad. made by the second author from Grenada County record these species as new to Mississippi. Forty-six taxa considered rare or uncommon to critically imperiled in Mississippi and tracked by the Mississippi Natural Heritage Program (2006a) were located during the course of field surveys (Table 1). Eight of these species, *Equisetum arvense, Dryopteris ×australis, Osmorhiza longistylis, Panax quinquefolius, Pachysandra procumbens, Platanthera cristata, Schisandra glabra,* and *Chelone glabra,* are illustrated (Figs. 2, 3, 4, 5, 6, 7, 8, 9). In addition, nine vascular plant species on the Mississippi Natural Heritage Program Special Plants Watch List (2006b), *Antennaria solitaria, Comandra umbellata, Dasistoma macrophyllum, Rhynchosia latifolia, Carex albicans* var. *albicans, Carex meadii, Carex oklahomensis, Lilium superbum,* and *Melanthium (= Veratrum) virginicum*, all of which have S3S4 rank-ings, were documented in Grenada County. Based on this study, it was determined that approximately 18.4% of the flora is not native to the area.

A systematic list of the vascular flora of Grenada County, Mississippi has never been presented. Thus, following is a list of native and naturalized vascular plants of this area based on collections by the authors (Morris 1987). It is arranged alphabetically by family and species under the major taxonomic divisions. Herbarium specimens based on this study are primarily housed in IBE, and specimens were also deposited in DSC, MICH, MISSA, SWSL, ctb (personal herbarium of Charles T. Bryson), mwm (personal herbarium of Michael Wayne Morris), jrm (personal herbarium of John R. MacDonald), and other herbaria. Information on relative abundance, habitats, and the physiographic region(s) in which each taxon occurs is also included. Relative abundance terms are ranked from highest to lowest as follows: Abundant, Common, Frequent, Occasional, Infrequent, Uncommon, and Rare. An asterisk (*) indicates the species is most common in a particular region. Physiographic regions are indicated as follows: **YMD** = Yazoo-Mississippi Delta; **LB** = Loess Bluffs; **NCP** = North Central Plateau; **LB/YMD & LB/NCP** = transition areas; and "Throughout" = throughout county. "Introduced" means the species is likely not native to the area. Regarding collection numbers, **MWM** = Morris, and **JRM** = MacDonald.

LYCOPHYTES

Lycopodiaceae

Lycopodium alopecuroides L. Rare; exposed seepage slope; NCP. JRM 8973

Lycopodium appressum (Chapm.) Lloyd & Underw. Rare; wet meadows and open sandy bogs; NCP. MWM 2803, 3054; JRM 8984

Selaginellaceae

Selaginella apoda (L.) Spring. Infrequent; wet meadows and stream banks; LB, NCP. MWM 546; JRM 7860

EQUISETOPHYTES

Equisetaceae

Equisetum arvense L. Rare (although locally common); sandy stream and creek banks; LB. MWM 590, 722, 2747

Equisetum hyemale L. Occasional (locally abundant); sandy stream and creek banks; LB. MWM 533

Table 1. Vascular plant species in Grenada County, Mississippi on Mississippi Natural Heritage Program special plants tracking list along with state ranking regarding conservation status.

Agalinis viridis S2S3
Aralia racemosa S1?
Asclepias hirtella S2
Asclepias purpurascens S1
Carex decomposita S3
Carex grisea S1
Carex stricta S2
Carya leiodermis S2S3
Celastrus scandens S2S3
Cheilanthes lanosa S2
Chelone glabra S3
Crataegus calpodendron S3
Cypripedium parviflorum var. *pubescens* S2S3
Dryopteris xaustralis S1
Echinacea purpurea S3
Equisetum arvense S1S2
Fraxinus profunda S3
Hybanthus concolor S2S3
Iris fulva S3
Isotria verticillata S3
Juglans cinerea S2
Lobelia appendiculata S2S3
Luzula acuminata S3
Matelea carolinensis S3
Matelea obliqua S2?
Muhlenbergia sylvatica SU
Osmorhiza longistylis S3
Pachysandra procumbens S3
Panax quinquefolius S3
Penstemon tenuis S2S3
Platanthera cristata S3
Platanthera lacera S1S2
Platanthera peramoena S2S3
Pycnanthemum verticillatum var. *pilosum* S1
Quercus similis S3
Rudbeckia subtomentosa S1
Sabatia campestris S2S3
Schisandra glabra S3
Scleria reticularis S2
Spiranthes lacera var. *gracilis* S2S3
Spiranthes ovalis S2S3
Staphylea trifolia S3
Symphyotrichum puniceum S1
Triosteum angustifolium S3
Triphora trianthophora S2S3
Ulmus serotina S3

POLYPODIOPHYTES

Aspleniaceae

Asplenium platyneuron (L.) Britton, Sterns & Poggenb. Common; low to upland woods, thickets, and old fields; Throughout. MWM 2928; JRM 7571

Blechnaceae

Woodwardia areolata (L.) Moore. Frequent; bogs, spring branches, and seepage slopes; LB, NCP*. MWM 380; JRM 7682

Dennstaedtiaceae

Pteridium aquilinum (L.) Kuhn. Common; old fields and upland woods; LB, NCP. MWM 2942; JRM 7405

Dryopteridaceae

Athyrium filix-femina (L.) Roth. Frequent; rich and low woods, seepage areas and spring branches; throughout (rare in YMD). MWM 957; JRM 7413

Dryopteris x *australis* (Wherry) Small. Rare; swampy woods at base of bluff; LB. MWM 2910, 2955

Onoclea sensibilis L. Frequent; low woods, marshes, and seepage slopes; throughout. MWM 986a; JRM 7618

Polystichum acrostichoides (Michx.) Schott. Common; rich woods; LB, NCP. MWM 3065; JRM 7412

Woodsia obtusa (Spreng.) Torr. Rare; rich woods; LB, LB/NCP. MWM 2960; JRM 7251

Lygodiaceae

Lygodium japonicum (Thunb.) Sw. Uncommon; low disturbed areas in second-growth forests; LB/NCP. Introduced. JRM 7616, 9122

Ophioglossaceae

Botrychium biternatum (Sav.) Underw. Common; low and rich woods, old fields, and thickets; throughout. MWM 2678; JRM 7623

Botrychium virginianum (L.) Sw. Common; rich woods; LB*, NCP. MWM 956

Ophioglossum vulgatum L. Occasional; bottomland woods; LB, NCP, YMD*. MWM 631, 2713, 2753; JRM 7319

Osmundaceae

Osmunda cinnamomea L. Frequent; bogs, spring branches, and seepage slopes; LB, NCP*. MWM 740

Osmunda regalis L. var. *spectabilis* (Willd.) A. Gray. Frequent; bogs, spring branches, seepage slopes, and swampy woods; LB, NCP*. MWM 761; JRM 7414

Polypodiaceae

Polypodium polypodioides (L.) Watt. Common; epiphytic on living trees, on fallen logs, and rarely on bare soil; throughout. MWM 2911; JRM 7320

Pteridaceae

Adiantum pedatum L. Frequent; rich woods; LB*, NCP. MWM 763

Cheilanthes lanosa (Michx.) D.C. Eaton. Rare; sandstone outcrops; NCP. JRM 8224

Salviniaceae

Azolla caroliniana Willd. Occasional; aquatic in bald cypress-water tupelo swamps and in sloughs; throughout. MWM 2735

Thelypteridaceae

Macrothelypteris torresiana (Gaudich.) Ching. Infrequent; low disturbed areas in hardwood forests; LB/NCP. Introduced. JRM 7615, 9120

Phegopteris hexagonoptera (Michx.) Fee. Frequent; rich woods; LB, NCP. MWM 3069; JRM 7470

Thelypteris kunthii (Desv.) Morton. Rare; moist meadows in upland hardwoods; LB/NCP. JRM 7613, 9121

Thelypteris noveboracensis (L.) Nieuwl. Rare; seepage slopes and boggy woods; NCP. MWM 2896

Thelypteris palustris Schott. Rare; seepage areas and swampy woods; LB, NCP. MWM 2954, 3008

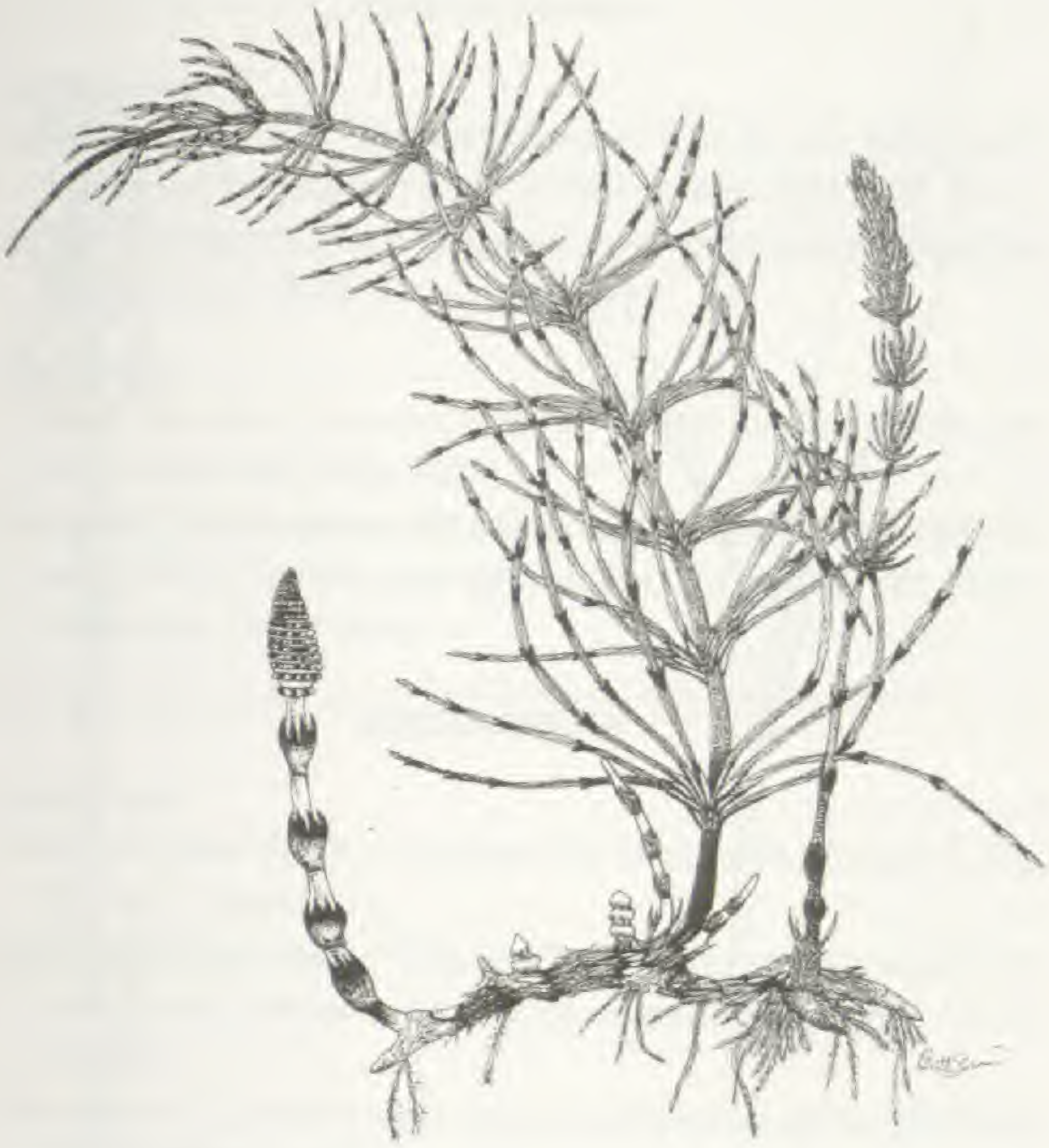

Fig. 2. *Equisetum arvense.*

Fig. 3. *Dryopteris ×australis.*

Fig. 4. *Osmorhiza longistylis.*

Fig. 5. *Panax quinquefolius.*

FIG. 6. *Pachysandra procumbens.*

FIG. 7. *Platanthera cristata.*

FIG. 8. *Schisandra glabra.*

FIG. 9. *Chelone glabra.*

GYMNOSPERMS

Cupressaceae

Juniperus virginiana L. Common; upland woods, old fields, and fence rows; throughout (rare in YMD). MWM 3066; JRM 7375

Taxodium distichum (L.) Rich. Frequent; swamp forests and sloughs; LB, NCP, YMD*. MWM 2884a; JRM 8330

Pinaceae

Pinus echinata Mill. Common; upland woods and old fields; LB, NCP*. MWM 3067; JRM 9027

Pinus taeda L. Uncommon; old fields, along streams, and upland woods; NCP. Planted throughout and common in the introduced state. MWM 2995

ANGIOSPERMS

Acanthaceae

Justicia lanceolata Small. Frequent; low woods and marshes; LB, NCP, YMD*. MWM 1020

Ruellia caroliniensis (Walter) Steud. Occasional; upland woods to well-drained bottomland woods; throughout. MWM 1176; JRM 8851

Ruellia strepens L. Uncommon; bottomland hardwood forests; YMD, LB/YMD. MWM 2899

Adoxaceae

Sambucus nigra L. ssp.*canadensis* (L.) Bolli. Common; woodland borders, creek banks, and Roadsides; throughout. MWM 1189a; JRM 8789

Viburnum nudum L. Occasional; bogs and spring branches; NCP. MWM 2399, 2401

Viburnum rufidulum Raf. Occasional; upland woods; LB, NCP. MWM 585, 589, 938, 2457a, 2550; JRM 7376

Agavaceae

Manfreda virginica (L.) Rose. Frequent; dry woods and roadsides; LB, NCP. MWM 2290; JRM 8975

Yucca flaccida Haw. Infrequent; roadsides and old house sites; LB, NCP. Introduced. MWM s.n.

Alismataceae

Echinodorus cordifolius (L.) Griseb. Occasional; marshes and margins of sloughs; LB, NCP, YMD*. MWM 2267; JRM 9229

Sagittaria engelmanniana J.G. Sm. Infrequent; bogs and spring branches; NCP. MWM 3019; JRM 7781

Sagittaria latifolia Willd. Occasional; marshes, mudflats, and margins of sloughs; throughout. MWM 3032; JRM 8946

Sagittaria montevidensis Cham. & Schltdl. Infrequent; marshes and margins of sloughs; YMD, LB/YMD. Introduced. MWM 2865

Altingiaceae

Liquidambar styraciflua L. Common; low to upland woods; throughout. MWM 2038; JRM 8283

Amaranthaceae

Amaranthus hybridus L. Common; cultivated fields and roadsides; throughout. Introduced. MWM 2471; JRM 8124

Amaranthus spinosus L. Common; cultivated fields and roadsides; throughout. Introduced. MWM 2473; JRM 7496, 9750

Amaranthus tuberculatus (Moq.) J.D. Sauer. Infrequent; margins of bald cypress-water tupelo swamps and sloughs; YMD. Introduced. MWM 2997

Amaryllidaceae

Allium ampeloprasum L. Infrequent; roadsides; throughout. Introduced. MWM 2849

Allium canadense L. Frequent; meadows and woodland borders; throughout (rare in YMD). MWM 858; JRM 8420

Allium vineale L. Common; roadsides, fields, and waste places; throughout. Introduced. MWM 2022

Hymenocallis occidentalis (LeConte) Kunth. Occasional; low and rich woods; throughout. MWM 2474

Hypoxis hirsuta (L.) Coville. Uncommon; dry-mesic hardwoods; NCP. JRM 7027

Narcissus poeticus L. Occasional; roadsides and old house sites; throughout. Introduced. MWM 2768; JRM 8493

Narcissus pseudo-narcissus L. Occasional; roadsides and old house sites; throughout. Introduced. MWM 2706

Nothoscordum bivalve (L.) Britton. Frequent; pastures, roadsides, and woodland borders; throughout (rare in YMD). MWM 547

Anacardiaceae

Pistachia chinensis Bunge. Persistent at old house site; NCP. Introduced. JRM 7223

Rhus copallina L. Common; woodlands and clearcut areas; LB, NCP. MWM 2147; JRM 8994

Rhus glabra L. Common; woodland borders, roadsides, and clearcut areas; throughout. MWM 2016; JRM 9028

Toxicodendron radicans (L.) Kuntze. Abundant; low to upland woods, fencerows, and waste places; throughout. MWM 3043

Toxicodendron toxicarium (Salisb.) Gillis. Infrequent; dry upland woods; NCP. JRM 7058

Annonaceae

Asimina triloba (L.) Dunal. Frequent; rich and bottomland woods; throughout. MWM 545; JRM 7693

Apiaceae

Ammoselinum butleri J. M. Coult. & Rose. Rare; roadside ditch; NCP. Introduced. JRM 8335

Chaerophyllum tainturieri Hook. Common; fields, meadows, and roadsides; throughout. MWM 607

Cicuta maculata L. Common; low woods, wet meadows, and ditches; throughout. MWM 2028, 2408, 2961, 3034; JRM 8764 [Some robust individuals of this species were incorrectly determined as *Angelica atropurpurea* L. in Morris (1988).]

Cryptotaenia canadensis (L.) DC. Frequent; rich and low woods; LB*, NCP, YMD. MWM 934; JRM 7782

Cyclospermum leptophyllum (Pers.) Sprague ex Britton & Wilson. Rare; edges of fields and roadside ditches in uplands; LB/NCP, NCP. JRM 8773

Cynosciadium digitatum DC. Occasional; low, wet woods; LB, NCP, YMD*. MWM 1069

Daucus carota L. Occasional; roadsides and waste places; throughout. Introduced. MWM 2050; JRM 7318, 8888b

Daucus pusillus Michx. Infrequent; sandy roadsides and waste places; LB. MWM 1169; JRM 8799

Eryngium integrifolium Walt. Uncommon; bogs and spring branches; NCP. MWM 2457; JRM 9052

Eryngium prostratum Nutt. Frequent; wet meadows and ditches; throughout. MWM 1188

Eryngium yuccifolium Michx. Frequent; borders of upland woods, roadsides, and clearcut areas; LB, NCP*. MWM 2150

Limnosciadium pinnatum (DC.) Math. & Const. Infrequent; ditches and margins of low, wet woods; YMD, NCP. MWM 2852; JRM 7270, 8794

Osmorhiza longistylis (Torr.) DC. Occasional; rich woods; LB*, LB/NCP. MWM 717, 764; JRM 8471

Oxypolis rigidior (L.) Raf. Occasional; bogs and spring branches; NCP. MWM 2451; JRM 9068

Ptilimnium capillaceum (Michx.) Raf. Common; wet meadows, marshes, and roadside ditches; throughout. MWM 2028a, 2145a; JRM 8214b

Ptilimnium nuttallii (DC.) Britton. Uncommon; dry meadows and roadsides; NCP. JRM 7269, 8849

Sanicula canadensis L. Common; rich and bottomland woods; throughout. MWM 853, 972; JRM 8783

Sanicula marilandica L. Uncommon; mesic woods; NCP. MWM 2922

Sanicula odorata (Raf.) K. M. Pryer & L. R. Phillippe. Frequent; rich woods; LB*, LB/NCP. MWM 755; JRM 8782

Sanicula smallii C. Bicknell. Occasional; upland woods; NCP. MWM 2814; JRM 8846

Thaspium trifoliatum (L.) A. Gray. Frequent; dry-mesic to rich woods and woodland borders; LB, NCP. MWM 765, 2041, 2106a; JRM 7330, 8586b, 9032

Torilis arvensis Link. Infrequent; roadsides, fields, and waste places; throughout. Introduced. MWM 2049; JRM 8805

Trepocarpus aethusae Nutt. Occasional; bottomland hardwood forests; LB, NCP, YMD*. MWM 1186

Apocynaceae

Amsonia tabernaemontana Walter. Infrequent; bottomlands and rich woods; LB, NCP, YMD*. MWM 652

Apocynum cannabinum L. Frequent; roadsides and woodland borders; throughout. MWM 940

Asclepias amplexicaulis Sm. Occasional; borders of upland woods; NCP. MWM 998; JRM 9471, 8887

Asclepias hirtella (Pennell) Woodson. Rare; meadow near rich hardwoods; NCP. MWM 2358

Asclepias perennis Walter. Occasional; low, wet woods and swamp forests; LB, NCP, YMD*. MWM 1067

Asclepias purpurascens L. Rare; bottomland hardwood forest; YMD. MWM 2380

Asclepias tuberosa L. Common; roadsides, meadows, and borders of upland woods; LB, NCP. MWM 1191; JRM 9081

Asclepias variegata L. Frequent; mesic to dry-mesic woods; LB, NCP. MWM 937; JRM 8768, 8779

Asclepias viridiflora Raf. Uncommon; borders of upland woods and fields; LB, LB/NCP. MWM 2968; JRM 7238, 8948

Cynanchum laeve Pers. Infrequent; fields and thickets; LB, YMD. MWM 2863, 2981

Gonolobus suberosus (L.) R. Br. Occasional; thickets and rich woods; throughout. MWM 1189; JRM 8797

Matelea carolinensis (Jacq.) Woodson. Infrequent; rich woods; LB*, NCP. MWM 773; JRM 7838, 8781, 8997

Matelea obliqua (Jacq.) Woodson. Rare; dry-mesic woods; NCP. JRM 9481

Trachelospermum difforme (Walter) A. Gray. Frequent; bottomland woods, thickets, and marshes; throughout. MWM 987; JRM 8778

Vinca major L. Rare; old house sites; NCP. Introduced. MWM 2720

Aquifoliaceae

Ilex decidua Walter. Common; low to upland woods and thickets; throughout. MWM 650; JRM 7379 [The additional collections JRM 7059, 7331 correspond with *I. decidua* var. *longipes* (Chapm. ex Trel.) Ahles.]

Ilex opaca Aiton. Frequent; rich and bottomland woods; throughout. MWM 2137; JRM 7374

Ilex verticillata (L.) A. Gray. Infrequent; bogs and spring branches; NCP. MWM 2154, 2692

Ilex vomitoria Aiton. Rare; at margin of pine plantation; LB/NCP. Introduced. JRM s.n.

Araceae

Arisaema dracontium (L.) Schott. Frequent; rich and low woods; throughout. MWM 754, 766

Arisaema triphyllum (L.) Schott ssp. *quinatum* (Nutt.) Huttleston. Common; rich and bottomland woods; throughout. MWM 723; JRM 8477

Arisaema triphyllum (L.) Schott ssp. *triphyllum*. Occasional; rich woods; LB*, NCP. MWM 860

Lemna perpusilla Torr. Frequent; aquatic in bald cypress-water tupelo swamps and sluggish streams; throughout. MWM 2275, 2715

Orontium aquaticum L. Uncommon; acid streams and spring branches; NCP. MWM 548

Peltandra virginica (L.) Kunth. Uncommon; along streams in low woods and margins of bald cypress-water tupelo swamps; LB/YMD. MWM 2771, 2864

Spirodela polyrhiza (L.) Schleid. Occasional; aquatic in bald cypress-water tupelo swamps and sluggish streams; throughout. MWM 2716, 2767

Wolffia brasiliensis Wedd. Infrequent; aquatic in bald cypress-water tupelo swamps; YMD. MWM 2373

Wolffiella gladiata (Hegelm.) Hegelm. Occasional; aquatic in bald cypress-water tupelo swamps; YMD, LB/YMD. MWM 2714

Araliaceae

Aralia racemosa L. Rare; rich woods; LB/NCP. JRM 9163

Aralia spinosa L. Common; upland woods, thickets, and creek banks; throughout. MWM 2387; JRM 8164

Hydrocotyle ranunculoides L. f. Rare; swampy depression at base of bluff; LB/YMD. MWM 2746

Hydrocotyle verticillata Thunb. Occasional; margins of bald cypress-water tupelo swamps and low, wet woods; LB, NCP, YMD*. MWM 2350

Panax quinquefolius L. Infrequent; rich woods; LB*, NCP. MWM 2236; JRM 7067, 8978

Arecaceae

Sabal minor (Jacq.) Pers. Frequent; low woods; YMD*, LB. MWM 3028

Aristolochiaceae

Aristolochia serpentaria L. Frequent; mesic to bottomland woods; throughout. MWM 962

Aristolochia tomentosa Sims. Frequent (locally abundant); in bottomland hardwood forests on natural levees of large creeks and the Yalobusha River; throughout. MWM 945, 1004

Asparagaceae

Asparagus officinalis L. Infrequent; roadsides; LB. Introduced. MWM 2933

Asteraceae

Achillea millefolium L. Infrequent; pastures and roadsides; LB, NCP. Introduced. MWM 2840; JRM 8798

Acmella oppositifolia (Lam.) R.K. Jansen. Frequent; swamp forests and low, wet woods; LB, YMD*. MWM 2348

Ageratina altissima (L.) R. M. King & H. Rob. Occasional; rich woods; LB*, NCP. MWM 2352; JRM 7768, 9182

Ambrosia artemisiifolia L. Abundant; pastures, fields, roadsides, and woodland borders; throughout. MWM 2564; JRM 7483

Ambrosia bidentata Michx. Infrequent; borders of upland woods and roadsides; NCP. MWM 2528; JRM 7295, 7401, 9071

Ambrosia trifida L. Abundant; woodland borders, creek banks, and roadsides; throughout. MWM 2556, 2689; JRM 7617

Antennaria plantaginifolia Hook. Common; upland woods and clearings; LB, NCP. MWM 600; JRM 8324

Antennaria solitaria Rydb. Infrequent; upper slopes in rich hardwood forests; LB, NCP. MWM 532, 2728; JRM 9292

Anthemis cotula L. Occasional; roadsides, fields, and waste places; throughout. Introduced. MWM 1001

Arnoglossum atriplicifolium (L.) H. Rob. Occasional; dry-mesic to rich woods and woodland borders; LB, NCP. MWM 2481; JRM 8993

Arnoglossum ovatum (Walter) H. Rob. Occasional; bogs and spring branches; NCP. MWM 2453; JRM 7469, 9054

Baccharis halimifolia L. Occasional; woodland borders, old fields, clearcut areas, and waste places; throughout. MWM 2683; JRM 8213

Bidens aristosa (Michx.) Britton. Common; ditches, woodland borders, and waste places; throughout. MWM 2295, 3035; JRM 7624

Bidens bipinnata L. Occasional; borders of upland woods and waste places; LB, NCP. MWM 2386; JRM 9172

Bidens discoidea (Torr. & A. Gray) Britton. Frequent; swamp forests and low, wet woods; LB, NCP, YMD*. MWM 2374, JRM 9222

Bidens frondosa L. Occasional; roadsides, fields, and woodland borders; LB, NCP. JRM 9228

Boltonia asteroides L'Her. Infrequent; old fields; YMD, LB. MWM 3059

Boltonia diffusa Elliott. Common; borders of low and upland woods, old fields, and roadside ditches; throughout. MWM 2475; JRM 7364

Brickellia eupatorioides (L.) Shinners. Infrequent; upland woods and clearcut areas; NCP. MWM 2653; JRM 8091, 9176

Centaurea maculosa Lam. Rare; roadside at edge of upland woods; NCP. Introduced. JRM 7218

Chrysopsis mariana (L.) Elliott. Common; upland woods and roadsides; LB, NCP. MWM 2646a; JRM 7843, 9205

Cirsium altissimum (L.) Hill. Infrequent; clearings in upland woods; LB*, LB/NCP. MWM 2465; JRM 7468

Cirsium carolinianum (Walter) Fernald & B. G. Schub. Infrequent; dry upland woods and clearcut areas; NCP. MWM 2816; JRM 8728

Cirsium discolor (Muhl.) Spreng. Frequent; pastures, old fields, and woodland borders; throughout. MWM 2567; JRM 7559

Cirsium horridulum Michx. Common; pastures, fields, woodland borders, and roadsides; throughout. MWM 770; JRM 8415

Cirsium vulgare (Savi) Ten. Rare; cutover woods and roadsides; LB/NCP. Introduced. JRM 8902

Conoclinium coelestinum (L.) DC. Common; pastures, woodland borders, and roadside ditches; throughout. MWM 2494; JRM 7556

Conyza bonariensis (L.) Cronq. Infrequent; roadsides and cutover woods; LB/NCP, NCP. Introduced. JRM 7217, 8758

Conyza canadensis (L.) Cronquist. Abundant; fields, roadsides, and clearcut areas; throughout. MWM 2253; JRM 7347

Coreopsis lanceolata L. Occasional; upland woods and roadsides; LB, NCP. MWM 746

Coreopsis pubescens Elliott. Occasional; upland woods and roadsides; NCP. JRM 8775

Coreopsis tinctoria Nutt. Infrequent; roadsides and waste places; throughout. Introduced. MWM 2051; JRM 7494

Coreopsis tripteris L. Common; upland to alluvial woods, roadsides, and clearcut areas; LB, NCP*. MWM 2455

Doellingeria sericocarpoides Small. Rare (although locally common); bogs; NCP. MWM 2972, 2987

Echinacea purpurea (L.) Moench. Rare; woodland borders; LB. MWM 2134

Eclipta prostrata (L.) L. Common; low woods, wet meadows, and marshes; throughout. MWM 2282; JRM 7433, 9190

Elephantopus carolinianus Willd. Common; rich and bottomland woods; throughout. MWM 2486; JRM 7484

Elephantopus tomentosus L. Common; upland woods; LB, NCP. MWM 2383; JRM 7411

Erechtites hieracifolia (L.) Raf. Abundant; woodland borders, clearcut areas, roadsides, and waste places; throughout. MWM 2535; JRM 7513

Erigeron annuus (L.) Pers. Common; fields, roadsides, and meadows; throughout. MWM 929, 1052; JRM 8227b

Erigeron philadelphicus L. Common; fields, roadsides, meadows, and lawns; throughout. MWM 608, 831; JRM 8297, 8499

Erigeron pulchellus Michx. Occasional; rich woods; LB, LB/NCP. MWM 534; JRM 8488

Erigeron strigosus Muhl. ex Willd. Common; fields, roadsides, and clearcut areas; throughout. MWM 2854

Erigeron tenuis Torrey & A. Gray. Rare; roadsides and periodically mowed meadows; NCP. JRM 7332

Eupatoriadelphus fistulosus (Barratt) R. M. King & H. Rob. Frequent; low woods, bogs, and creek banks; throughout (rare in YMD). MWM 2332; JRM 7406

Eupatorium album L. Occasional; upland woods and roadsides; LB, NCP*. MWM 2339

Eupatorium capillifolium (Lam.) Small. Abundant; fields, roadsides, and waste places; throughout. MWM 2655; JRM 7854

Eupatorium hyssopifolium L. Occasional; upland woods, roadsides, and clearcut areas; LB, NCP*. MWM 2454, 3017; JRM 7538, 9125

Eupatorium perfoliatum L. Frequent; low woods and bogs; throughout. MWM 2549; JRM 7672

Eupatorium rotundifolium L. Common; upland woods, roadsides, and clearcut areas; LB, NCP. MWM 2340; JRM 7407

Eupatorium semiserratum DC. Occasional; woodland borders; LB, NCP, YMD*. MWM 2965

Eupatorium serotinum Michx. Common; woodland borders, roadsides, and waste places; throughout. MWM 2543; JRM 7560

Eurybia hemispherica (Alex.) G.L. Nesom. Common; upland woods, roadsides, and clearcut areas; LB, NCP. MWM 2341; JRM 7544b, 7607, 9179

Euthamia leptocephala (Torr. & A. Gray) Greene ex Porter & Britton. Frequent; woodland borders; throughout. MWM 2624; JRM 7687

Facelis retusa (Lam.) Sch.-Bip. Rare; upland roadsides; NCP. Introduced. JRM 8761

Fleischmannia incarnata (Walter) R. M. King & H. Rob. Occasional; rich and bottomland woods; LB*, NCP, YMD. MWM 2649, 2652; JRM 7767

Gamochaeta antillana (Urban) Anderb. Rare; margin of artificial pond; NCP. JRM s.n.

Gamochaeta purpurea (L.) Cabrera. Common; fields, lawns, and woodland borders; throughout. MWM 632; JRM 8422

Helenium amarum (Raf.) H. Rock. Abundant; roadsides, pastures, and waste places; throughout. MWM 1185; JRM 7400

Helenium autumnale L. Occasional; low, wet woods and meadows; LB, NCP. MWM 2581

Helenium flexuosum Raf. Occasional; wet meadows and pastures; throughout. MWM 2238; JRM 7317

Helianthus angustifolius L. Abundant; old fields, woodland borders, and roadsides; throughout. MWM 2585; JRM 7675

Helianthus annuus L. Rare; roadsides; LB, NCP. Introduced. MWM 2936; JRM 7259

Helianthus divaricatus L. Common; upland woods and clearings; LB, NCP. MWM 2046; JRM 7606

Helianthus grosseserratus M. Martens. Frequent; roadsides and woodland borders; throughout. MWM 2607

Helianthus hirsutus Raf. Infrequent; woodland borders; NCP. MWM 2388; JRM 9681

Helianthus microcephalus Torr. & A. Gray. Common; upland woods, clearcut areas, and roadsides; LB, NCP. MWM 2570, 2988; JRM 7517, 7687d

Helianthus mollis Lam. Rare; upland meadows and woodland borders; NCP. JRM 9050

Helianthus silphioides Nutt. Uncommon; borders of upland woods and dry meadows; NCP. MWM 2588; JRM 7850

Heliopsis helianthoides (L.) Sweet. Rare; rich woods and woodland borders; LB/NCP. JRM 8715

Hieracium gronovii L. Common; upland woods and roadsides; LB, NCP. MWM 2330; JRM 7395

Iva annua L. Common; fields and roadsides; throughout. MWM 2650; JRM 7690

Krigia caespitosa (Raf.) K. L. Chambers. Common; fields, roadsides, and pastures; throughout. MWM 595; JRM 8243

Krigia dandelion (L.) Nutt. Common; dry woods, pastures, lawns, and roadsides; LB, NCP. JRM 8382

Krigia virginica (L.) Willd. Occasional; upland fields, pastures, lawns, and woodland borders; LB, NCP. MWM 625; JRM 7094

Lactuca canadensis L. Common; roadsides, fields, and waste places; throughout. MWM 2135, 2579

Lactuca floridana (L.) Gaertn. Occasional; within and at margins of bottomland and rich woods; throughout. MWM 2554; JRM 7497

Lactuca serriola L. Common; fields, roadsides, and waste places; throughout. Introduced. MWM 2247; JRM 7267

Leucanthemum vulgare L. Infrequent; pastures and roadsides; LB, NCP. Introduced. MWM 2819; JRM 8729

Liatris spicata (L.) Willd. Rare; clearing in upland woods near bogs; NCP. MWM 2971

Liatris squarrosa (L.) Michx. Common; borders of upland woods; LB, NCP. MWM 2272; JRM 7381

Liatris squarrulosa Michx. Occasional; borders of dry upland woods; LB/NCP, NCP. MWM 2587, 2640; JRM 7842, 9206

Matricaria discoidea DC. Infrequent; fields, roadsides, and waste places; throughout. Introduced. MWM 2709; JRM 8331

Mikania scandens (L.) Willd. Common; low woods, marshes, and thickets; throughout. MWM 2375; JRM 7428, 7820b

Packera glabella (Poir.) C. Jeffrey. Common; low woods and wet fields; throughout. MWM 597; JRM 8430b, 8474

Pityopsis graminifolia (Michx.) Nutt. Common; dry upland woods and roadsides; NCP. MWM 2669; JRM 7847, 9207

Pluchea camphorata (L.) DC. Common; low woods, marshes, and ditches; throughout. MWM 2545; JRM 7612

Prenanthes altissima L. Common; rich woods; LB, NCP. MWM 2655a; JRM 7695, 9201

Pseudognaphalium helleri (Britton) Anderb. Infrequent; open upland woods; NCP. JRM 8133

Pseudognaphalium obtusifolium (L.) Hilliard & B.L. Burtt. Common; old fields and woodland borders; LB, NCP. 2638a

Pyrrhopappus carolinianus (Walter) DC. Common; fields, lawns, pastures, and roadsides; throughout. MWM 855, 2033; JRM 8589, 8852

Rudbeckia fulgida Aiton. Uncommon; low, wet woods; LB, LB/YMD. MWM 2557

Rudbeckia hirta L. Common; woodland borders and roadsides; LB, NCP. MWM 968, 2235

Rudbeckia subtomentosa Pursh. Rare; moist meadows; NCP. JRM 9049, 9171

Silphium integrifolium Michx. Frequent; woodland borders; LB, NCP. MWM 2249, 2996; JRM 7362

Silphium perfoliatum L. Infrequent; low woodland borders; LB/YMD. MWM 2470

Smallanthus uvedalius (L.) Mack ex Small. Occasional; rich and bottomland woods; throughout. MWM 2105; JRM 8857

Solidago arguta Aiton. Infrequent; upland woods and clearings; NCP. MWM 3002, 3004, 3011; JRM 7564, 7687b

Solidago caesia L. Frequent; rich woods; LB, NCP. MWM 2623; JRM 7771

Solidago canadensis L. Common; old fields, pastures, woodland borders, and roadsides; throughout. MWM 2611; JRM 7663

Solidago gigantea Aiton. Common; old fields and moist woodland borders; throughout. MWM 2456; JRM 7346, 7490b

Solidago nemoralis Aiton. Frequent; upland, woods and clearings; LB, NCP. JRM 7676, 9123

Solidago odora Aiton. Common; upland woods, clearcut areas, and roadsides; LB, NCP*. MWM 2577; JRM 7508, 9131

Solidago patula Muhl. ex Willd. Frequent; bogs, spring branches, and seepage slopes; LB, NCP*. MWM 2573; JRM 7685, 9181

Solidago petiolaris Aiton. Infrequent; upland woods and roadsides; NCP. MWM 2660; JRM 7848

Solidago puberula Nutt. Occasional; woodland borders and roadsides; LB, NCP. MWM 2618; JRM 8172, 9204

Solidago rugosa Mill. Occasional; borders of upland woods and moist meadows; NCP. MWM 2673; JRM 7674, 7770

Solidago speciosa Nutt. Occasional; upland woods and roadsides; NCP. MWM 2659; JRM 7841, 9180

Solidago ulmifolia Muhl. ex Willd. Frequent; dry-mesic to rich woods and clearings; LB, NCP. MWM 2459, 2561, 2661; JRM 7563, 8093, 9254

Soliva sessilis Ruiz & Pav. Infrequent; lawns, roadsides, and waste places; throughout. Introduced. MWM 2796; JRM 8304

Sonchus asper (L.) Hill. Common; roadsides and waste places; throughout. Introduced. MWM 834

Symphyotrichum concolor (L.) G.L. Nesom. Occasional; dry upland woods and clearcut areas; NCP. MWM 2671; JRM 7849, 8090

Symphyotrichum divaricatum (Nutt.) G.L. Nesom. Occasional; low fields, marshes, and roadsides; LB, NCP, YMD*. MWM 2633; JRM 9186b, 9187

Symphyotrichum drummondii (Lindl.) G.L. Nesom. Frequent; rich woods; LB*, NCP. MWM 2621

Symphyotrichum dumosum (L.) G. L. Nesom. Common; bottomlands to uplands, clearcut areas, old fields, and roadsides; throughout. MWM 2632, 2667; JRM 7845

Symphyotrichum laeve (L.) A. Love & D. Love var. *purpuratum* (Nees) G. L. Nesom. Rare; border of upland woods; NCP. MWM 2685

Symphyotrichum lanceolatum (Willd.) Nesom. Rare; margin of upland woods; LB/NCP. JRM 9255

Symphyotrichum lateriflorum (L.) A. Love & D. Love. Common; rich and bottomland woods; Throughout. MWM 2662; JRM 7769, 9225

Symphyotrichum novae-angliae (L.) G.L. Nesom. Uncommon; low woodland borders; LB/YMD. MWM 3062

Symphyotrichum ontarionis (Wiegand) Nesom. Rare; wet meadow; YMD. JRM 9257

Symphyotrichum patens (Aiton) G.L. Nesom. Common; upland woods, roadsides, and clearcut areas; LB, NCP. MWM 2639; JRM 7844, 9178

Symphyotrichum pilosum (Willd.) G. L. Nesom. Abundant; roadsides, fields, woodland borders, and waste places; throughout. MWM 2622; JRM 7851, 9227

Symphyotrichum praealtum (Poir.) Nesom. Rare; upland woods and roadsides; NCP. JRM 9220

Symphyotrichum puniceum (L.) A. Love & D. Love. Uncommon; bogs; NCP. MWM 2679. 2940, 3061

Symphyotrichum undulatum (L.) G. L. Nesom. Occasional; upland woods, roadsides, and clearcut areas; NCP. MWM 2672; JRM 8092, 9253

Taraxacum officinale Weber. Common; lawns, roadsides, and waste places; throughout. Introduced. MWM 2725; JRM 8330

Verbesina alternifolia (L.) Britton. Occasional; borders of low, rich woods; LB, NCP. MWM 2491, 2552, 2605; JRM 7485

Verbesina helianthoides Michx. Occasional; borders of upland woods and roadsides; LB, NCP. MWM 1168; JRM 8822

Verbesina virginica L. Occasional; borders of low, rich woods; LB, NCP. MWM 2606; JRM 7533

Vernonia gigantea Trel., Branner & Coville. Common; borders of low woods, wet pastures, and roadside ditches; throughout. MWM 2277; JRM 7493

Vernonia texana (A. Gray) Small. Uncommon; borders of dry upland woods; LB/NCP. MWM 2994

Xanthium strumarium L. Common; cultivated fields, sandy creek banks, and waste places; throughout. MWM 3073

BALSAMINACEAE

Impatiens capensis Meerb. Frequent; low woods, marshes, and stream banks; throughout. MWM 2143; JRM 7416

Berberidaceae

Podophyllum peltatum L. Common; rich woods; LB, LB/YMD, NCP. MWM 638

Betulaceae

Alnus serrulata (Aiton) Willd. Infrequent; bogs, spring branches, and creek banks; NCP. MWM 772

Betula nigra L. Frequent; low woods and river banks; throughout. MWM 1010

Carpinus caroliniana Walter. Common; rich and bottomland woods; throughout. MWM 3074; JRM 8265

Corylus americana Walter. Occasional; rich woods; LB, NCP*. MWM 743; JRM 7541

Ostrya virginiana K. Koch. Common; rich to dry-mesic woods; LB, NCP. MWM 718

Bignoniaceae

Bignonia capreolata L. Common; bottomland to upland woods and thickets; throughout. MWM 768

Campsis radicans (L.) Seem. Common; woodland borders, fence rows, roadsides, and waste places; throughout. MWM 1064; JRM 8843

Catalpa bignonioides Walter. Infrequent; creek banks and low woods; throughout. MWM 1008

Boraginaceae

Cynoglossum virginianum L. Frequent; rich woods; LB*, NCP. MWM 604, 724; JRM 8588

Heliotropium indicum L. Occasional; marshes, ditches, and dried-up sloughs; throughout. Introduced. MWM 1184; JRM 7519

Lithospermum tuberosum Rugel ex A. DC. Uncommon; rich woods; LB/NCP, NCP. MWM 1060; JRM 9507

Myosotis macrosperma Engelm. Common; low and rich woods and woodland borders; throughout. MWM 616

Myosotis verna Nutt. Infrequent; fields, dry woods, and roadsides; NCP. MWM 771

Onosmodium virginianum (L.) A. DC. Uncommon; borders of dry upland woods; NCP. MWM 3005; JRM 9489, 9754

Brassicaceae

Brassica kaber (DC.) L. C. Wheeler. Infrequent; roadsides; NCP. Introduced. JRM 8587

Brassica napus L. Infrequent; roadsides; throughout. Introduced. MWM 748; JRM 7085, 8586

Capsella bursa-pastoris (L.) Medik. Common; roadsides, lawns, fields, and waste places; throughout. Introduced. MWM 2710; JRM 8238

Cardamine bulbosa Britton, Sterns & Poggenb. Common; low and rich woods, adjacent wet meadows; throughout. MWM 544; JRM 8286

Cardamine concatenata (Michx.) Sw. Rare (although locally common); rich woods; LB. MWM 2754

Cardamine hirsuta L. Common; fields, lawns, and waste places; throughout. Introduced. MWM 563

Cardamine parviflora L. Rare; open sandy area in cutover woods; LB/NCP. JRM 8258

Coronopus didymus (L.) Smith. Rare; fields; NCP. Introduced. JRM 7261

Draba brachycarpa Nutt. ex Torr. & A. Gray. Infrequent; fields and pastures; LB, LB/NCP. MWM 2707; JRM 8305

Lepidium densiflorum Schrad. Rare; roadside adjacent to open field; NCP. Introduced. JRM 7215

Lepidium virginicum L. Common; fields, roadsides, and waste places; throughout. MWM 833; JRM 8239

Rorippa palustris (L.) Besser. Infrequent; marshes and borders of low, wet woods; YMD. MWM 2635

Rorippa sessiliflora (Nutt.) Hitchc. Infrequent; marshes, river banks, and borders of low, wet woods; YMD. MWM 2794

Sibara virginica (L.) Rollins. Common; fields, roadsides, and waste places; throughout. MWM 558; JRM 8241

Buxaceae

Pachysandra procumbens Michx. Infrequent; rich woods; LB*, LB/NCP. MWM 569; JRM 7666

Cabombaceae

Brasenia schreberi J. F. Gmel. Uncommon; ponds; NCP. MWM 2873

Cabomba caroliniana A. Gray. Infrequent; aquatic in bald cypress-water tupelo swamps near the Yalobusha River; LB/YMD. MWM 3044

Cactaceae

Opuntia humifusa Raf. Uncommon; upland woods and clearings; NCP. MWM 2013

Campanulaceae

Lobelia appendiculata A. DC. Rare; woodland borders; YMD. MWM 969

Lobelia cardinalis L. Frequent; low woods, wet meadows, and stream banks; throughout. MWM 2548; JRM 7492, 9069

Lobelia inflata L. Occasional; rich woods and adjacent meadows; LB*, LB/NCP. MWM 2353, 2492, 2520; JRM 8938

Lobelia puberula Michx. Common; woodland borders, stream banks, and meadows; LB, NCP. MWM 2489, 2546, 2638; JRM 7512

Lobelia siphilitica L. Rare; rich woods; LB. MWM 3050

Lobelia spicata Lam. Infrequent; meadows and borders of upland woods; NCP. MWM 2118

Triodanis biflora Greene. Common; roadsides, fields, and waste places; throughout. MWM 721

Triodanis perfoliata (L.) Nieuwl. Occasional; woodland borders and roadsides; LB, NCP. MWM 2778; JRM 8473

Cannabaceae

Celtis tenuifolia Nutt. Occasional; sandy upland woods; LB/NCP, NCP*. MWM 2141

Celtis laevigata Willd. Frequent; bottomland hardwood forests; throughout (not common in NCP). MWM 1174

Cannaceae

Canna ×generalis Bailey. Occasional; roadsides; throughout. Introduced. MWM 3030

Caprifoliaceae

Lonicera japonica Thunb. Abundant; woodlands, roadsides, and fence rows; throughout. Introduced. MWM 788; JRM 7819

Lonicera sempervirens L. Uncommon; upland woods and thickets; LB, NCP. MWM 832

Symphoricarpos orbiculatus Moench. Rare; rich woods; LB, LB/NCP. MWM 2484; JRM 7322

Triosteum angustifolium L. Infrequent; rich woods; LB, NCP. MWM 2268, 2774; JRM 8592b, 8949

Caryophyllaceae

Arenaria serpyllifolia L. Occasional; borders of upland woods and roadsides; NCP. Introduced. MWM 2837

Cerastium diffusum Pers. Rare; lawns; NCP. Introduced. JRM 9325

Cerastium fontanum Baumg. Rare (locally common); lawns; NCP. Introduced. JRM 8770, 9326

Cerastium glomeratum Thuill. Common; roadsides, fields, and waste places; throughout. Introduced. MWM 591

Dianthus armeria L. Rare; roadside adjacent to alluvial woods; NCP. Introduced. JRM 7249

Sagina decumbens (Elliott) Torr. & A. Gray. Frequent; fields, roadsides, and waste places; throughout. MWM 634; JRM 8336

Saponaria officinalis L. Rare; woodland borders; LB/NCP. Introduced. MWM 2937

Silene stellata (L.) Aiton f. Frequent; rich woods; LB, NCP. MWM 2252; JRM 8903

Silene virginica L. Rare; rich woods; LB. MWM 719

Stellaria media (L.) Cirillo. Common; fields, roadsides, and woodland borders; throughout. Introduced. MWM 637

Celastraceae

Celastrus scandens L. Infrequent; rich woods; LB*, NCP. MWM 2278, 2654; JRM 9454

Euonymus americanus L. Frequent; stream banks in low and rich woods; throughout. MWM 755a; JRM 7766

Ceratophyllaceae

Ceratophyllum demersum L. Infrequent; aquatic in bald cypress-water tupelo swamps in the Yalobusha River floodplain; LB/YMD. MWM 3045

Chenopodiaceae

Chenopodium album L. Occasional; fields, barnyards, and waste places; throughout. JRM 8141

Chenopodium ambrosioides L. Occasional; fields, pastures, sandbars along creeks, and waste places; throughout. MWM 2635a, 2951; JRM 7883

Chenopodium standleyanum Aellen. Infrequent; woodland borders and fields; LB. MWM 2525

Cistaceae

Lechea mucronata Raf. Occasional; old fields and borders of upland woods; LB, NCP. MWM 2338, 2394a; JRM 7263

Lechea tenuifolia Michx. Occasional; dry upland woods and clearcut areas; NCP. MWM 3040

Cleomaceae

Cleome houtteana Raf. Infrequent; roadsides; NCP. Introduced. MWM 2908

Clusiaceae

Hypericum crux-andreae Crantz. Rare; open seepage areas and wet meadows; NCP. MWM 3009; JRM 7449

Hypericum drummondii (Grev. & Hook.) Torr. & A. Gray. Common; woodland borders, old fields, and roadsides; throughout. MWM 2242; JRM 7254

Hypericum gentianoides (L.) Britton, Sterns & Poggenb. Infrequent; dry upland woods and roadsides; NCP. MWM 2245, 3036; JRM 8132

Hypericum gymnanthum Engler & A. Gray. Rare; open seepage areas; NCP. JRM 8985

Hypericum hypericoides Crantz. Common; bottomland to upland woods; throughout. MWM 2138, 2533; JRM 7415

Hypericum lobocarpum Gatt. Rare; bogs and spring branches; NCP. MWM 2458, 3053

Hypericum mutilum L. Common; low woodland borders, marshes, and ditches; throughout. MWM 2243; JRM 7420

Hypericum prolificum L. Rare; borders of mesic woods; NCP. JRM 7297, 8892

Hypericum punctatum Lam. Common; woodland borders, fields, ditches, and roadsides; throughout. MWM 2153; JRM 7258, 7421

Triadenum virginicum (L.) Raf. Infrequent; low woods, sloughs, and margins of bald cypress-water tupelo swamps; YMD. MWM 2391

Triadenum walteri (J. F. Gmel.) Gleason. Frequent; seepage slopes, bogs, and in bald cypress-water tupelo swamps; throughout. MWM 2476, 2575; JRM 9134

Colchicaceae

Uvularia grandiflora Sm. Frequent; rich woods; LB*, NCP. MWM 525; JRM 8263

Uvularia sessilifolia L. Frequent; along streams in rich woods and edges of bogs; LB, NCP* MWM 603

Commelinaceae

Commelina communis L. Occasional; woodland borders, roadsides, and waste places; throughout. Introduced. MWM 2029, 2139; JRM 8904b

Commelina diffusa Burm. f. Infrequent; low woods; throughout. MWM 2631; JRM 7521

Commelina erecta L. Rare; dry sandy woods; LB/NCP. MWM 2628

Commelina virginica L. Common; low woods; throughout. MWM 2347a, 3029; JRM 7302

Tradescantia hirsutiflora Bush. Infrequent; dry woods; NCP. MWM 2817a, 2836

Tradescantia ohiensis Raf. Occasional; woodland borders and roadsides; throughout. MWM 835, 2847

Tradescantia subaspera Ker. Gawl. Uncommon; rich woods; LB. MWM 1019

Convolvulaceae

Cuscuta campestris Yunck. Occasional; on various herbaceous hosts along roadsides, woodland borders, and in old fields; throughout. MWM 2042; JRM 7328, 8951

Cuscuta compacta Juss. Occasional; on several woody hosts in low thickets and swamps; throughout. MWM 2573a; JRM 7432

Cuscuta gronovii Willd. ex Roem. & Schult. Infrequent; on woody and herbaceous hosts in low woods; LB. MWM 2556a; JRM 9187

Dichondra carolinensis Michx. Occasional; woodland borders, old fields, and lawns; throughout. MWM 622; JRM 8337

Ipomoea hederacea (L.) Jacq. Common; fields, roadsides, and woodland borders; throughout. Introduced. MWM 2582

Ipomoea lacunosa L. Common; fields, roadsides, and woodland borders; throughout. MWM 2522; JRM 7431

Ipomoea pandurata G. Mey. Common; fields, woodland borders, and roadsides; throughout. MWM 2151; JRM 7430

Ipomoea purpurea (L.) Roth. Infrequent; fields, roadsides, and woodland borders; throughout. Introduced. MWM 2024; JRM s.n.

Ipomoea wrightii A. Gray. Infrequent; fields, woodland borders, and marshes; LB, NCP, YMD*. Introduced. MWM 2898, 2920a; JRM 8212

Jacquemontia tamnifolia (L.) Griseb. Occasional; fields, woodland borders, and roadsides; throughout. Introduced. MWM 2359; JRM 7361

Stylisma humistrata Chapm. Uncommon; dry sandy woods; LB/NCP. MWM 2140, 2289; JRM 8943

Cornaceae

Cornus drummondii C. A. Meyer. Rare; open upland woodlands; NCP. JRM 9475

Cornus florida L. Common; upland woods; LB, LB/YMD, NCP. MWM 602; JRM 7377

Cornus foemina Mill. Frequent; low woods, swamp forests, bogs, and spring branches; throughout. MWM 933, 950, 2544; JRM 9455

Cucurbitaceae

Cayaponia quinqueloba (Raf.) Shinners. Occasional; low woods, wet thickets, and margins of sloughs; LB, NCP, YMD*. MWM 2349, 2889, 2924; JRM 9745

Cucurbita pepo L. Rare; escape from cultivation; NCP. Introduced. JRM 8987

Melothria pendula L. Frequent; low woods, thickets, and marshes; throughout. MWM 2170; JRM 7436

Cyperaceae

Bulbostylis capillaris (L.) Clarke. Uncommon; sandy open areas; NCP. JRM s.n.

Carex abscondita Mack. Frequent; rich and low woods; throughout. MWM 781; JRM 8592

Carex albicans Willd. Frequent; mesic to low woods; throughout. MWM 654, 741; JRM 8259, 8596

Carex albolutescens Schwein. Infrequent; low areas in bottomland hardwoods; throughout. JRM 8847, 9426

Carex amphibola Steud. Frequent; low woods; throughout. MWM 2755; JRM 7070

Carex annectens E. P. Bicknell. Infrequent; low woods; LB, NCP, YMD*. MWM 2788

Carex artitecta Mack. Infrequent; dry woods; LB. MWM 2729

Carex atlantica L. H. Bailey. Occasional; bogs and spring branches; NCP. MWM 737, 2738; JRM 9425

Carex austrina (Small) Mack. Occasional; open upland fields; NCP. JRM 9369

Carex blanda Dewey. Frequent; low woods; throughout. MWM 647

Carex bromoides Schkuhr. Infrequent; low woods and seepages; LB, LB/YMD. MWM 759

Carex bushii Mack. Uncommon; moist meadows; LB/NCP. JRM 9367

Carex caroliniana Schweinitz. Occasional; bottomland woods; LB, NCP, YMD*. MWM 707

Carex cephalophora Muhl. ex Schkuhr. Infrequent; mesic woods; LB*, NCP, YMD. MWM 2760

Carex cherokeensis Schwein. Occasional; bottomland woods; LB, NCP, YMD*. MWM 705

Carex complanata Torr. & Hook. Common; dry woods and moist sandy meadows; LB, NCP*. MWM 844, 2780, 2853, 2882; JRM 8429

Carex corrugata Fernald. Infrequent; low, moist woods; LB/NCP. JRM s.n.

Carex crebriflora Wieg. Infrequent; low, rich woods; LB, NCP*. MWM 782

Carex crinita Lam. Frequent; bogs, marshes, and stream banks; LB, NCP*. MWM 734

Carex crus-corvi Shuttlew. ex Kuntze. Uncommon; low woods and ditches; YMD. MWM 2798

Carex debilis Michx. Common; bogs and low woods; throughout. MWM 736; JRM 8900

Carex decomposita Muhl. Rare; on fallen logs, knees, and trunks of bald cypress in swamp forests; YMD. MWM 2834, 2884

Carex digitalis Willd. Infrequent; rich woods; LB, NCP. MWM 742

Carex festucacea Schkuhr. Infrequent; low woods and meadows; throughout. MWM 704; JRM 9368

Carex flaccosperma Dewey. Frequent; low woods; throughout. MWM 787

Carex frankii Kunth. Common; low woods, ditches, and marshes; throughout. MWM 1016, 2466; JRM 8801

Carex glaucodea Tuckerman. Infrequent; borders of upland woods; LB/NCP. JRM s.n.

Carex granularis Muhl. ex Schkuhr. Rare; low woods bordering a bald cypress-water tupelo swamp in the Yalobusha River floodplain; LB/YMD. MWM 2822

Carex grayi Carey. Rare; bottomland woods; YMD. MWM 2790, 2869

Carex grisea Wahlenb. Rare; rich, low woods; LB. MWM 2756

Carex hirsutella Mack. Infrequent; dry woods; NCP. MWM 2868; JRM 9375

Carex hyalinolepis Steud. Occasional; low woods, ditches, and marshes; YMD. MWM 706

Carex intumescens Rudge. Occasional; bogs and low woods; throughout. MWM 701, 1059, 2770, 2799

Carex joori L. H. Bailey. Infrequent; low woods and slough margins; YMD*, LB. MWM 2355, 2380a

Carex laevivaginata (Kuk.) Mack. Infrequent; bogs and spring branches; NCP. MWM 735

Carex laxiflora var. *serrulata* F.J. Herm. Uncommon; rich woods; LB. MWM 2758; JRM 8593

Carex leavenworthii Dewey. Common; low woods, ditches, and fields; throughout. MWM 646

Carex leptalea Wahlenb. Occasional; bogs and spring branches; NCP. MWM 2740, 2801; JRM 8837

Carex longii Mack. Occasional; fields, meadows, and edges of woods; throughout. MWM 785

Carex louisianica L. H. Bailey. Infrequent; low woods; YMD. MWM 2845

Carex lupulina Muhl. ex Schkuhr. Occasional; low woods, ditches, and marshes; LB, NCP, YMD*. MWM 2384, 2831

Carex lurida Wahlenb. Common; bogs, marshes, and stream banks; LB, NCP*. MWM 373, 786, 863; JRM 8803

Carex meadii Dewey. Rare; seasonally moist meadows; NCP. JRM 8383, 8321

Carex muhlenbergii Schkuhr. Occasional; sandy upland woods; LB*, NCP. MWM 966, 2783; JRM 7062

Carex nigromarginata Schwein. Frequent; mesic and dry woods; LB, NCP. MWM 2718, 2721, 2734

Carex oklahomensis Mack. Rare; wet open areas; LB/NCP, NCP. Introduced. JRM 9400, 9480

Carex oxylepis Torr. & Hook. Infrequent; mesic to bottomland woods; LB*, NCP, YMD. MWM 747; JRM 8481

Carex reniformis (L. H. Bailey) Small. Occasional; low woods, ditches, and marshes; YMD. MWM 703

Carex retroflexa Muhl. ex Schkuhr. Common; bottomland to upland woods; throughout. MWM 639, 640; JRM 8475

Carex rosea Schkuhr. Occasional; rich woods; LB, LB/NCP. MWM 2866; JRM 9376, 9424

Carex squarrosa L. Infrequent; bottomland woods; throughout. MWM 1054, 2877a

Carex striatula Michx. Frequent; mesic woods; LB, NCP*. MWM 2732, 2880; JRM 9509

Carex stricta Lam. Uncommon; bogs and spring branches; NCP. MWM 2775; JRM 8835

Carex styloflexa Buckley. Infrequent; bogs and spring branches; NCP. MWM 738; JRM 9427

Carex swanii (Fernald) Mack. Rare (although locally common); somewhat sandy, rich woods; NCP. MWM 375, 2821, 2929; JRM 8848, 9472, 9510

Carex triangularis Boeckeler. Frequent; low woods, ditches, and marshes; throughout. MWM 845; JRM 8421

Carex tribuloides Wahlenb. Frequent; low woods; throughout. MWM 995; JRM 8802

Carex typhina Michx. Occasional; low woods; LB, NCP, YMD*. MWM 927, 1055

Carex umbellata Schkuhr. Ex Willd. Uncommon; borders of upland woods; NCP. JRM 7091

Carex vulpinoidea Michx. Common; low woods, ditches, and marshes; throughout. MWM 702, 1017; JRM 9477

Carex willdenowii Schkuhr. Occasional; rich woods; LB*, NCP. MWM 2727, 2733, 2757; JRM 8594

Cyperus aristatus Rottb. Rare; in sandy soil in drawn-down pool in Yalobusha River floodplain; NCP. MWM 2682

Cyperus compressus L. Rare; weed in lawn; NCP. JRM 7477

Cyperus croceus Vahl. Frequent; sandy woods, fields, and roadsides; throughout. MWM 2129, 2991; JRM 7481, 9185

Cyperus difformis L. Rare; exposed pond bottom; NCP. Introduced. JRM 7335

Cyperus echinatus (L.) Wood. Frequent; sandy woods, fields, and roadsides; throughout. MWM 1190a; JRM 7402

Cyperus erythrorhizos Muhl. Frequent; mudflats around Grenada Lake, drawn-down sloughs; throughout. MWM 2919, 2945; JRM 7678

Cyperus esculentus L. Occasional; sandy fields, roadsides, and waste places; throughout. Introduced. MWM 2029b, 2651; JRM 7387

Cyperus flavescens L. Rare; open sandy seepages and swampy depression at the base of a bluff; LB/YMD, NCP. MWM 3051; JRM 8974

Cyperus haspan L. Rare; open sandy seepage area; NCP. MWM 3015

Cyperus iria L. Common; marshes, ditches, and fields; throughout. Introduced. MWM 2168, 2280; JRM 7236

Cyperus lancastriensis Porter in A. Gray. Rare (although locally common); dry sandy woods; LB/NCP. MWM 2285, 2891

Cyperus odoratus L. Rare; exposed pond bottom; NCP. JRM 7327

Cyperus plukenetii Fern. Infrequent; dry sandy woods; LB/NCP, NCP. MWM 2626a, 2921; JRM 7569

Cyperus polystachyos Rottb. var. *texensis* (Torr.) Fernald. Infrequent; sandy creek and river banks; LB/NCP. MWM 2690

Cyperus pseudovegetus Steud. Common; marshes and ditches; throughout. MWM 2124, 2240a; JRM 8095

Cyperus retrorsus Chapm. Frequent; sandy woods and fields; throughout. MWM 2029a; JRM 7425

Cyperus rotundus L. Common; fields and waste places; throughout. Introduced. MWM 2031; JRM 7507

Cyperus strigosus L. Common; marshes, ditches, and fields; throughout. MWM 2043, 2152, 2241, 2943; JRM 7475

Eleocharis microcarpa Torr. Rare; exposed wet depression in upland woods; NCP. JRM 9126

Eleocharis obtusa (Willd.) Schult. Abundant; marshes and ditches; throughout. MWM 944, 2578, 2665; JRM 7524

Eleocharis tenuis (Willd.) Schult. Uncommon; wet open meadows, bogs, and spring branches; NCP. MWM 2804

Eleocharis tuberculosa (Michx.) Roem. & Schult. Rare (although locally common); bog at edge of beaver pond; NCP. MWM 2686

Fimbristylis annua Roem. & Schult. Rare; exposed wet slope and ditch in pine woods; NCP. Introduced. MWM 2982; JRM 7394

Fimbristylis autumnalis (L.) Roem. & Schult. Frequent; sandy creek banks and ditches; throughout. MWM 2343; JRM 7455

Fimbristylis miliacea (L.) Vahl. Infrequent; sandy creek banks, ditches in pine woods; LB/NCP, NCP*. MWM 2617, 2691; JRM 7523

Fimbristylis puberula (Michx.) Vahl. Uncommon; open wet meadows; NCP. JRM 8777

Fimbristylis tomentosa Vahl. Infrequent; marshes and ditches in pine woods; LB/NCP, NCP. Introduced. MWM 2946, 2984; JRM 9127

Fimbristylis vahlii (Lam.) Link. Frequent; mudflats around Grenada Lake and drawn-down sloughs; throughout. MWM 2541; JRM 9031

Fuirena squarrosa Michx. Occasional; bogs, marshes, and ditches in pine woods; NCP. MWM 2404, 2663; JRM 8166

Isolepis carinata Hook. & Arn. ex Torr. Common; low fields; throughout. MWM 629, 2784; JRM 8326

Kyllinga odorata Vahl. Infrequent; marshes and low areas in pastures; NCP. MWM 3012; JRM 7476

Kyllinga pumila Michx. Infrequent; marshes and ditches; LB, NCP. MWM 2284; JRM 7625

Rhynchospora caduca Elliott. Rare; moist meadow on hillside; NCP. JRM 8888

Rhynchospora corniculata (Lam.) A. Gray. Frequent; low woods, ditches, and marshes; LB, NCP, YMD*. MWM 2053, 2934; JRM 9223

Rhynchospora globularis (Chapm.) Small. Occasional; sandy bogs, seeps, and ditches in pine woods; NCP. MWM 2342, 2887

Rhynchospora glomerata (L.) Vahl. Frequent; bogs, ditches in pine woods, and sandy creek banks; LB, NCP*. MWM 2021, 2112a, 2362; JRM 7457, 7688

Rhynchospora gracilenta A. Gray. Rare; boggy area along spring branch; NCP. JRM 8934

Rhynchospora miliacea (Lam.) A. Gray. Uncommon; swampy woods at bases of bluffs; LB/YMD. MWM 1049

Schoenoplectus pungens (Vahl) Palla (= *Scirpus americanus* Pers.). Rare; in sandy soil on edge of Pond in Yalobusha River floodplain near Grenada Lake; LB/NCP. MWM 2990

Scirpus atrovirens Willd. Infrequent; marshes and ditches; LB, NCP*. MWM 2838, 2857; JRM 9478

Scirpus cyperinus (L.) Kunth. Common; marshes and ditches; throughout. MWM 2149; JRM 7665

Scirpus pendulus Muhl. Infrequent; marshes and swampy woods at bases of bluffs; LB/YMD. MWM 932, 2830

Scleria oligantha Michx. Frequent; bottomland to mesic woods; throughout (uncommon in YMD). JRM 7284

Scleria pauciflora Muhl. ex Willd. Infrequent; ditches in pine woods and bogs; NCP. MWM 2344

Scleria reticularis Michx. Rare; bogs; NCP. MWM 2664

Scleria triglomerata Michx. Occasional; along ditches in pine woods; NCP. MWM 942

Dioscoreaceae

Dioscorea batatas Decne. Occasional; low and rich woods; LB, NCP. Introduced. MWM 2004

Dioscorea villosa L. Frequent; bottomland to upland woods; throughout. MWM 830; JRM 9479, 9483

Droseraceae

Drosera brevifolia Pursh. Rare (although locally common); open sandy seepage areas; NCP. MWM 2802, 2818

Ebenaceae

Diospyros virginiana L. Common; low to upland woods and old fields; throughout. MWM 839; JRM 7368

Elaeagnaceae

Elaeagnus umbellata Thunb. Infrequent; borders of upland woods, roadsides; NCP. Introduced. MWM 2742; JRM 8417

Ericaceae

Montropa hypopithys L. Occasional; upland woods; LB, NCP. MWM 2001, 2005

Monotropa uniflora L. Rare; upland woods; NCP. MWM 560

Rhododendron canescens (Michx.) Sweet. Occasional; bogs, spring branches, seepage slopes, and along streams; LB, NCP*. MWM 653, 2270; JRM 8328

Vaccinium arboreum Marshall. Common; upland woods and rarely in well-drained bottomland woods; throughout (rare in YMD). MWM 958; JRM 7371

Vaccinium corymbosum L. Infrequent; bogs and spring branches; NCP. MWM 2117, 2357, 2527, 2895

Vaccinium elliottii Chapm. Frequent; along streams in low or rich woods to dry-mesic woods; LB, NCP*. MWM 540; JRM 7378

Vaccinium stamineum L. Frequent; upland woods; LB, NCP*. MWM 750, 989

Euphorbiaceae

Acalypha gracilens A. Gray. Common; woodland borders and roadsides; throughout. MWM 2240, 2531; JRM 7876

Acalypha rhomboidea Raf. Common; fields, woodland borders, and roadsides; throughout. MWM 2261; JRM 7491a

Acalypha virginica L. Infrequent; borders of upland woods; NCP. MWM 2675; JRM 7262, 7360, 7491b

Chamaesyce humistrata (Engelm. ex A. Gray) Small. Rare; in sandy soil at edge of cultivated field; LB. MWM 2462

Chamaesyce maculata (L.) Small. Common; cultivated fields, roadsides, and waste places; throughout. MWM 3042

Chamaesyce nutans (Lag.) Small. Common; cultivated fields, roadsides, and waste places; throughout. MWM 2162, 2461; JRM 7386

Croton capitatus Michx. Common; sandy fields, pastures, and borders of upland woods; throughout. MWM 2248; JRM 7389

Croton glandulosus L. Infrequent; sandy fields and borders of upland woods; LB, NCP. MWM 2145

Euphorbia corollata L. Common; borders of upland woods and roadsides; LB, NCP. MWM 980; JRM 7391

Euphorbia obtusata Pursh. Rare; open hay pasture; NCP. Introduced. JRM 9374

Phyllanthus caroliniensis Walter. Occasional; woodland borders, fields, and roadsides; throughout. MWM 2397, 3003; JRM 7504, 9192

Triadica sebifera (L.) Small. Rare; roadside; YMD. Introduced. MWM 2979

Fabaceae

Aeschynomene indica L. Rare; low, wet fields; YMD. MWM 2918

Albizia julibrissin Durazz. Occasional; roadsides and woodland borders; throughout. Introduced. MWM 2019; JRM 7871

Amorpha fruticosa L. Occasional; low woods and stream banks; LB, NCP, YMD*. MWM 847

Amphicarpaea bracteata (L.) Fern. Occasional; thickets and stream banks in rich woods; LB, NCP. MWM 2553; JRM 7621, 7875b

Apios americana Medik. Frequent; thickets and woodland borders; throughout. MWM 2360; JRM 7434

Baptisia alba (L.) Vent. Infrequent; meadows near creeks and streams; LB, NCP. MWM 867; JRM 7220

Centrosema virginianum (L.) Benth. Common; woodland borders and clearings; throughout. MWM 2233; JRM 7435

Cercis canadensis L. Common; bottomland to upland woods; throughout. MWM 526

Chamaecrista fasciculata (Michx.) Greene. Common; woodland borders, old fields, and roadsides; throughout. MWM 2111; JRM 7363

Chamaecrista nictitans (L.) Moench. Occasional; woodland borders, old fields, and roadsides; LB, NCP. MWM 2487; JRM 7354

Clitoria mariana L. Frequent; upland woods and roadsides; LB, NCP. MWM 1180; JRM 7367

Crotalaria sagittalis L. Frequent; borders of upland woods; LB, NCP*. MWM 2012; JRM 7382

Crotalaria spectabilis Roth. Rare; sandy roadside; LB. Introduced. MWM 2583

Dalea candida Michx. ex Willd. Rare; opening in dry upland woods; LB. MWM 2881

Desmanthus illinoensis MacMill. Occasional; roadsides and fields; throughout. MWM 2172

Desmodium canescens (L.) DC. Common; bottomland to upland woods and roadsides; throughout. MWM 3026; JRM 7495

Desmodium ciliare (Muhl. ex Willd.) DC. Occasional; dry woods and clearcut areas; LB, NCP*. MWM 2578a; JRM 7871b

Desmodium cuspidatum (Willd.) Loudon. Rare; borders of upland woods; NCP. JRM 7875

Desmodium glabellum (Michx.) DC. Occasional; borders of mesic to dry-mesic woods; NCP. JRM 7542b

Desmodium glutinosum (Muhl. ex Willd.) Wood. Occasional; dry-mesic to rich woods; LB, NCP. MWM 1173; JRM 7472

Desmodium laevigatum (Nutt.) DC. Common; dry woods and clearcut areas; NCP. MWM 3000, 3041; JRM 7542

Desmodium marilandicum (L.) DC. Occasional; dry upland woods and clearcut areas; NCP, LB/NCP. MWM 3021, 3022; JRM 7565

Desmodium nudiflorum (L.) DC. Common; dry-mesic to rich woods; LB, NCP. MWM 2048, 2279a; JRM 7874

Desmodium nuttallii (Schindl.) B. G. Schub. Rare; dry upland woods; NCP. MWM 3055; JRM 7537

Desmodium paniculatum (L.) DC. Frequent; woodland borders and edges of fields; throughout. MWM 2488, 2523; JRM 7501

Desmodium pauciflorum (Nutt.) DC. Occasional; rich woods; LB*, NCP. MWM 2158

Desmodium perplexum B. G. Schub. Infrequent; woodland borders; NCP. MWM 2109; JRM 7689, 7872

Desmodium rotundifolium DC. Occasional; dry woods; LB, NCP*. MWM 2586; JRM 7668

Desmodium sessilifolium Torr. & A. Gray. Uncommon; borders of upland woods and roadsides; NCP. MWM 2989, 3052; JRM 7324

Desmodium viridiflorum (L.) DC. Infrequent; mesic to dry upland woods; NCP. JRM 7540

Dioclea multiflora C. Mohr. Occasional; bottomland to mesic woods and clearings; LB, NCP, YMD*. MWM 1066

Galactia regularis (L.) Britton, Sterns, & Poggenb. Infrequent; margins of mesic to dry-mesic woodlands; NCP. JRM 7876b

Galactia volubilis (L.) Britton. Occasional; margins of bottomland to dry-mesic woodlands; throughout. MWM 2148, 2393; JRM 7329

Gleditsia aquatica Marsh. Uncommon; sloughs and margins of bald cypress-water tupelo swamps; YMD. MWM 2376

Gleditsia triacanthos L. Frequent; bottomland to upland woods, roadsides, and fence rows; throughout (not common in NCP). MWM 2287; JRM 8491

Kummerowia stipulacea (Maxim.) Makino. Uncommon; roadsides; NCP. Introduced. JRM 9753

Kummerowia striata (Thunb.) Schindl. Common; woodland borders, roadsides, and waste places; throughout. Introduced. MWM 2485; JRM 7356

Lathyrus hirsutus L. Common; fields, roadsides, and waste places; throughout. Introduced. MWM 851; JRM 8500

Lespedeza bicolor Turcz. Infrequent; roadsides and old fields; NCP, LB/NCP. Introduced. MWM 3037; JRM 7296

Lespedeza cuneata G. Don. Common; woodland borders and roadsides; throughout. Introduced. MWM 1194; JRM 7358

Lespedeza hirta Hornem. Common; borders of upland woods and clearcut areas; LB/NCP, NCP*. MWM 2616a; JRM 7562

Lespedeza procumbens Michx. Occasional; upland woods and clearcut areas; LB/NCP, NCP*. MWM 2658, 3023; JRM 7544

Lespedeza repens W. P. C. Barton. Common; upland woods, clearings, and roadsides; LB, NCP. MWM 1178, 2641

Lespedeza stuevei Nutt. Infrequent; dry upland woods and clearcut areas; NCP. MWM 2983; JRM 9047

Lespedeza violacea (L.) Pers. Infrequent; borders of mesic and upland woods and clearcut areas; NCP. MWM 2985; JRM 7232

Lespedeza virginica (L.) Britton. Common; borders of upland woods, clearcut areas, and roadsides; LB, NCP. MWM 2389, 3031; JRM 7365

Medicago arabica (L.) Huds. Common; roadsides, lawns, and waste places; throughout. Introduced. MWM 2761

Medicago lupulina L. Infrequent; roadsides; NCP. Introduced. JRM 7265, 7558

Melilotus alba Medik. Occasional; roadsides and waste places; LB, NCP. Introduced. MWM 1190

Melilotus officinalis (L.) Pallas. Rare; roadsides; NCP. Introduced. JRM 9453

Mimosa microphylla Dryand. Frequent; upland woods and clearings; LB, NCP. MWM 1000

Orbexilum pedunculatum (Mill.) Rydb. Frequent; upland woods and clearings; LB, NCP. MWM 790; JRM 8425

Phaseolus polystachyus (L.) Britton, Sterns, & Poggenb. Rare; thickets in and at margin of mesic woods; LB, NCP. JRM 7240, 7535

Pueraria montana (Lour.) Merr. Common; roadsides and woodland margins; throughout. Introduced. MWM 2465a; JRM 7446

Rhynchosia latifolia Nutt. Infrequent; dry upland woods, roadsides, and clearings; NCP. MWM 2008; JRM 7316, 9634

Rhynchosia tomentosa (L.) Hook. & Arn. Occasional; dry woods and clearcut areas; NCP. MWM 2009

Robinia pseudoacacia L. Infrequent; woodland borders and roadsides; throughout. Introduced. MWM 866; JRM 7664

Senna marilandica (L.) Link. Rare; woodland borders; NCP. JRM 9084, 9086

Senna obtusifolia (L.) H. S. Irwin & Barneby. Occasional; cultivated fields, roadsides, and waste places; throughout. Introduced. MWM 2354

Sesbania herbacea (Mill.) McVaugh. Common; cultivated fields, roadsides, and waste places; throughout. MWM 2256; JRM 7775

Strophostyles helvula (L.) Elliott. Frequent; sandy creek and river banks and adjacent fields; throughout. MWM 2237; JRM 7429

Strophostyles leiosperma (Torr. & A. Gray) Piper. Infrequent; roadsides, dry woods, and clearings; NCP. JRM 7241, 9051

Strophostyles umbellata (Muh. ex Willd.) Britt. Infrequent; dry woods and clearings; NCP. MWM 2948, 3048; JRM 7543

Stylosanthes biflora (L.) Britton, Sterns & Poggenb. Common; upland woods, roadsides, and clearcut areas; LB, NCP. MWM 1181

Tephrosia spicata (Walter.) Torr. & A. Gray. Infrequent; upland woods and clearings; NCP. MWM 2032; JRM 8890

Tephrosia virginiana (L.) Pers. Common; upland woods, roadsides, and clearcut areas; LB, NCP. MWM 973

Trifolium arvense L. Infrequent; roadsides and waste places; LB, NCP. Introduced. MWM 2856; JRM 9429

Trifolium campestre Schreb. Common; fields, roadsides, and waste places; throughout. Introduced. MWM 757; JRM 8416

Trifolium dubium Sibth. Common; fields, lawns, roadsides, and waste places; throughout. Introduced. MWM 626; JRM 8333

Trifolium incarnatum L. Common; roadsides, fields, and waste places; throughout. Introduced. MWM 660

Trifolium lappaceum L. Rare; roadside adjacent to open field; NCP. Introduced. JRM 8725

Trifolium pratense L. Occasional; roadsides; LB, NCP. Introduced. MWM 848

Trifolium repens L. Common; lawns, roadsides, pastures, and waste places; throughout. Introduced. MWM 726; JRM 7515

Trifolium resupinatum L. Infrequent; roadsides and waste places; throughout. Introduced. MWM 2764

Trifolium vesiculosum Savi. Occasional; pastures, fields, and roadsides; LB, NCP. Introduced. MWM 2839; JRM 8792

Vicia caroliniana Walter. Frequent; dry-mesic to rich woods; LB, NCP. MWM 598; JRM 8257

Vicia grandiflora Scop. Infrequent; pastures and roadsides; LB, NCP. Introduced. MWM 2730; JRM 8785

Vicia minutiflora Dietr. Rare; open woods near sandy creek bottom; NCP. JRM 8291

Vicia sativa L. Common; fields, roadsides, and waste places; throughout. Introduced. MWM 714; JRM 8244

Vicia tetrasperma (L.) Schreb. Infrequent; roadsides; NCP. JRM 8424

Vicia villosa Roth. Common; fields, roadsides, and waste places; throughout. Introduced. MWM 849

Wisteria frutescens (L.) Poir. Occasional; woods and thickets along streams, creeks, and rivers; throughout. MWM 2281

Wisteria sinensis Sweet. Infrequent; old house sites, roadsides; throughout. Introduced. MWM 2737; JRM 8327

Fagaceae

Castanea dentata Borkh. Occasional; stump sprouts near streams and spring branches in dry-mesic to rich woods; a few individuals over 7 m in height; LB, NCP*. MWM 749, 2107, 2115, 2781; JRM 7092, 7694, 8490

Castanea pumila (L.) Mill. Rare; sandy upland woods; NCP. MWM 776, 2688, 2817

Fagus grandifolia Ehrh. Common; rich woods; LB, NCP. MWM 643; JRM 7622

Quercus alba L. Common; dry-mesic to rich woods; LB, NCP. MWM 2250; JRM 8762b

Quercus coccinea Muench. Infrequent; upland woods; LB, NCP. MWM 2534; JRM 7474, 8866

Quercus falcata Michx. Common; upland woods; LB, NCP. MWM 3072; JRM 7368

Quercus hemisphaerica W. Bartram. Uncommon; dry upland woods and adjacent sandy creek bottom of the Batupan Bogue; LB/NCP. MWM 3047

Quercus laurifolia Michx. Infrequent; bottomland hardwood forests; YMD, NCP. MWM 2276, 2703; JRM 7333

Quercus lyrata Walt. Occasional; low woods; LB, NCP, YMD*. MWM 971

Quercus marilandica Muench. Common; upland woods; LB, NCP*. MWM 3070; JRM 7566

Quercus michauxii Nutt. Frequent; bottomland hardwood forests and along streams in rich woods; throughout. MWM 727; JRM 8999

Quercus muehlenbergii Engelm. Infrequent; dry-mesic to rich woods; LB*, LB/NCP. MWM 1171, 2007

Quercus nigra L. Common; low to upland woods; throughout. MWM 2346; JRM 7538b

Quercus pagoda Raf. Common; bottomland hardwood forests; throughout. MWM 2560

Quercus phellos L. Common; low to upland woods; throughout. MWM 728, 2847a; JRM 7785

Quercus rubra L. Occasional; rich woods; LB, NCP. MWM 2547; JRM s.n.

Quercus shumardii Buckley. Occasional; rich to well-drained bottomland hardwood forests; throughout. MWM 2563; JRM 8998, 7536

Quercus similis Ashe (= *Quercus mississippiensis* Ashe). Occasional; bottomland hardwood forests; YMD. MWM 1071

Quercus stellata Wang. Common; upland woods; LB, NCP. MWM 2232

Quercus texana Buckley. (= *Quercus nuttallii* E.J. Palmer). Frequent; low woods; YMD. MWM 1198

Quercus velutina Lam. Common; upland woods; LB, NCP. MWM 2015

Fumariaceae

Corydalis flavula (Raf.) DC. Occasional; rich and alluvial woods; LB, YMD*. MWM 587, 2717

Gentianaceae

Bartonia paniculata (Michx.) Muhl. Infrequent; bogs and spring branches; NCP. MWM 2538, 2610; JRM 7684

Gentiana saponaria L. Occasional; bogs and spring branches; NCP. MWM 2699, 2700

Gentiana villosa L. Occasional; upland woods; LB, NCP. MWM 2701; JRM 7874b, 9170

Obolaria virginica L. Occasional; rich woods; LB, NCP. MWM 583

Sabatia angularis (L.) Pursh. Occasional; moist woodland borders and meadows; LB, NCP. MWM 2244; JRM 8927

Sabatia brachiata Elliott. Rare; borders of upland woods; NCP. JRM 7237, 7239, 8893

Sabatia campestris Nutt. Rare; borders of upland woods; NCP. JRM 9682

Geraniaceae

Geranium carolinianum L. Common; fields, roadsides, lawns, and waste places; throughout. MWM 609

Geranium dissectum L. Infrequent; roadsides and waste places; throughout. Introduced. MWM 2792

Geranium maculatum L. Occasional; rich woods; LB, NCP. MWM 662

Haloragaceae

Myriophyllum aquaticum (Vell.) Verdc. Infrequent; aquatic in bald cypress-water tupelo swamps, sloughs, and ditches; throughout. Introduced. MWM 778

Hamamelidaceae

Hamamelis virginiana L. Frequent; rich woods; LB, NCP*. MWM 751, 2702

Heloniadaceae

Chamaelirium luteum (L.) A. Gray. Frequent; rich to dry-mesic woods; LB, NCP*. MWM 774; JRM 9428

Hyacinthaceae

Muscari racemosum (L.) Mill. Infrequent; pastures and meadows; throughout. Introduced. MWM 593

Hydrangeaceae

Decumaria barbara L. Frequent; along streams in low, rich woods, bogs, and spring branches; LB, NCP*. MWM 994; JRM 7683

Hydrangea arborescens L. Frequent; rich woods and stream banks; LB, NCP. MWM 1170; JRM 7426

Hydrangea quercifolia W. Bartram. Common; rich to dry-mesic woods; LB, NCP. MWM 986; JRM 7397

Hydrocharitaceae

Limnobium spongia (Bosc) Steud. Infrequent; aquatic in bald cypress-water tupelo swamps; YMD. MWM 2736

Hydroleaceae

Hydrolea uniflora Raf. Frequent; margins of bald cypress-water tupelo swamps, sloughs, ditches, and marshes; LB, NCP, YMD*. MWM 2291; JRM 7459

Iridaceae

Iris cristata Aiton. Frequent; rich and mesic woods; LB, NCP. MWM 744, 2751; JRM 7068

Iris fulva Ker. Gawl. Occasional; low woods, marshes, and margins of cypress swamps; YMD, LB/YMD. MWM 2769

Iris germanica L. Infrequent; old house sites; throughout. Introduced. MWM 2791

Iris giganticaerulea Small. Rare; margin of bald cypress-water tupelo swamp in the Yalobusha River Floodplain; LB/YMD. MWM 2823

Iris virginica L. Rare; marsh at edge of bottomland woods; YMD. MWM 2791

Sisyrinchium albidum Raf. Infrequent; rich woods; LB*, NCP. MWM 715

Sisyrinchium angustifolium Mill. Frequent; low woods and meadows; throughout. MWM 784

Sisyrinchium exile Bickn. Infrequent; lawns; NCP. Introduced. JRM s.n.

Sisyrinchium rosulatum Bickn. Infrequent; pastures and lawns; LB, NCP. Introduced. JRM s.n.

Iteaceae

Itea virginica L. Frequent; swamp forests, bogs, spring branches, and along streams; throughout. MWM 931

Juglandaceae

Carya aquatica (Michx. f.) Nutt. Frequent; low woods; LB, NCP, YMD*. MWM 1197

Carya carolinae-septentrionalis (Ashe) Engl. & Graebn. Occasional; dry-mesic to rich woods; NCP. MWM 791

Carya cordiformis (Wang.) K. Koch. Frequent; rich woods and creek bottoms; LB, NCP. MWM 964, 2518; JRM 9064

Carya glabra (Mill.) Sweet. Infrequent; dry-mesic to rich woods; LB, NCP. MWM 2693

Carya illinoiensis (Wang.) K. Koch. Infrequent; bottomland woods; YMD; planted elsewhere and locally naturalized throughout. MWM 2378

Carya leiodermis Sarg. Infrequent; bottomland hardwood forests; LB, NCP, YMD*. MWM 2377, 2917; JRM 6241, 7087

Carya ovalis (Wang.) Sarg. Frequent; upland woods; LB, NCP. MWM 2644

Carya ovata (Mill.) K. Koch. Occasional; bottomland to rich woods; throughout. MWM 976; JRM 7784

Carya pallida (Ashe) Engl. & Graebn. Occasional; dry upland woods; LB, NCP. MWM 2116, 2817b; JRM 7086, 7567

Carya tomentosa (Poir.) Nutt. Common; upland woods; LB, NCP. MWM 2687

Juglans cinerea L. Rare; rich woods; LB. MWM 2006, 3038

Juglans nigra L. Occasional; rich woods and creek bottoms; LB, NCP; planted elsewhere and locally naturalized throughout. MWM 2040; JRM 8492, 9065

Juncaceae

Juncus acuminatus Michx. Frequent; marshes, ditches, and wet fields; throughout. MWM 807

Juncus brachycarpus Engelm. Infrequent; roadside ditches; NCP. JRM 7292, 8864

Juncus bufonius L. Infrequent; fields and ditches; throughout. MWM 2824, 2842; JRM 8498

Juncus canadensis J. Gay ex La Harpe. Rare; open sandy seepage area; NCP. MWM 3058

Juncus coriaceus Mack. Occasional; marshes and ditches; throughout. MWM 2166

Juncus dichotomus Elliott. Occasional; marshes and ditches; throughout. MWM 2806

Juncus diffusissimus Buckley. Occasional; wet creek banks and pond margins; NCP. MWM 3057

Juncus effusus L. Common; marshes, ditches, and pond margins; throughout. MWM 797

Juncus elliottii Coville. Rare; edge of beaver pond; NCP. JRM 8860

Juncus marginatus Rostk. Frequent; bogs, marshes, and ditches; throughout. MWM 977, 2870

Juncus nodatus Coville. Infrequent; marshes, ditches, and pond margins; throughout. MWM 2793, 2835; JRM 8950

Juncus scirpoides Lam. Occasional; sandy creek banks and wet upland roadsides; LB, NCP. MWM 965

Juncus tenuis Willd. Common; fields, roadsides, and waste places; throughout. MWM 642, 2833

Juncus torreyi Coville. Rare; low, wet meadow; NCP. JRM 7291

Juncus validus Coville. Frequent; wet fields and ditches; throughout. MWM 857, 992; JRM 8094

Luzula acuminata Raf. Rare; lower slopes in rich woods; LB/NCP. JRM 8487

Luzula bulbosa (Wood) Rydb. Infrequent; dry woods and in clay soils on roadsides; NCP. MWM 2724; JRM 8321c

Luzula echinata (Small) F. J. Herm. Frequent; sandy soil in rich woods and on bluffs; LB, NCP. MWM 2173, 2722; JRM 8287

Lamiaceae

Blephilia ciliata Raf. Frequent; upland woods and thickets; LB*, NCP. MWM 963; JRM 8714

Callicarpa americana L. Common; bottomland to upland woods; throughout. MWM 2014a; JRM 7514

Collinsonia canadensis L. Infrequent; rich woods; LB, NCP. MWM 2619; JRM 7667, 9186

Collinsonia tuberosa Michx. Rare; dry-mesic woods; NCP. JRM 7873

Glecoma hederacea L. Occasional; woodland borders, pastures, and lawns; throughout. Introduced. MWM 645

Hedeoma hispida Pursh. Occasional; pastures, dry fields, and woodland borders; LB, NCP. MWM 948; JRM 7065, 8772

Lamium amplexicaule L. Common; fields, roadsides, lawns, and waste places; throughout. Introduced. MWM 636; JRM 8292

Lamium purpureum L. Infrequent; roadsides and waste places; throughout. Introduced. MWM 588; JRM 8306

Lycopus rubellus Moench. Frequent; in bald cypress-water tupelo swamps and low, wet woods; YMD. MWM 3033

Lycopus virginicus L. Common; low, wet woods, marshes, and ditches; throughout. MWM 2539, 3020; JRM 7687c, 9135

Monarda fistulosa L. Common; upland woods, clearings, and roadsides; LB, NCP. MWM 1193; JRM 8820

Perilla frutescens (L.) Britton. Occasional; pastures, woodland borders, and roadsides; throughout. Introduced. MWM 2627; JRM 7777, 9191

Physotegia virginiana (L.) Benth. Infrequent; moist meadows and roadside ditches; LB/NCP, NCP. MWM 2034

Prunella vulgaris L. Occasional; pastures and woodland borders; LB, NCP. Introduced. MWM 861; JRM 8790

Pycnanthemum albescens Torr. & A. Gray. Occasional; upland woods, clearings, and roadsides; LB, NCP. MWM 2361; JRM 7510

Pycnanthemum verticillatum (Michx.) Pers. var. *pilosum* (Nutt.) Cooperrider. Rare; moist meadows and borders of upland woods; NCP. JRM 7671, 9083

Pycnanthemum tenuifolium Schrad. Frequent; moist meadows and woodland borders; LB, NCP. MWM 1179; JRM 7380

Salvia lyrata L. Common; upland woods, meadows, lawns, and roadsides; LB, NCP. MWM 614; JRM 8381

Scutellaria elliptica Muhl. Uncommon; upland woods; NCP. MWM 2108

Scutellaria incana Spreng. Occasional; upland woods; LB, NCP. MWM 2136, 2274, 2285a; JRM 8850

Scutellaria integrifolia L. Common; woodland borders, pastures, and roadsides; throughout. MWM 993, 1051; JRM 7820

Scutellaria lateriflora L. Occasional; margins of bald cypress-water tupelo swamps, sloughs, and low, wet woods; YMD*, LB. MWM 2467

Scutellaria ovata Hill. Rare; rich woods; NCP. MWM 1058

Scutellaria parvula Michx. Occasional; woodland borders and fields; throughout. MWM 709; JRM 9373

Stachys tenuifolia Willd. Occasional; low, wet woods and thickets; LB, NCP, YMD*. MWM 2157, 2286; JRM 8980

Teucrium canadense L. Occasional; low woods and thickets; LB, NCP, YMD*. MWM 2120; JRM 7250

Trichostema dichotomum L. Infrequent; upland woods and clearings; NCP. MWM 2615

Lauraceae

Lindera benzoin (L.) Blume. Frequent; stream banks and rich woods; LB/YMD, LB*, NCP. MWM 584, 659, 2704; JRM 7691

Sassafras albidum (Nutt.) Nees. Common; bottomland to upland woods, fence rows, and old fields; throughout. MWM 3075; JRM 8284

Lentibulariaceae

Utricularia biflora Lam. Occasional; aquatic in bald cypress-water tupelo swamps, sloughs, and shallow pools; LB, NCP, YMD*. MWM 2296, 2886

Liliaceae

Lilium superbum L. Occasional; rich woods along streams, wet meadows at woodland borders, and edges of bogs; LB, NCP*. MWM 2337, 2927; JRM 7060

Linaceae

Linum medium (Planch.) Britton. Common; upland woods, clearings, and old fields; LB, NCP. MWM 2110, 2119, 2165

Linum striatum Walter. Occasional; low woods, bogs, stream and creek banks; LB, NCP*. MWM 2039; JRM 7301

Linderniaceae

Lindernia dubia (L.) Pennell. Occasional; wet fields, swamp forests, and marshes; throughout. MWM 1182, 2177; JRM 7522

Micranthemum umbrosum (J. F. Gmel.) S. F. Blake. Rare (although locally common); marshes and pond margins; NCP. MWM 2402; JRM 8980b

Loganiaceae

Gelsemium sempervirens (L.) Aiton f. Uncommon; upland woods; NCP. JRM 7321

Mitreola petiolata (J. F. Gmel.) Torr. & A. Gray. Rare; wet meadow and bog at edge of beaver pond; NCP. MWM 3013; JRM 9124

Spigelia marilandica L. Frequent; rich woods and adjacent meadows; LB, NCP. MWM 954; JRM 8821

Lythraceae

Ammania coccinea Rottb. Common; marshes, mudflats, and drawn-down sloughs; throughout. MWM 2239; JRM 7440

Cuphea carthagenensis (Jacq.) J. F. MacBr. Infrequent; wet meadows, ditches, and marshes along the Batupan Bogue; LB/NCP. Introduced. MWM 2283

Lagerstroemia indica L. Infrequent; old house sites; throughout. Introduced. MWM 2472; JRM 9088

Lythrum lanceolatum Elliott. Frequent; marshes, ditches, and low woodland borders; throughout. MWM 2131

Lythrum salicaria L. Rare; open ditch bank; NCP. Introduced. MWM 2890

Rotala ramosior (L.) Koehne. Common; marshes, mudflats, low woodland borders, and drawn-down sloughs; throughout. MWM 2122; JRM 7439

Magnoliaceae

Liriodendron tulipifera L. Common; rich woods; LB, NCP. MWM s.n.

Magnolia acuminata L. Frequent; rich woods; LB*, NCP. MWM 656, 794, 2923; JRM 7465

Magnolia grandiflora L. Rare; along streams in rich woods; NCP. Introduced. MWM 3071; JRM s.n.

Magnolia macrophylla Michx. Uncommon (although locally common); rich woods; NCP. MWM 2114

Malvaceae

Abutilon theophrastii Medik. Uncommon; pastures, fields, and disturbed roadsides; LB/NCP, NCP. Introduced. JRM 9751

Anoda cristata (L.) Schlect. Rare; fields; NCP. Introduced. JRM 7865

Hibiscus laevis All. Frequent; marshes, sloughs, and margins of bald cypress-water tupelo swamps; throughout. MWM 2259

Hibiscus lasiocarpos Cav. Frequent; marshes, sloughs, roadside ditches, and margins of bald cypress-water tupelo swamps; throughout. MWM 2515

Hibiscus moscheutos L. Rare; edge of pond; NCP. JRM 9221

Hibiscus syriacus L. Rare; old house sites; LB. Introduced. MWM 2559

Modiola caroliniana (L.) G. Don. Rare; marshes and wet fields; NCP. MWM 2785; JRM 8245

Sida rhombifolia L. Infrequent; woodland borders and fields; throughout. Introduced. MWM 2626

Sida spinosa L. Common; cultivated fields, roadsides, and waste places; throughout. Introduced. MWM 2463a; JRM 7776

Melanthiaceae

Veratrum virginicum (L.) Aiton. Infrequent; bogs and spring branches; NCP. MWM 2811, 2930; JRM 8898

Melastomataceae

Rhexia mariana L. Frequent; moist, sandy soil in meadows, ditches, and along woodland borders; throughout. MWM 2010, 2126; JRM 7352, 7525

Rhexia virginica L. Occasional; bogs, low meadows, and marshes; NCP. MWM 2333; JRM 8976

Meliaceae

Melia azedarach L. Occasional; woodland borders and roadsides; throughout. Introduced. MWM 2516

Menispermaceae

Calycocarpum lyonii (Pursh) Nutt. Frequent; in thickets and along streams in rich woods; LB*, NCP. MWM 990; JRM 8795

Cocculus carolinus (L.) DC. Common; bottomland woods and thickets; throughout. MWM 2146

Molluginaceae

Mollugo verticillata L. Common; fields, lawns, and sandbars along creeks and rivers; throughout. Introduced. MWM 1006; JRM 7505

Montiaceae

Claytonia virginica L. Common; bottomland to upland woods, pastures, roadsides, and lawns; throughout (not common in YMD). MWM 535; JRM 8294

Moraceae

Broussonetia papyrifera (L.) Vent. Infrequent; old house sites and roadsides; throughout. Introduced. MWM 2637

Maclura pomifera (Raf.) C. K. Schneid. Occasional; pastures, woodland borders, and roadsides; LB, LB/NCP. Introduced. MWM 2398; JRM 8496

Morus rubra L. Common; bottomland and rich woods; throughout. MWM 2351a

Nymphaeaceae

Nymphaea odorata Aiton. Rare; aquatic in artificial pond; NCP. JRM 9792

Nyssaceae

Nyssa aquatica L. Frequent; swamp forests; LB, NCP, YMD*. MWM 2351

Nyssa sylvatica Marshall. Common; bottomland to upland woods; throughout. MWM 1007, 2449; JRM 7372, 8868

Oleaceae

Forestiera acuminata (Michx.) Poir. Frequent; margins of bald cypress-water tupelo swamps, river banks, and low woods; throughout. MWM 527

Fraxinus americana L. Frequent; bottomland, rich, and dry-mesic woods; throughout. MWM 2160, 2406

Fraxinus pensylvanica Marshall. Frequent; low woods; throughout. MWM 978; JRM 8844

Fraxinus profunda (Bush) Bush. Rare; swamp forest at base of bluff; LB. MWM 2407, 2558

Ligustrum sinense Lour. Abundant; low woods, fence rows, thickets, and waste places; throughout. Introduced. MWM 856; JRM 10000

Onagraceae

Circaea canadensis (L.) Hill. Occasional; rich and alluvial woods; LB*, LB/YMD, LB/NCP. MWM 1172; JRM 8762

Gaura biennis L. Frequent; woodland borders, meadows, and roadsides; LB, NCP. MWM 2483; JRM 7852

Ludwigia alternifolia L. Common; marshes, ditches, and low woods; throughout. MWM 2171, 2345; JRM 7450

Ludwigia decurrens Walter. Common; marshes, ditches, and low woodland borders; throughout. MWM 2264; JRM 7458

Ludwigia glandulosa Walter. Common; marshes, ditches, and low woods; throughout. MWM 2292; JRM 7256

Ludwigia leptocarpa (Nutt.) H. Hara. Uncommon; mudflats around Grenada Lake and near the Yalobusha River; LB/NCP, NCP. MWM 2681; JRM 9213

Ludwigia palustris (L.) Elliott. Common; marshes and ditches; throughout. MWM 1056; JRM 7464

Ludwigia peploides (Kunth) P. H. Raven var. *glabrescens* (Kuntze) Shinners. Common; marshes, ditches, and ponds; throughout. Introduced. MWM 2130

Oenothera biennis L. Frequent; woodland borders, roadsides, and fields; throughout. MWM 2464; JRM 7467

Oenothera laciniata Hill. Common; fields, roadsides, and waste places; throughout. MWM 648; JRM 8136

Oenothera linifolia Nutt. Rare; dry woods; NCP. MWM 2822; JRM 7221

Oenothera pilosella Raf. Rare; low, wet meadow on roadside; NCP. JRM 9452

Oenothera speciosa Nutt. Occasional; roadsides and waste places; throughout. Introduced. MWM 981; JRM 9372

Orchidaceae

Calopogon tuberosus (L.) Britton, Sterns & Poggenb. Rare; open sandy bogs; NCP. MWM 2888

Corallorhiza odontorhiza (Willd.) Nutt. Rare; rich to dry-mesic woods; NCP. MWM 561; JRM 8165

Corallorhiza wisteriana Conrad. Rare; on rich bluff above Yalobusha River floodplain; LB. MWM 612

Cypripedium parviflorum Salisb. var. *pubescens* (Willd.) Knight. Uncommon; rich ravines; LB*, LB/NCP. MWM 2750; JRM 7230

Isotria verticillata (Muhl. ex Willd.) Raf. Occasional; seepage slopes in rich woods and edges of bogs; NCP. MWM 2020, 2763

Listera australis Lindl. Occasional; mossy stream banks and seepage slopes in rich woods; LB, NCP. MWM 528, 543; JRM 8289

Malaxis unifolia Michx. Infrequent; upland pine-oak-hickory woods and edges of bogs; NCP. MWM 975

Platanthera ciliaris (L.) Lindl. Uncommon; bogs and spring branches; NCP. MWM 2938

Platanthera clavellata (Michx.) Luer. Frequent; bogs, spring branches, seepage slopes, and along streams in low, rich woods; LB, NCP*. MWM 2263, 2356, 2926; JRM 8945

Platanthera cristata (Michx.) Lindl. Rare; bogs; NCP. MWM 2405

Platanthera flava (L.) Lindl. Infrequent; low, wet woods; LB, LB/YMD. MWM 2262, 2916

Platanthera lacera (Michx.) G. Don in Sweet. Rare; moist woodland borders and along streams in rich woods; NCP. MWM 996; JRM 8767, 9485

Platanthera peramoena A. Gray. Rare; low, wet woods and adjacent meadows in the Yalobusha River floodplain; LB/NCP. MWM 2913

Spiranthes cernua (L.) Rich. Frequent; bogs, along streams in low, rich woods, and meadows; LB, NCP*. MWM 2680; JRM 7877, 8167

Spiranthes lacera (Raf.) Raf. var. *gracilis* (Bigel.) Luer. Rare; moist, sandy soil along rich woodland border near stream; NCP. MWM 105

Spiranthes ovalis Lindl. Infrequent; bottomland hardwood forests, terraces along streams in rich woods, gentle slopes bordering swamps, and natural levees of rivers and creeks; throughout. MWM 2634, 2677; JRM 9228b

Spiranthes tuberosa Raf. Frequent; dry pine or pine-oak-hickory woods; NCP. MWM 2037, 2123; JRM 8891

Spiranthes vernalis Engelm. & A. Gray. Frequent; meadows and pastures; throughout (rare in YMD). MWM 2023

Tipularia discolor (Pursh) Nutt. Frequent; along streams in rich woods to rather dry upland woods; throughout (rare in YMD). MWM 2335, 2925; JRM 7681, 8992

Triphora trianthophora (Sw.) Rydb. Rare; bottomland hardwood forests; NCP. JRM 7937, 9865

Orobanchaceae

Agalinis fasciculata (Elliott) Raf. Common; woodland borders, meadows, and old fields; throughout. MWM 2549a; JRM 7561

Agalinis gattingeri (Small) Small. Rare; moist woodland borders; NCP. JRM 7662, 9177

Agalinis purpurea (L.) Pennell. Infrequent; woodland borders, meadows, and old fields; NCP. JRM s.n.

Agalinis tenuifolia (Vahl) Raf. Frequent; borders of upland woods, meadows, and old fields; LB, NCP. MWM 2540, 2642; JRM 7851b

Agalinis viridis (Small) Pennell. Uncommon; moist meadows; NCP. JRM 7821, 9167

Aureolaria flava (L.) Farw. Frequent; in and at the edges of upland woods; LB, NCP. MWM 3006; JRM 7511

Aureolaria pectinata (Nutt.) Pennell. Occasional; dry upland woods; NCP. MWM 2537; JRM 7573

Buchnera floridana Gand. Uncommon; moist meadows; NCP. JRM 7298, 8894, 9747

Dasistoma macrophyllum (Nutt.) Raf. Uncommon; low, rich woods; LB, LB/NCP. MWM 2409, 2999; JRM 9067

Epifagus virginiana (L.) Barton. Frequent; parasitic on roots of *Fagus* in rich woods; LB, NCP. MWM 2684; JRM 7696

Pedicularis canadensis L. Occasional; rich to dry-mesic woods; LB, NCP. MWM 599; JRM 8329

Oxalidaceae

Oxalis articulata Sav. in Lam. Infrequent; disturbed sites; throughout. Introduced. MWM 2731

Oxalis dillenii Jacq. Common; lawns, roadsides, fields, and waste places; throughout. MWM 623

Oxalis stricta L. Common; woods and thickets; throughout. MWM 2825, 2828; JRM 9791

Oxalis violacea L. Common; rich to dry-mesic woods; LB, NCP. MWM 605; JRM 8597

Papaveraceae

Sanguinaria canadensis L. Rare (although locally common); rich woods; LB. MWM 529, 531

Passifloraceae

Passiflora incarnata L. Common; woodland borders, thickets, fields, and roadsides; throughout. MWM 1192; JRM 7516

Passiflora lutea L. Frequent; bottomland to upland woods and thickets; throughout. MWM 2176; JRM 7498

Penthoraceae

Penthorum sedoides L. Frequent; low, wet woods and marshes; throughout. MWM 2347; JRM 7418

Phrymaceae

Mazus pumilus (Burm. f.) Steenis. Rare; lawns; NCP. Introduced. JRM s.n.

Mimulus alatus Aiton. Frequent; marshes, low woods, and stream and creek banks; throughout. MWM 2336; JRM 7417

Phryma leptostachya L. Frequent; rich woods; LB*, NCP. MWM 2156; JRM 7473

Phytolaccaceae

Phytolacca americana L. Common; woodland borders, roadsides, clearcut areas, and waste places; throughout. MWM 2044; JRM 7355

Plantaginaceae

Bacopa rotundifolia Wettst. Rare; edges of ponds; LB/NCP, NCP. MWM 2993; JRM 7275, 8211

Callitriche heterophylla Pursh. Frequent; ephemeral pools, wet fields, and ditches; throughout. MWM 633, 2762; JRM 8227

Callitriche pedunculosa Nutt. Infrequent; low fields; LB. MWM 2748

Callitriche peploides Nutt. Uncommon; exposed ditch banks and bottomland hardwoods; NCP. JRM 9486

Chelone glabra L. Uncommon; bogs and spring branches; NCP. MWM 2620

Gratiola neglecta Torr. Frequent; wet fields and low woodland borders; throughout. MWM 713; JRM 8228

Gratiola virginiana L. Frequent; marshes, swamp forests, and ditches; throughout. MWM 708

Leucospora multifida (Michx.) Nutt. Infrequent; woodland borders and fields; LB. MWM 2460

Mecardonia acuminata (Walter) Small. Occasional; marshes and wet fields; LB, NCP. MWM 2493; JRM 7399

Nuttallanthus canadensis (L.) D. A. Sutton. Common; fields, woodland borders, and roadsides; throughout. MWM 635; JRM 8242

Penstemon laxiflorus Pennell. Occasional; dry upland woods and roadsides; NCP. MWM 789

Penstemon tenuis Small. Rare; bottomland woods; YMD. MWM 2824

Plantago aristata Michx. Common; fields, roadsides, and waste places; throughout. MWM 1057; JRM 8788

Plantago heterophylla Nutt. Infrequent; fields, NCP. MWM 2744; JRM 8300

Plantago lanceolata L. Common; fields, roadsides, lawns, and waste places; throughout. Introduced. MWM 1012; JRM 8845

Plantago rugelii Decne. Common; fields, pastures, lawns, and waste places; throughout. MWM 2027; JRM 8868b

Plantago virginica L. Common; fields, roadsides, and waste places; throughout. MWM 610; JRM 8495

Sophronanthe pilosa (Michx.) Small. Uncommon; open sandy bogs and seepage areas; NCP. MWM 3007; JRM 7300

Veronica arvensis L. Common; lawns, fields, roadsides, and waste places; throughout. Introduced. MWM 559, 621

Veronica peregrina L. Common; fields, roadsides, and waste places; throughout. MWM 2712

Veronicastrum virginicum (L.) Farw. Rare; moist meadows and woodland borders; NCP. JRM 7325, 9026

Platanaceae

Platanus occidentalis L. Common; low woods, especially along creek and river banks; throughout. MWM 2113; JRM 9029

Poaceae

Agrostis elliottiana Schult. Infrequent; dry woods and roadsides; NCP. MWM 2777; JRM 8418

Agrostis hyemalis (Walter) Britton, Sterns & Poggenb. Common; fields, meadows, and roadsides; throughout. MWM 841

Agrostis perennans (Walter) Tuck. Common; low woods, marshes, and ditches; throughout. MWM 2396, 2448; JRM 7686

Aira elegans Willd. ex Gaudin. Frequent; pastures, fields, and roadsides; throughout. Introduced. MWM 946

Alopecurus carolinianus Walter. Common; low fields and ditches; throughout. MWM 628; JRM 8298

Andropogon gerardii Vitman. Occasional; dry woods and fields; throughout. MWM 2568; JRM 7545, 9230

Andropogon glomeratus (Walter) Britton, Sterns, & Poggenb. Occasional; low woods, bogs, and roadsides; LB, NCP, YMD, LB/YMD*. MWM 2695; JRM 8134, 9193

Andropogon gyrans Ashe. Rare; dry pine woods; NCP. MWM 3039; JRM 9218

Andropogon ternarius Michx. Infrequent; dry woods and clearcut areas; NCP. MWM 2674; JRM 9219

Andropogon virginicus L. Abundant; dry to low woods, fields, and roadsides; throughout. MWM 2643, 2648; JRM 9189

Aristida dichotoma Michx. Occasional; dry woods and roadsides; NCP. MWM 2616; JRM 9129

Aristida longespica Poir. Occasional; dry woods and roadsides; LB/NCP, NCP. MWM 2657; JRM 7348, 9128

Aristida oligantha Michx. Common; dry woods, fields, and roadsides; throughout. MWM 2480; JRM 7839

Aristida purpurascens Poir. Infrequent; dry woods and roadsides; LB/NCP, NCP. MWM 2656; JRM 7452, 7846

Aristida ramosissima Engelm. ex A. Gray. Uncommon; roadsides in upland areas; LB/NCP, NCP. JRM 7840, 9066

Arthraxon hispidus (Thunb.) Makino var. *cryptatherus* (Hackel) Honda. Frequent; low woods, ditches, and creek banks; LB, NCP. Introduced. MWM 2625; JRM 7779, 9184

Arundinaria gigantea (Walter) Muhl. Common; low, rich, and dry-mesic woods; throughout. MWM 2000; JRM 8260

Arundo donax L. Infrequent; roadsides; throughout. Introduced. MWM 2980; JRM 7669

Avena sativa L. Occasional; disturbed areas; throughout. Introduced. MWM 1015

Axonopus fissifolius (Raddi) Kuhlm. Infrequent; moist, sandy soil in pine woods; NCP. MWM 2949; JRM 7478

Axonopus furcatus (Fluegge) Hitchc. Rare; low, wet meadows; NCP. JRM 9056

Bothriochloa ischaemum (L.) Keng. Rare; roadside; LB/NCP. Introduced. JRM 9274

Bothriochloa laguroides (DC.) Herter. Infrequent; roadsides and open woods; LB. Introduced. MWM 2696

Brachyelytrum erectum (Schreb.) P. Beauv. Frequent; rich woods; LB, NCP. MWM 2025, 2047, 2106; JRM 8869

Briza minor L. Occasional; meadows and woodland borders; throughout. Introduced. MWM 2795; JRM 8723

Bromus arvensis L. Infrequent; meadows and woodland borders; LB, NCP. Introduced. MWM 939

Bromus catharticus Vahl. Infrequent; moist meadows; NCP. Introduced. JRM 7277

Bromus pubescens Willd. Rare; rich woods; LB. MWM 2026

Bromus racemosus L. Common; roadsides, fields, and waste places; throughout. Introduced. MWM 850; JRM 8760, 8776

Bromus tectorum L. Occasional; roadsides, fields, and waste places; LB, NCP. Introduced. MWM 864

Chasmanthium latifolium (Michx.) Yates. Frequent; low or rich woods and creek banks; throughout. MWM 2251; JRM 7489

Chasmanthium laxum (L.) Yates. Occasional; bogs and low woods; throughout. MWM 2897; JRM 8941

Chasmanthium sessiliflorum (Poir.) Yates. Frequent; bottomland to upland woods; throughout. MWM 2146a; JRM 8942

Chloris virgata Sw. Rare; ruderal; NCP. Introduced. JRM 7506, 8979, 9748

Cinna arundinacea L. Occasional; low, rich woods and bogs; throughout. MWM 2566, 2572, 2574; JRM 7539, 9169

Cynodon dactylon (L.) Pers. Common; fields, roadsides, and waste places; throughout. Introduced. MWM 1014

Dactylis glomerata L. Infrequent; pastures, meadows, and roadsides; LB, NCP. Introduced. MWM 2161; JRM 8726

Danthonia sericea Nutt. Frequent; dry woods and roadsides; NCP. MWM 2776, 2800; JRM 8427

Danthonia spicata (L.) P. Beauv. ex Roem. & Schult. Rare; dry woods; LB/NCP. MWM 2885

Dichanthelium aciculare (Desv. ex Poir.) Gould & C. A. Clark. Occasional; dry woods; NCP. MWM 2142, 2805; JRM 7281, 9130

Dichanthelium acuminatum (Sw.) Gould & C. A. Clark. var. *acuminatum*. Occasional; dry woods and roadsides; NCP. MWM 2815; JRM 7282

Dichanthelium acuminatum (Sw.) Gould & C. A. Clark var. *lindheimeri* (Nash) Gould & Clark. Occasional; moist meadows, woodland borders, and fields; throughout. MWM 2958, 2964; JRM 7353

Dichanthelium boscii (Poir.) Gould & C. A. Clark. Frequent; dry to mesic woods; LB, NCP. MWM 837; JRM 7609c, 8091b

Dichanthelium clandestinum (L.) Gould. Occasional; stream and creek banks; throughout. MWM 1002, 2843

Dichanthelium commutatum (Schult.) Gould. Frequent; low and rich woods; throughout. MWM 777, 2810; JRM 7383

Dichanthelium depauperatum (Muhl.) Gould. Occasional; dry woods; NCP. MWM 843; JRM 8426, 9130

Dichanthelium dichotomum (L.) Gould. Frequent; dry woods and roadsides; LB, NCP. MWM 846, 985, 2521a, 2530

Dichanthelium laxiflorum (Lam.) Gould. Common; dry to mesic woods and roadsides; LB, NCP. MWM 838, 842

Dichanthelium ravenelii (Scribn. & Merr.) Gould. Infrequent; dry woods; NCP. JRM 7294, 8428b

Dichanthelium scoparium (Lam.) Gould. Common; low woods, ditches, and roadsides; throughout. MWM 1065; JRM 7408, 7609b

Dichanthelium sphaerocarpon (Elliott) Gould var. *isophyllum* (Scribn.) Gould & C. A. Clark. Frequent; stream and creek banks in low or rich woods; throughout. MWM 2877; JRM 7384, 7773

Digitaria ciliaris (Retz.) Koeler. Common; fields, roadsides, and waste places; throughout. MWM 2612; JRM 7480, 7488

Digitaria filiformis (L.) Koel. Infrequent; borders of upland woods; NCP. JRM 7572

Digitaria violascens Link. Frequent; lawns, fields, and waste places; throughout. Introduced. MWM 2163; JRM 7454b

Echinochloa colonum (L.) Link. Occasional; low fields, ditches, and marshes; throughout. Introduced. MWM 2963; JRM 7461

Echinochloa crus-galli (L.) Beauv. Common; low fields, marshes, and waste places; throughout. Introduced. MWM 1068, 2234

Eleusine indica (L.) Gaertn. Common; fields, roadsides, and waste places; throughout. Introduced. MWM 2260, 2478a; JRM 8139

Elymus virginicus L. Common; woodland borders, meadows, and roadsides; throughout. MWM 960, 1175; JRM 8865

Eragrostis capillaris (L.) Nees. Infrequent; borders of upland woods; NCP. JRM 7490

Eragrostis cilianensis (All.) Viguolo ex Janch. Infrequent; roadsides and waste places; LB. Introduced. MWM 2978; JRM 7315

Eragrostis curvula (Schrad.) Nees. Occasional; sandy creek banks and borders of upland woods; spread from being planted for erosion control; LB, NCP. Introduced. MWM 1005

Eragrostis hirsuta (Michx.) Nees. Infrequent; in sandy soil along creeks; LB. MWM 2931

Eragrostis hypnoides (Lam.) Britton, Sterns & Poggenb. Occasional; mudflats around Grenada Lake and drawn-down sloughs; throughout. MWM 2542

Eragrostis intermedia Hitchc. Uncommon; roadsides; NCP. JRM s.n.

Eragrostis japonica (Thunb.) Trin. Occasional; sandbars along creeks and rivers, mudflats; throughout. Introduced. MWM 2395, 2468

Eragrostis minor Host. Common; roadsides; NCP. Introduced. JRM 7482

Eragrostis pectinacea (Michx.) Nees. Frequent; sandbars along creeks, roadsides, and waste places; throughout. MWM 2175, 2288a; JRM 7479, 9752

Eragrostis pilosa (L.) Beauv. Frequent; roadsides, fields, and waste places; throughout. Introduced. MWM 2944; JRM 7334b, 9749

Eragrostis refracta (Muhl.) Scribn. Uncommon; ditches in pine woods and along sandy creek banks; NCP. MWM 2396a; JRM 9168

Eragrostis spectabilis (Pursh) Steud. Common; sandy fields, dry woods, and clearcut areas; throughout. MWM 2666, 2959, 2966; JRM 7575

Festuca subverticillata (Pers.) E. B. Alexeev. Infrequent; low, cutover woods and pastures; LB/NCP, NCP. MWM 2879; JRM 8480

Glyceria striata (Lam.) Hitchc. Frequent; low woods and ditches; throughout. MWM 2787, 2832; JRM 8497

Gymnopogon ambiguus (Michx.) Britton, Sterns & Poggenb. Infrequent; dry woods and clearcut areas; NCP. MWM 2973, 2986; JRM 7608

Hordeum pusillum Nutt. Common; roadsides, fields, and waste places; throughout. MWM 712, 862; JRM 8419

Leersia lenticularis Michx. Occasional; low woods; YMD. MWM 2495

Leersia oryzoides (L.) Sw. Frequent; marshes, ditches, and low woods; throughout. MWM 2609, 2614; JRM 7680, 9224

Leersia virginica Willd. Common; low woods, marshes, and ditches; throughout. MWM 2392, 2565; JRM 7424

Leptochloa panicea (Retz) Ohwi. Occasional; fields, roadsides; throughout. MWM 2463

Leptochloa panicoides (Presl.) Hitchc. Frequent; wet woods and margins or sloughs; LB, NCP, YMD*. Introduced. MWM 2257; JRM 7520

Leptochloa uninervia (Presl.) Hitchc. & Chase. Infrequent; moist meadows and roadsides; NCP. Introduced. JRM 7774

Lolium perenne L. Common; roadsides, fields, and waste places; throughout. Introduced. MWM 924, 1053; JRM 8804

Melica mutica Walter. Frequent; rich and dry woods; LB, NCP. MWM 664; JRM 8484

Microstegium vimineum (Trin.) A. Camus. Frequent; low woods, ditches, and creek banks; LB*, NCP. Introduced. MWM 3060; JRM 9210

Muhlenbergia capillaris (Lam.) Trinius. Rare; roadside in dry open woods; NCP. JRM s.n.

Muhlenbergia schreberi J.F. Gmel. Infrequent; low and rich woods; LB. MWM 2957; JRM 7880

Muhlenbergia sylvatica (Torr.) Torr. ex A. Gray. Infrequent; along sandy stream and creek banks in rich woods; LB/NCP, NCP. JRM 7423, 7438, 7778

Oplismenus hirtellus (L.) P. Beauv. ssp. *setarius* Mez ex Ekman. Infrequent; low woods; LB/YMD. MWM 3046

Oryza sativa L. Infrequent; roadside ditches at edges of bottomland hardwoods; YMD. Introduced. MWM 3025

Panicum anceps Michx. Common; roadsides, meadows, and dry woods; throughout. MWM 2112; JRM 7502

Panicum dichotomiflorum Michx. Abundant; fields, roadsides, and low or upland woods; throughout. MWM 2394, 2697; JRM 7456, 9183

Panicum rigidulum Nees. Frequent; low woods, marshes, and margins of sloughs; throughout. MWM 2331; JRM 7453

Panicum virgatum L. Occasional; meadows and roadsides; throughout. MWM 2482; JRM 7366

Paspalum boscianum Flugge. Occasional; low fields; throughout. MWM 2477; JRM 7390

Paspalum dilatatum Poir. Common; roadsides, fields, and waste places; throughout. Introduced. MWM 2169

Paspalum distichum L. Infrequent; ditches and low woods; throughout. MWM 2952

Paspalum floridanum Michx. Occasional; roadsides, meadows, and dry woods; throughout. MWM 2571; JRM 7349

Paspalum fluitans (Elliott) Kunth. Occasional; margins of sloughs and on mudflats; LB, NCP, YMD*. MWM 2555

Paspalum laeve Michx. Common; fields, meadows, and roadsides; throughout. MWM 1187, 2947; JRM 7351

Paspalum notatum Flugge. Common; roadsides and waste places; throughout. Introduced. MWM 2045

Paspalum setaceum Michx. Infrequent; upland fields and roadsides; NCP. MWM 1187a

Paspalum urvillei Steud. Common; roadsides, fields, and waste places; throughout. Introduced. MWM 2164; JRM 7486

Phalaris caroliniana Walter. Occasional; woodland borders and roadsides; LB, NCP, YMD*. MWM 923; JRM 7837

Phanopyrum gymnocarpon (Elliott) Nash. Occasional; margins of bald cypress-water tupelo swamps and drawn-down sloughs; YMD, LB/YMD. MWM 2967, 2977

Piptochaetium avenaceum (L.) Parodi. Rare; dry woods; LB/NCP. MWM 2766; JRM 9450

Poa annua L. Abundant; lawns, fields, and waste places; throughout. Introduced. MWM 596; JRM 8222

Poa autumnalis Muhl. ex Elliott. Frequent; rich and low woods; throughout (uncommon in YMD). MWM 720; JRM 8479

Poa bulbosa L. Rare; open grassy areas; NCP. Introduced. JRM 8334

Poa chapmaniana Scribn. Occasional; fields, woodland borders, and waste places; throughout. MWM 2789, 2823

Poa pratensis L. Occasional; pastures, lawns, and waste places; LB, NCP. Introduced. MWM 947; JRM 8494

Saccharum alopecuroides (L.) Nutt. Infrequent; meadows and woodland borders in uplands; NCP. MWM 2529; JRM 9209

Saccharum baldwinii Spreng. Occasional; low woods and meadows; LB, NCP, YMD*. MWM 2630

Saccharum brevibarbe (Michx.) Pers. var. *contortum* (Elliott) R. Webster. Frequent; meadows, borders of upland woods; LB, NCP. MWM 2645; JRM 7858

Saccharum giganteum (Walter) Pers. Frequent; meadows, creek banks, and woodland borders; throughout. MWM 2479; JRM 7670

Schedonorus phoenix (Scop.) Holub. Common; roadsides, fields, and waste places; throughout. Introduced. MWM 922; JRM 8138

Schizachyrium scoparium (Michx.) Nash. Frequent; dry woods, fields, and roadsides; LB, NCP. MWM 2608

Setaria faberi R. A. W. Herrm. Infrequent; roadsides, fields, and waste places; throughout. Introduced. MWM 2900, 2935; JRM 7264

Setaria parviflora (Poir.) Kerguelen. Common; roadsides, fields, and waste places; throughout. MWM 1177; JRM 7268

Setaria pumila (Poir.) Roem. & Schult. Occasional; roadsides, fields, and waste places; throughout. Introduced. JRM 7266

Sorghastrum elliottii (C. Mohr) Nash. Rare; dry woods; NCP. MWM 2676; JRM 9166

Sorghastrum nutans (L.) Nash. Frequent; low to dry woods, meadows, and roadsides; LB, NCP. MWM 2576; JRM 7679

Sorghum halepense (L.) Pers. Abundant; roadsides, cultivated fields, and waste places; throughout. Introduced. MWM 1195; JRM 7503

Sorghum bicolor (L.) Moench. Rare; borders of bottomland hardwoods; throughout. Introduced. MWM 2998; JRM 7460

Sphenopholis filiformis (Chapm.) Scribn. Infrequent; upland meadows and woodland borders; NCP. JRM 8322

Sphenopholis nitida (Biehler) Scribn. Infrequent; open meadows; NCP. JRM 8485

Sphenopholis obtusata (Michx.) Scribn. Frequent; low woods, roadsides, and waste places; throughout. MWM 619, 783, 852, 2812

Sphenopholis pensylvanica (L.) Hitchc. Infrequent; bogs and spring branches; NCP. MWM 739

Sporobolus clandestinus (Biehler) Hitchc. Rare; dry open woods; NCP. JRM 7610b

Sporobolus indicus (L.) R. Br. Occasional; roadsides, fields, and waste places; throughout. Introduced. MWM 2266, 2912

Sporobolus junceus (Michx.) Kunth. Infrequent; dry open woods; NCP. MWM 2670; JRM 7610

Sporobolus vaginiflorus (Torr.) Wood. Rare; open disturbed area; NCP. JRM s.n.

Steinchisma hians (Elliott) Nash. Occasional; low woods, ditches, and marshes; throughout. MWM 2293, 2542a, 2894

Tridens flavus (L.) Hitchc. Common; meadows, woodland borders, and roadsides; throughout. MWM 2390, 2478, 2646; JRM 7323

Tridens strictus (Nutt.) Nash. Occasional; meadows, woodland borders, and roadsides; throughout. MWM 2294, 2498; JRM 7451

Tripsacum dactyloides L. Occasional; low woods, meadows, and roadsides; throughout. MWM 1013; JRM 7487

Triticum aestivum L. Infrequent; escape from food plots; NCP. Introduced. JRM 8595

Urochloa platyphylla (Munro ex C. Wright) R. D. Webster. Frequent; fields and waste places; throughout. MWM 2381

Urochloa ramosa (L.) Nguyen. Infrequent; escape from wildlife food plots; NCP. Introduced. JRM 7314

Vulpia myuros (L.) K. C. Gmel. Occasional; roadsides and meadows; NCP. Introduced. JRM 7064

Vulpia octoflora (Walter) Rydb. Occasional; fields, roadsides, and dry woods; LB, NCP. MWM 979, 983

Zea mays L. Rare; borders of dry woods; LB/NCP. Introduced. MWM 3001

Zoysia japonica Steud. Infrequent; lawns; NCP. Introduced. JRM 8301

Polemoniaceae

Phlox carolina L. Rare (although locally common); bottomland woods and meadows; YMD. MWM 2846

Phlox divaricata L. Frequent; rich woods; LB*, NCP. MWM 539; JRM 8254

Phlox pilosa L. Common; upland woods, meadows, and roadsides; LB, NCP. MWM 630

Polygalaceae

Polygala incarnata L. Occasional; borders of upland woods and old fields; NCP. MWM 2035

Polygala mariana Mill. Occasional; borders of upland woods, old fields, and bogs; NCP. MWM 2036

Polygala sanguinea L. Infrequent; woodland borders and old fields; NCP. MWM 2104

Polygonaceae

Brunnichia ovata (Walter) Shinners. Common; bottomland woods, fields, roadsides, and river banks; throughout. MWM 2133

Fallopia scandens (L.) Holub. Frequent; woodland borders, thickets, fence rows, and creek banks; LB*, NCP, YMD. MWM 2524

Persicaria glabra (Willd.) M. Gomez. Occasional; marshes, ditches, and margins of bald cypress-water tupelo swamps; LB, NCP, YMD*. MWM 2668

Persicaria hydropiperoides (Michx.) Small. Common; marshes, ditches, and the margins of bald cypress-water tupelo swamps; throughout. MWM 2920; JRM 7398

Persicaria lapathifolia (L.) S.F. Gray. Frequent; marshes, ditches, and margins of bald cypress-water tupelo swamps; throughout. MWM 2617a, 2636; JRM 7276

Persicaria longiseta (de Bruijn) Kitagawa. Rare; fields and roadsides; NCP. Introduced. JRM 7819b, 9082

Persicaria pensylvanica (L.) M. Gomez. Common; marshes, ditches, and low fields; throughout. MWM 2497; JRM 7279, 8220

Persicaria punctata (L.) Small. Infrequent; marshes, wet meadows, and swamp forests; NCP. MWM 997; JRM 8221

Persicaria sagittata (L.) H. Gross. Occasional; bogs and marshes; NCP. MWM 2574a, 2647

Persicaria setacea (Baldwin) Small. Infrequent; low fields and bottomland woods; throughout. MWM 2382, 2561a; JRM 7499

Persicaria virginiana (L.) Gaertn. Common; bottomland and rich woods; throughout. MWM 2334a; JRM 7619

Polygonum aviculare L. Common; fields, roadsides, and waste places; throughout. Introduced. MWM 2698; JRM 7261

Rumex acetosella L. Infrequent; disturbed upland woods; NCP. Introduced. JRM 7299

Rumex crispus L. Common; fields, roadsides, and waste places; throughout. Introduced. MWM 854, 2046a; JRM 8585

Rumex hastatulus Baldwin. Occasional; sandy fields; LB, NCP. MWM 779; JRM 8295

Rumex pulcher L. Common; fields pastures, and waste places; throughout. Introduced. MWM 955; JRM 8774

Rumex verticillatus L. Occasional; low woods and swamp forests; YMD*, LB. MWM 700

Pontederiaceae

Heteranthera limosa (Sw.) Willd. Occasional; marshes, mudflats, ephemeral pools, and rice fields; LB, NCP, YMD*. MWM 2334

Portulacaceae

Portulaca oleracea L. Infrequent; fields, waste places, and sandbars along creeks and rivers; throughout. Introduced. MWM 2128

Potamogetonaceae

Potamogeton diversifolius Raf. Infrequent; pools and ponds; LB/NCP, NCP. MWM 2872; JRM 7410

Potamogeton pusillus L. Rare; artificial ponds; NCP. JRM 7409

Primulaceae

Lysimachia ciliata L. Rare; low, rich woods; NCP. MWM 3024

Lysimachia lanceolata Walter. Occasional; bogs, moist meadows, thickets, and along streams; LB, NCP*. MWM 2018, 2867

Lysimachia radicans Hook. Frequent; low, wet woods; YMD. MWM 1196, 2054

Samolus parviflorus Raf. Infrequent; low, wet woods; throughout. MWM 1050, 2848; JRM 8763, 8855

Ranunculaceae

Actaea pachypoda Elliott. Occasional; rich woods; LB*, NCP. MWM 663, 716, 796; JRM 8591, 8939

Anemone virginiana L. Rare; rich woods; NCP. MWM 2167; JRM 9508

Clematis crispa L. Occasional; woodland borders and thickets; YMD. MWM 699

Clematis virginiana L. Frequent; in thickets and along streams and creeks in rich or low woods; throughout. MWM 2519; JRM 7419

Consolida ajacis (L.) Schur. Rare; roadsides; NCP. Introduced. MWM 2875

Myosurus minimus L. Occasional; low fields; throughout. MWM 2723, 2745

Ranunculus abortivus L. Common; low woods, fields, lawns, and waste places; throughout. MWM 594, 2786; JRM 8303

Ranunculus hispidus Michx. Occasional; rich to dry-mesic woods; LB, NCP. MWM 542; JRM 8329b

Ranunculus muricatus L. Rare; lawns; NCP. Introduced. JRM 8239b

Ranunculus parviflorus L. Infrequent; wet meadows and lawns; NCP. Introduced. JRM 7088

Ranunculus pusillus Poir. Common; marshes, ditches, and wet fields; throughout. MWM 627; JRM 7089

Ranunculus recurvatus Poir. Frequent; rich and low woods; LB*, NCP, YMD. MWM 793, 2759, 2773; JRM 8473b

Ranunculus sardous Crantz. Abundant; fields, pastures, roadsides, lawns, and waste places; throughout. Introduced. MWM 795, 1003, 2752; JRM 7090, 8137

Thalictrum pubescens Pursh. Occasional; rich woods, meadows, and stream banks; LB, NCP. MWM 974; JRM 9482

Rhamnaceae

Berchemia scandens (Hill) K. Koch. Common; low to upland woods; throughout. MWM 925

Ceanothus americanus L. Frequent; upland woods and clearings; LB, NCP. MWM 984; JRM 8819

Frangula caroliniana (Walter) A. Gray. Occasional; rich woods; LB, NCP. MWM 613, 2159

Rosaceae

Agrimonia parviflora Aiton. Infrequent; low, rich woodland borders and stream banks; LB, NCP. MWM 2551; JRM 7611

Agrimonia rostellata Wallr. Common; rich to dry-mesic woods; LB, NCP. MWM 2279, 2974

Alchemilla microcarpa Boiss. & Reuter. Rare; wet meadows and lawns; NCP. Introduced. JRM s.n.

Amelanchier arborea (Michx. f.) Fern. Frequent; upland woods, along streams, and slopes near springs and bogs; LB, NCP*. MWM 523, 658, 2532

Crataegus berberifolia Torr. & A. Gray. var. *engelmannii* (Sarg.) Eggl. Rare; along streams and creeks in rich woods; NCP. MWM 3056

Crataegus calpodendron (Ehrh.) Medik. Occasional; rich woods; LB*, LB/NCP. MWM 725, 756; JRM 9096

Crataegus crus-galli L. Occasional; upland woods; NCP. MWM 2011, 2271, 3018; JRM 9484

Crataegus marshallii Eggl. Common; bottomland to upland woods; throughout. MWM 2017

Crataegus pruinosa (H. L. Wendl.) K. Koch. Uncommon; low, rich woods and stream banks; NCP. MWM 2155, 2772

Crataegus pulcherrima Ashe. Rare; upland woods; NCP. MWM 2909

Crataegus viridis L. Frequent; low woods; LB, NCP, YMD*. MWM 665

Duchesnea indica (Andrews) Focke. Common; woodland borders, pastures, lawns, and waste places; Introduced. Throughout. MWM 649

Geum canadense Jacq. Occasional; rich and low woods; LB*, NCP, YMD. MWM 935; JRM 8940

Photinia pyrifolia (Lam.) K. R. Robertson & J. B. Phipps. Occasional; bogs and spring branches; NCP. MWM 2400, 2739; JRM 7242, 9054

Potentilla recta L. Infrequent; meadows and roadsides; LB. Introduced. MWM 2827

Potentilla simplex Michx. Common; bottomland to upland woods; throughout (not common in YMD). MWM 657

Prunus angustifolia Marshall. Common; woodland borders and roadsides; throughout. Introduced. MWM 2705; JRM 9456

Prunus mexicana S. Watson. Frequent; bottomland to upland woods; throughout. MWM 524, 541; JRM 8896

Prunus persica (L.) Batsch. Infrequent; roadsides and woodland borders; throughout. Introduced. MWM 2711

Prunus serotina Ehrh. Common; bottomland to upland woods; throughout. MWM 620

Pyrus communis L. Infrequent; escape at old house sites; NCP. Introduced. JRM s.n.

Rosa carolina L. Common; upland woods and roadsides; LB, NCP. MWM 936; JRM 9457

Rosa chinensis Jacq. Infrequent; escape from planting; NCP. Introduced. JRM 9474

Rosa eglanteria L. Infrequent; along fence rows and in pastures; LB, NCP. Introduced. MWM 999

Rosa multiflora Thunb. Occasional; along roadsides, fence rows, pastures, and thickets; throughout. Introduced. MWM 865; JRM 9370

Rubus bifrons Vest. Rare; roadside thickets; LB/NCP. Introduced. MWM 2855

Rubus flagellaris Willd. Occasional; bottomland to upland woods and woodland borders; LB, NCP. JRM s.n.

Rubus pensilvanicus Poir. Abundant; bottomland to upland woods, old fields, fence rows, and pastures; throughout. MWM 762

Rubus trivialis Michx. Frequent; woodland borders, exposed creek banks, roadsides, and old fields; throughout. MWM 624

Spiraea menziesii Hook. Rare; woodland borders; NCP. Introduced. MWM 2874

Spiraea prunifolia Siebold & Zucc. Infrequent; woodland borders and old house sites; NCP. Introduced. MWM 2719

Rubiaceae

Cephalanthus occidentalis L. Common; margins of bald cypress-water tupelo swamps, low woods, along creeks and rivers, and marshes; throughout. MWM 2052; JRM 8818

Diodia teres Walter. Common; sandy fields, woodland borders, roadsides, and waste places; throughout. MWM 2030; JRM 7357

Diodia virginiana L. Common; ditches, low woodland borders, lawns, and marshes; throughout. MWM 1188a; JRM 7404

Galium aparine L. Common; woodland borders, roadsides, fields, and waste places; throughout. MWM 611

Galium circaezans Michx. Common; bottomland to upland woods; throughout. MWM 943

Galium parisiense L. Occasional; roadsides; NCP. Introduced. JRM 8784

Galium pedemontanum (Bellardi) Allioni. Rare; cutover woods and moist meadow; NCP. Introduced. JRM 8771, 8796

Galium pilosum Aiton. Occasional; dry upland woods; LB, NCP. MWM 2726, 2883; JRM 8850b

Galium tinctorium L. Infrequent; low woods; throughout. MWM 711; JRM 9451

Galium triflorum Michx. Occasional; rich woods; LB, NCP. MWM 2871; JRM 8854

Galium uniflorum Michx. Common; upland woods; LB, NCP*. MWM 982, 2109a

Houstonia micrantha (Shinners) Terrell. Infrequent; lawns; NCP. JRM 7026

Houstonia purpurea (L.) Torr. & A. Gray. Occasional; woodland borders, meadows, and old fields; LB, NCP. MWM 769

Houstonia pusilla Schopf. Common; woodland borders, old fields, pastures, lawns, and roadsides; throughout. MWM 562; JRM 8240

Houstonia rosea (Raf.) Terrell. Rare; lawns; NCP. JRM 8225

Mitchella repens L. Common; bottomland to upland woods; throughout. MWM 775; JRM 8903b

Oldenlandia boscii (DC.) Chapm. Occasional; marshes, wet meadows, mudflats around Grenada Lake, and moist sandbars along creeks and rivers; NCP. MWM 2650a, 2970; JRM 7437

Oldenlandia uniflora L. Rare; wet meadows and pond margins; NCP. JRM 7454

Richardia brasiliensis Gomes. Rare; fallowed field; NCP. Introduced. JRM 8214

Richardia scabra L. Rare; disturbed ground around construction site; NCP. Introduced. JRM 7388

Sherardia arvensis L. Infrequent; woodland borders, lawns, and roadsides; throughout. Introduced. MWM 758; JRM 8725, 8765

Spermacoce glabra Michx. Occasional; low, wet woods, marshes, and ditches; YMD. MWM 2255

Ruscaceae

Maianthemum racemosum (L.) Link. Frequent; rich to dry-mesic woods; LB, NCP. MWM 753; JRM 7869b

Polygonatum biflorum (Walter) Elliott. Occasional; rich woods; LB, NCP. MWM 859

Salicaceae

Populus alba L. Infrequent; old house sites; throughout. Introduced. MWM 2526

Populus deltoides Marshall. Frequent; low woods and along creeks and rivers; throughout. MWM 1009; JRM 9030

Populus heterophylla L. Frequent; swamp forests; LB, NCP, YMD*. MWM 1183

Salix exigua Nutt. Infrequent; sandbars along creeks; LB. MWM 2345a

Salix nigra Marshall. Common; low woods, creek and river banks; throughout. MWM 661; JRM 7403

Santalaceae

Comandra umbellata (L.) Nutt. Rare (known site probably destroyed); roadside in dry open woods; NCP. JRM 8325

Sapindaceae

Acer floridanum (Chapm.) Pax. Frequent; rich woods; LB*, NCP. MWM 638a

Acer negundo L. Frequent; low woods, especially along creek and river banks; throughout. MWM 655

Acer rubrum L. Common; low to upland woods; throughout. MWM 732; JRM 8285

Acer saccharinum L. Frequent; low woods, especially along creek and river banks; throughout. MWM 641; JRM 9188

Aesculus pavia L. Frequent; rich woods; throughout (rare in YMD). MWM 538; JRM 8264

Cardiospermum halicababum L. Infrequent; escape from cultivation; NCP. Introduced. JRM 7274, 9203

Sapotaceae

Sideroxylon lycioides L. Infrequent; along creeks in bottomland woods; YMD, LB, LB/NCP. MWM 2127

Saururaceae

Saururus cernuus L. Common; marshes, low woods, and margins of bald cypress-water tupelo swamps; throughout. MWM 1048; JRM 8895

Saxifragaceae

Micranthes virginiensis (Michx.) Small. Rare (although locally common); upper rocky slopes in rich woods; LB. MWM 567

Schisandraceae

Schisandra glabra (Brickell) Rehder. Occasional; rich woods; LB*, NCP. MWM 752, 2003

Scrophulariaceae

Scrophularia marilandica L. Uncommon; rich woods and thickets; LB. MWM 2490

Verbascum blattaria L. Rare; fields and borders of upland woods; LB. Introduced. MWM 2851; JRM 9716

Verbascum thapsus L. Occasional; roadsides and woodland borders; LB, NCP. Introduced. MWM 2385

Smilacaceae

Smilax bona-nox L. Occasional; low to upland woods; throughout. MWM 988

Smilax glauca Walter. Common; low to upland woods; throughout. MWM 840, 941; JRM 7822

Smilax herbacea L. Occasional; rich and low woods; LB, NCP. MWM 930

Smilax laurifolia L. Rare; bogs; NCP. MWM 2969, 2975

Smilax rotundifolia L. Common; low woods; throughout. MWM 618, 991

Smilax smallii Morong. Occasional; rich and low woods to upland woods; LB, NCP. MWM 606, 617; JRM 7823

Smilax tamnoides L. Frequent; rich and low woods; throughout (less common in NCP). MWM 792; JRM 7614

Solanaceae

Datura stramonium L. Rare; edges of cultivated fields; LB, NCP. Introduced. MWM 2956; JRM 7518

Petunia x hybrida E.Vilm. Rare; roadsides; NCP. Introduced. MWM 2876

Physalis angulata L. Frequent; cultivated fields and roadsides; throughout. MWM 2265; JRM 7427

Physalis heterophylla Nees. Infrequent; woodland borders; LB, NCP. MWM 2862; JRM 7620, 8429b

Physalis pubescens L. Infrequent; deciduous woods; LB. MWM 2580

Physalis virginiana Mill. Infrequent; woodland borders and roadsides; NCP. MWM 951

Solanum carolinense L. Common; roadsides, cultivated fields, and waste places; throughout. MWM 967; JRM 7509

Solanum ptychanthum Dunal. Occasional; bottomland to upland woods, fields, and roadsides; throughout. MWM 2288; JRM 7864

Solanum viarum Dunal. Rare; ruderal; NCP. Introduced. JRM 8981

Sphenocleaceae

Sphenoclea zeylanica Gaertn. Infrequent; margins of bald cypress-water tupelo swamps, drawn-down sloughs, and rice fields; throughout. Introduced. MWM 2962

Staphyleaceae

Staphylea trifolia L. Rare (although locally common); rich woods; LB. MWM 2749

Styracaceae

Styrax americanus Lam. Occasional; low woods; LB, NCP, YMD*. MWM 731, 926

Styrax grandifolius Aiton. Frequent; rich to dry-mesic woods; LB, NCP. MWM 601, 651; JRM 8414

Symplocaceae

Symplocos tinctoria (L.) L'Her. Frequent; bottomland to rich woods, along streams, and slopes near springs and bogs; throughout (rare in YMD). MWM 568, 3027; JRM 7692

Tetrachondraceae

Polypremum procumbens L. Common; sandy fields, borders of upland woods, and roadsides; throughout. MWM 2028b; JRM 7359

Tiliaceae

Tilia americana L. Rare; rich woods; LB/NCP, NCP. MWM 2743, 2914; JRM 8780

Trilliaceae

Trillium recurvatum Beck. Frequent; rich woods; LB*, NCP (uncommon in NCP). MWM 564; JRM 8288

Typhaceae

Typha latifolia L. Frequent; marshes and ditches; throughout. MWM 2174

Ulmaceae

Planera aquatica Walter ex J. F. Gmel. Frequent; margins of bald cypress-water tupelo swamps, sloughs, and river banks; throughout. MWM 1063

Ulmus alata Michx. Common; bottomland to upland woods; throughout. MWM 644, 729, 767, 953, 2002; JRM 7370

Ulmus americana L. Common; low woods and along creeks and streams; throughout. MWM 780a; JRM 8214b

Ulmus crassifolia Nutt. Infrequent; bottomland hardwood forests; YMD. MWM 2258

Ulmus rubra Muhl. Frequent; rich woods; LB, NCP. MWM 780; JRM 7231, 7534

Ulmus serotina Sarg. Uncommon; upland woods; LB. MWM 2517, 2629, 2782

Urticaceae

Boehmeria cylindrica (L.) Sw. Common; low woods, swamp forests, and marshes; throughout. MWM 2273; JRM 7422

Laportea canadensis (L.) Wedd. Infrequent; (although locally common); rich and alluvial woods; LB, LB/NCP. MWM 2584; JRM 7780

Pilea pumila (L.) A. Gray. Frequent; low woods; throughout. MWM 2562; JRM 7783

Urtica chamaedryoides Pursh. Infrequent; rich and alluvial woods; YMD, LB*. MWM 586

Valerianaceae

Valerianella radiata (L.) Dufr. Common; roadsides, fields, and woodland borders; throughout. MWM 592; JRM 8302

Verbenaceae

Phyla lanceolata (Michx.) Greene. Occasional; marshes, ditches, and low woods; LB, NCP, YMD*. MWM 2254, 2992

Verbena bonariensis L. Infrequent; roadsides, fields, and waste places; throughout. Introduced. MWM 2892; JRM 7247

Verbena brasiliensis Vell. Common; roadsides, fields, and waste places; throughout. Introduced. MWM 1011, 2893; JRM 8135

Verbena rigida (L.) Spreng. Rare; roadside ditch bank; NCP. Introduced. JRM 8766

Verbena simplex Lehm. Rare; moist meadow; NCP. JRM 9746

Verbena urticifolia L. Frequent; woodland borders, fields, marshes, and waste places; throughout. MWM 2121, 2976; JRM 7273

Violaceae

Hybanthus concolor (Forster) Spreng. Rare (although locally common); rich woods; LB/NCP. JRM 8590

Viola bicolor Pursh. Common; fields, roadsides, woodland borders, pastures, and lawns; throughout. MWM 522; JRM 8293

Viola palmata L. Common; upland woods; LB, NCP. MWM 566; JRM 8255, 8262

Viola primulifolia L. Rare (although locally common); bogs and spring branches; NCP. MWM 549

Viola sororia Willd. Common; rich and low woods; throughout. MWM 537

Viola walteri House. Frequent; rich woods; LB*, NCP. MWM 565; JRM 7248, 8261

Viscaceae

Phoradendron leucarpum (Raf.) Reveal & M.C. Johnst. Common; parasitic on branches and trunks of hardwoods; throughout. MWM 2708; JRM 9277

Vitaceae

Ampelopsis arborea (L.) Koehne. Common; low woodland borders, thickets, roadsides, and along ditches; throughout. MWM 2125

Ampelopsis cordata Michx. Frequent; low woods, thickets, and along creeks and streams; throughout (rare in NCP). MWM 1062

Parthenocissus quinquefolia (L.) Planch. Common; bottomland to upland woods; throughout. MWM 2144

Vitis aestivalis Michx. Frequent; bottomland to upland woods; throughout. MWM 2521

Vitis cinerea Engelm. ex Millard. Occasional; low woods; YMD. MWM 2841

Vitis palmata Vahl. Frequent; low woods; YMD. MWM 2496

Vitis rotundifolia Michx. Common; bottomland to upland woods; throughout. MWM 1061; JRM 7870

Vitis vulpina L. Infrequent; bottomland woods, especially along creek and river banks; throughout. MWM 959, 1199

Xanthorrhoeaceae

Hemerocallis fulva L. Occasional; roadsides and old house sites; throughout. Introduced. MWM 2844; JRM 8727

Xyridaceae

Xyris difformis Chapm. var. *curtissii* (Malme) Kral. Rare; open sandy seepage area; NCP. MWM 3010, 3016

Xyris torta Sm. Occasional; open bogs and seepage areas; NCP. MWM 2403, 2939, 3014; JRM 8904

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BOOK NOTICE

Gisella S. Cruz García. 2012. **Ethnobotanical Study of Wild Food Plants Used by Rice Farmers in Northeast Thailand.** (ISBN-13: 978-94-6173-275-0, pbk.). Thesis, Wageningen University, Wageningen, The Netherlands. (**Orders:** no order information available). $No price given, 215 pp., b/w figures, graphs, tables, 6½" × 9½".

From the Abstract: "A theoretical model was developed and field work was conducted in Kalasin, Northeast Thailand. The empirical analysis comprised three principle analytically and methodologically coherent research components: (a) botanical (species level), (b) ecological (ecosystem and sub-system) and (c) anthropological (household level). This was reflected in the use of research methodologies drawn from (ethno)botany, ecology and anthropology, respectively.

Results showed a total of 87 elicited wild food plant species comprising trees, terrestrial and aquatic herbs, climbers, shrubs, bamboos and a rattan growing in anthropogenic ecosystems including rice fields home gardens, secondary woods, upland fields, swamps and roadsides. Most species can be found in different places and more than two thirds of the species have extra uses besides food.

A total of 42 wild food plant species were reported in 102 sampling sites corresponding to seven sub-systems associated to lowland rice production, including shelters, hillocks, ponds, and their margins, tree rows, dikes and field margins.

This study highlighted the importance of diversity at species, sub-system and ecosystem level, and confirmed the theoretical model on seasonal and spatial complementarity of anthropogenic ecosystems and subsystems for provisioning and gathering wild food plants. It was concluded that this complementarity is crucial for household food security and dietary diversity, and has major societal implications for agricultural programs, food policies, biodiversity conservation initiatives and poverty alleviation strategies in the region.

Summaries in English and Dutch.

Key Words: Wild food plant, ethnobotany, domestication, anthropogenic ecosystem, rice ecosystem, home garden, gathering, abundance, diversity, seasonality, ecosystem complementarity, multi-functionality, poverty, vulnerability, rice farmers, Thailand, Southeast Asia."

CHECKLIST OF THE VASCULAR PLANTS OF WESTMORELAND COUNTY, PENNSYLVANIA

Cynthia M. Morton
Section of Botany
Carnegie Museum of Natural History
4400 Forbes Avenue
Pittsburgh, Pennsylvania 15213, U.S.A.
mortonc@carnegiemuseums.org

Loree Speedy
Section of Botany
Carnegie Museum of Natural History
4400 Forbes Avenue
Pittsburgh, Pennsylvania 15213, U.S.A.

ABSTRACT

Westmoreland County has been botanized since the mid 1800s, but a checklist of the county's vascular flora has not previously been published. A search of herbaria augmented by targeted fieldwork has resulted in a list of 1452 taxa of native and naturalized plants comprising 599 genera and 142 families. The five families with the largest number of species are Asteraceae, Cyperaceae, Fabaceae, Poaceae, and Rosaceae. *Carex, Quercus, Rubus, Symphyotrichum* and *Viola* are the largest genera. There are 346 non-native species that have been introduced mainly from Europe and Asia. This checklist recognizes 1347 species of Angiosperms, 17 species of Gymnosperms and 54 species of Pteridophytes. By The Nature Conservancy's system of conservation status designations, 76 species have global or state ranking.

RESUMEN

El condado de Westmoreland ha sido herborizado desde la mitad de los 1800s, pero no se ha publicado previamente ningún catálogo de flora vascular del condado. Una búsqueda en herbarios incrementada con trabajo de campo ha dado como resultado una lista de 1452 taxa de plantas nativas y naturalizadas que se incluyen en 599 géneros y 142 familias. Las cinco familias con mayor número de especies son Asteraceae, Cyperaceae, Fabaceae, Poaceae, y Rosaceae. *Carex, Quercus, Rubus, Symphyotrichum* y *Viola* son los géneros más grandes. Hay 346 especies no nativas que han sido introducidas principalmente de Europa y Asia. En el catálogo se reconocen 1347 especies de Angiospermas, 17 especies de Gimnospermas y 54 especies de Pteridophytas. Según las designaciones de status de conservación mediante el sistema de la Nature Conservancy, 76 especies tienen rango global o del estado.

INTRODUCTION

Even though Pennsylvania lacks checklists for most of its counties, the vascular flora known thus far is quite diverse. Rhoads and Klein (1993) reported 3318 taxa of vascular plants for the state, including 2076 native and 1242 introduced. Approximately 27 of Pennsylvania's 67 counties have floras completed, but some are theses and surveys and therefore unavailable to the public. The exact number of genera and species in the flora of Westmoreland County was not previously known because a checklist had never been widely or recently published. Such checklists provide baseline information that can be used to monitor environmental changes and guide conservation decisions.

Site Description

Westmoreland County, Pennsylvania, is located in the western-central part of the state (Fig. 1). It is bordered by Butler County to the northwest, Armstrong and Indiana counties to the north, and Cambria County to the northeast, Somerset County to the southeast, Fayette County to the south, and Washington County to the southwest and Allegheny County to the west. The county contains approximately 2683 sq km (1036 sq mi). Elevations in the county range from a maximum of 908 m (2980 ft) along the Laurel Ridge to a low of 222 m (727 ft) along the Monongahela River. Latitude ranges from 40.04035 to 40.68044°N and longitude ranges from 78.98418 to 79.90527°W.

Westmoreland County receives a total annual precipitation of approximately 119 cm (47 in). Average seasonal snowfall is 112 cm (44 in) annually. The average date of the last frost in the spring is usually around May 12th and the first frost of the season approximately September 12th. The length of the growing season, from the last killing frost in spring to the first killing frost in autumn, is between 113–203 (mean 160) days (USDA 1968).

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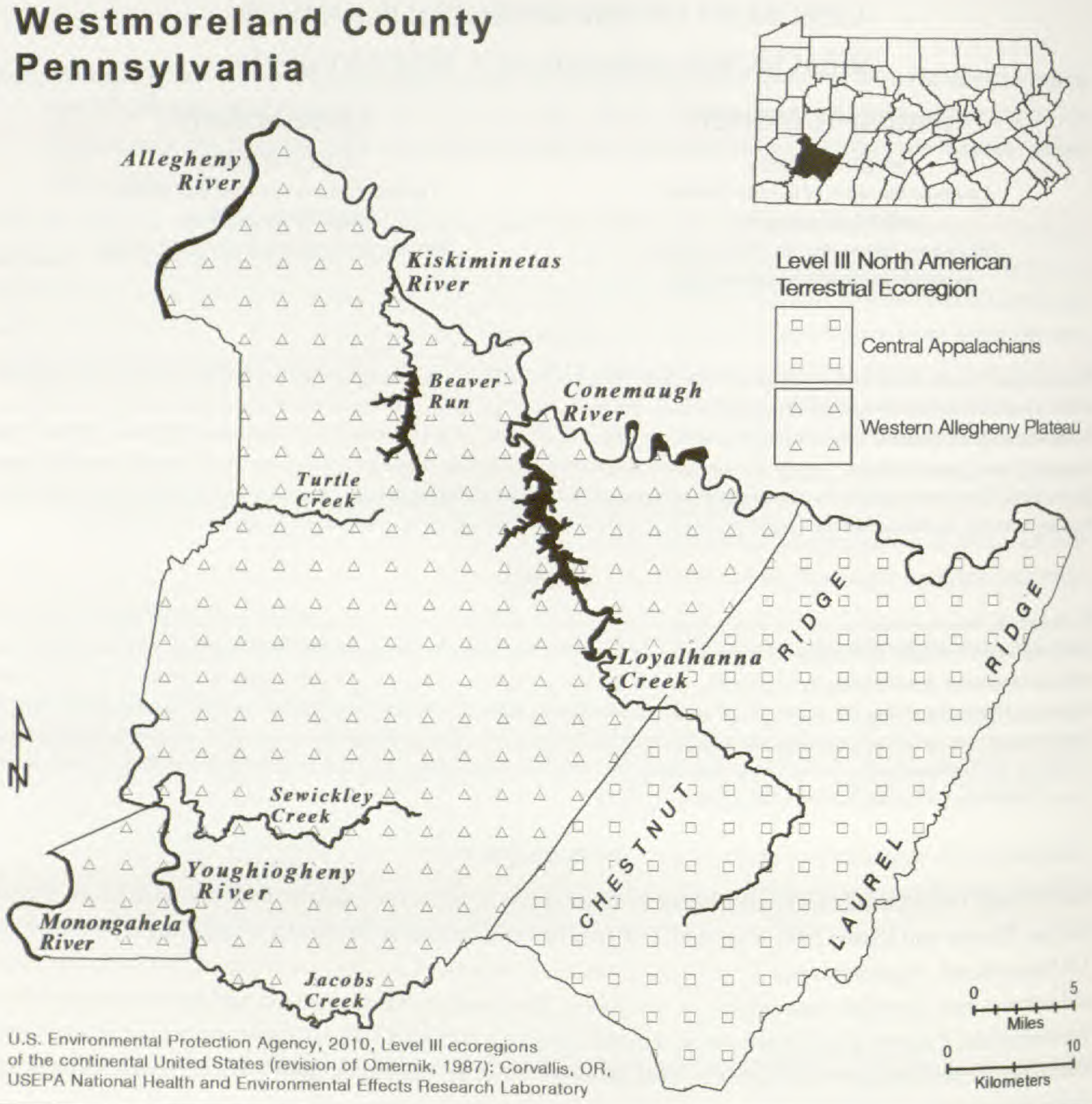

U.S. Environmental Protection Agency, 2010, Level III ecoregions of the continental United States (revision of Omernik, 1987): Corvallis, OR, USEPA National Health and Environmental Effects Research Laboratory

Fig. 1. Small map displays counties in Pennsylvania. Larger map displays major rivers, streams and terrestrial ecoregions in Westmoreland County.

Westmoreland County is comprised of two Level III Terrestrial Ecoregions, categorized according to location, climate, vegetation, hydrology, terrain, wildlife and land use/human activities. This concept of ecological classification, defined and described by the Commission for Environmental Cooperation (2011), is an attempt to classify and map ecological regions across the North American continent at multiple scales.

The western two-thirds of Westmoreland County is part of the Western Allegheny Plateau Level III Terrestrial Ecoregion, which covers southwest Pennsylvania, southeast Ohio, western West Virginia, and northeastern Kentucky. The climate of the mid-latitude ecoregion is humid continental, characterized by warm to hot summers and cold winters. The natural vegetation was mostly mixed mesophytic forest of chestnut oak, red maple, white oak, black oak, beech, yellow-poplar, sugar maple, ash, basswood, buckeye, and hemlock. The region contains many perennial moderate- and high-gradient streams; natural lakes are lacking, but some reservoirs have been built.

The area of this ecoregion was unglaciated in the last Ice Age. It now has the form of a dissected plateau and some rugged hills underlain by horizontally bedded, often carboniferous, sedimentary rock.

The Western Allegheny Plateau ecoregion is mostly forested. The region's land uses include some logging, areas of livestock and dairy farming, and some cropland with hay, corn, and small grains. There are public forest lands throughout. Surface and underground coal mining is extensive, and has caused the sedimentation and acidification of many surface waters.

The eastern third of Westmoreland County delineated as Chestnut Ridge and the west-facing slopes of Laurel Ridge, has been classified as the Central Appalachians Level III Terrestrial Ecoregion. This terrestrial ecoregion extends from central Pennsylvania through Maryland, West Virginia, Virginia, Kentucky, and into northern Tennessee. It is higher, cooler, steeper, more rugged, and more densely forested than the Western Allegheny Plateau to the west. This ecoregion also has a humid continental climate of warm to hot summers and cold winters.

The forest type in this region is a mostly mixed mesophytic forest. This forest was at one time dominated by the American chestnut but is now composed of chestnut oak, red maple, white oak, black oak, beech, yellow-poplar, sugar maple, ash, basswood, buckeye, and hemlock. The many perennial, moderate- to high-gradient streams have bedrock and boulder substrates. Some waterfalls will be found. This ecoregion also lacks lakes, and a few reservoirs occur. The terrain is rugged, and is characterized by high hills and low mountains, steep, narrow ridges, narrow winding valleys, and deep coves. It was also unglaciated in the last Ice Age, and is now a highly dissected, rugged plateau composed of sandstone, shale, conglomerate, and coal from the Pennsylvanian period. Maximum elevations and local relief are higher than in the Western Allegheny Plateau.

Mostly forestland uses prevail, along with some small areas of pasture, livestock, or dairy operations. Surface and underground bituminous coal mines are common and have reshaped ridges and hollows, and have caused siltation and acidification of many streams (Commission for Environmental Cooperation 2011).

The soils of Westmoreland County consist of seven main series: Westmoreland-Guernsey-Clarksburg association, Gilpin-Wharton-Cavode association, Gilpin-Dekalb-Cavode association, Calvin association, Weikert association, Philo-Monongahela-Atkins association, and Upshur-Gilpin-Clarksburg association (USDA 1968).

Rounded hills that have long, smooth, convex slopes, and gently sloping to nearly level benches and fans characterize the Westmoreland-Guernsey-Clarksburg association. These soils are over interbedded sandstone, shale and limestone. This association occurs mainly in the west-central part of the county and makes up about 9 percent of the county. These soils range from moderately deep to deep, and are somewhat poorly to well-drained. This association is well suited to farming although the seasonal high water table of some soils and the moderate depth to the bedrock in other areas create limitations. In areas where coal or natural gas has been removed, the level of the water table may have changed.

Gilpin-Wharton-Cavode association is characterized by broad, sloping hilltops and narrow valleys carved out by streams that form a branching pattern. This area is mainly in the northern and central parts of the county and covers about 19 percent of the county. The soil ranges from shallow to moderately deep and are poorly to well-drained. The gentle and moderate slopes of this association are used for agriculture however strip mining and natural gas removal is common in this association.

The Gilpin-Dekalb-Cavode association occurs mainly on Chestnut Ridge and Laurel Hill in the eastern part of the county. The soils range from moderately deep to deep and are somewhat poorly to well-drained. Soils that occur on ridges are underlain by acid, gray shale and sandstone. This association occupies about 14 percent of the county and consists of woodland that is used by private and State agencies for wildlife propagation or timber production.

On the uppermost parts of the Chestnut Ridge and Laurel Hill occurs the Calvin association. This association is in the eastern part of the county. It consists of moderately deep soils that are well-drained. This association occupies about 2 percent of the county. Most of this association is woodland or farmed.

The Weikert association occurs as escarpments cut by Loyalhanna Creek and the Kiskiminetas, Conemaugh, Allegheny, Youghiogheny, and Monongahela rivers. The largest areas occur where the streams have cut across the Chestnut Ridge and Laurel Hill. This association consists of shallow, well-drained rocky soils on escarpments along streams. Rock types include sandstone, shale, siltstone, and limestone. It occupies about two percent of the county. This association is wooded in areas where the soil is deep enough to support trees.

The Philo-Monongahela-Atkins association occurs along the larger streams of the county. Most of the association soils are deep and are moderately to poorly drained. Frequent flooding and a seasonal high water table are limitations that affect development. This association covers about 15 percent of the county. Most of the association is woodland and the rest is used for pasture or cropland.

The Upshur-Gilpin-Clarksburg association occurs in the northwestern part of the county. Most of the association soils are moderately deep to deep and are moderately to well-drained. These solids are over red and brown clay shale, siltstone and sandstone. This association covers about 5 percent of the county. Much of the association is occupied by woodland and the rest is used for pasture or cropland.

Major rivers and creeks that surround Westmoreland County are Kiskiminetas and Conemaugh rivers to the north, the Allegheny, Youghiogheny and Monongahela rivers to the west and Jacobs Creek to the south.

Westmoreland County contains eight major watersheds. These major watersheds are grouped into two subbasin categories: the Lower Allegheny Subbasin, and the Monongahela Subbasin.

The Lower Allegheny Subbasin has a total drainage area of 7,599 sq km (2,394 sq mi). It includes the lowermost portion of the Allegheny River from Clinton to Pittsburgh, including the entire Kiskiminetas-Conemaugh River system. The subbasin encompasses much of Allegheny, Indiana, Cambria, Somerset and Westmoreland counties with portions of Butler and Armstrong counties. The Lower Allegheny Subbasin contains the Conemaugh River-Blacklick Creek Watershed, the Kiskiminetas River Watershed, the Lower Allegheny River Watershed, and the Loyalhanna Creek Watershed.

The Kiskiminetas River Watershed has a total drainage area of 425 sq km (164 sq mi) and its major waterways include Kiskiminetas River and Beaver Run.

The Conemaugh River-Blacklick Creek Watershed has a total drainage area of 1,813 sq km (700 sq mi) and its major waterways include Blacklick Creek, Two Lick Creek and the middle portion of the Conemaugh River.

The Lower Allegheny River watershed drains a total area of 839 sq km (324 sq mi). Its major waterways include the lowest portion of the Allegheny River and Deer Creek. This watershed drains the northwestern portion of Westmoreland County.

The Loyalhanna Creek Watershed has a total drainage area of 958 sq km (370 sq mi). Its major waterways include Loyalhanna Creek, Blacklegs Creek and the lower portion of the Conemaugh River.

The Monongahela Subbasin has a total drainage area of 7,089 sq km (2,737 sq mi). It includes the Pennsylvania portion of the Monongahela River, from West Virginia and Maryland to Pittsburgh. This subbasin encompasses almost all of Fayette County, much of Greene, Washington, Westmoreland and Somerset counties and a small portion Allegheny County. The Monongahela Subbasin contains the Middle Monongahela River Watershed, Turtle Creek Watershed, and the Upper and Lower Youghiogheny River Watersheds.

The Middle Monongahela River watershed has a total drainage area of 1,318 sq km (509 sq mi) and its major streams include the middle portion of the Monongahela River, Pigeon Creek and Redstone Creek.

Turtle Creek watershed has a total drainage area of 523 sq km (202 sq mi) and its major stream is Turtle Creek.

The Upper Youghiogheny River has a total drainage area of 995 sq km (384 sq mi) and its major streams include the Indian Creek, Laurel Hill Creek and the upper portion of the Youghiogheny River. The Lower Youghiogheny River watershed has a total drainage area of 1,238 sq km (478 sq mi) and its major streams include Sewickley Creek, Jacobs Creek and the lower portion of the Youghiogheny River.

Watershed conditions need to be evaluated to detect if biodiversity is increasing or decreasing. These comparisons will be extremely important in mining areas because they will reflect the interactions of many of the other indicators, and these comparisons are measurable effects for management decisions (Pennsylvania DEP Watershed Notebook 2006).

History

The first Native American tribes to live in Western Pennsylvania were known as the Alligewe. They were conquered by the Lenni-Lenape, better known as the Delawares. It was mostly the Delawares who lived, hunted and had the most contacts with the white settlers in this area.

Access into western Pennsylvania in 1755 was either up the Juniata River and then by water down to the Kiskiminetas River to the Allegheny River or by Braddock's Road. In 1758 a new road was built and it was known as Forbes Road. This road cut from Bedford through what is now Somerset, Westmoreland and Allegheny counties. Previous to the building of this road Westmoreland was traveled by Native Americans and the occasional white trader or frontiersman.

The first settlers were mostly young men who came from the eastern counties of Lancaster, York and Northampton or were from Virginia or Cumberland Valley and were mainly of German or Scotch-Irish decent.

In August of 1763, the Battle of Bushy Run was fought near present day Jeannette, Pennsylvania, relieving Fort Pitt and setting in play the historical forces that would shape Westmoreland County. An Act of Assembly approved by Governor Richard Penn, on February 26, 1773, formed Westmoreland County.

One of the first early industries was run by Philip Freeman, who owned a tract of 1600 acres, and operated a gristmill in 1785 and later a saw mill and iron furnace. During this period farmers who raised more grain than they needed manufactured whiskey. By making whiskey from their grain they reduced a large quantity of grain into a smaller bulk while it still retained its value. From 1818 to 1840 roads and turnpikes were a thriving business. The arrival of these new roads also brought new industry such as the Rumbaugh brickyard. Rumbaugh brickyard was owned and operated by John Rumbaugh and a person traveling from Mammoth to Calumet could see large evacuation sites on the northern side of the road. This brickyard was active from around the last of the 19th and the first of the 20th centuries.

The demand for lumber by the growth of towns and railroads and the abundance of trees in Westmoreland County brought about the lumber industry. Byers and Allen of Pittsburgh built a large sawmill in Ligonier in 1902, and it was considered at that time the largest mill in the world. The lumber industry reached its peak of production in the early years of 1900, after which it became exhausted. During the years between the 1870s and the late 1920s, there was a great period of activity and prosperity in the southern part of Westmoreland Country and in Fayette County. It hummed with the mining of coal and the manufacture of coke. The Latrobe Steel Company is another large industry founded in 1913. Latrobe Steel Company was the first company on the North American continent to use electric furnaces exclusively for the melting and manufacture of manganese steel casting.

The first locomotive to enter Westmoreland County arrived in 1852 upon which trains began to run regularly. In the latter part of the nineteenth and first part of the twentieth century streetcars were a common means of transportation. The peak of this system was from about 1908 through World War I. During the 1930s when public works were needed, the Pennsylvania Turnpike was proposed. By 1940 it was finished and opened for travel from Cumberland County in central Pennsylvania to Westmoreland County.

Today Westmoreland County has world-class manufacturers of specialty steel, turbomachinery, tools and machinery. Over 7,500 small businesses provide a tremendous range of products and services. In the midst of growth and developing industry, the county retains a strong tradition of farming, recreational and conservation areas. Rich in recreational and conservation areas, Westmoreland County, has a dozens of county and state parks, country clubs, state game lands, state forests, and nature preserves.

The county is the eighth largest county in Pennsylvania encompassing some 2,655 sq km (1,025 sq mi) and has a population of 368,983. It is comprised of 21 townships, 37 boroughs and seven cities; within these incorporated municipalities are numerous unincorporated towns and villages.

Major Collectors

Collecting in Westmoreland County for the Carnegie Museum Herbarium began in the early 1800s, and has continued to the present. Most of the collectors have been members of the Botanical Society of Western Pennsylvania and the staff of the Section of Botany at Carnegie Museum.

Botanists who have made significant contributions to the knowledge of the Westmoreland County are Frederick H. Utech, Otto E. Jennings, Loree Speedy, Leroy K. Henry and CharlesW. DeMoise.

METHODS

This checklist was compiled by searching the herbaria of the Carnegie Museum of Natural History (CM). Herbarium collection information was obtained from the Morris Arboretum (MOAR) for ten samples. Other herbaria that were examined for specimens include the Philadelphia Herbarium (PH) at the Academy of Natural Sciences. Most of the collections were made during the 1910s and the 1990s, and underrepresented areas of the county were targeted during the last three years. Several specimens date back as far as 1862 and 1869. The majority of the specimens are deposited at the Carnegie Museum of Natural History (CM). Three floristic Westmoreland publications were examined for specimens, Demoise and Duman (1951), Pearth (1975), and Utech (1999). Rhoads and Block (2000) was the primary source for plant identification. For generic and species names we have followed the Synthesis of North American Flora (Kartesz 1999). Authorities are abbreviated for the majority of taxa according to Brummitt and Powell (1992).

RESULTS AND DISCUSSION

This list includes the names of all native and naturalized species known to occur in Westmoreland County. It includes a total of 142 families, 599 genera, 1418 species, and 1452 total taxa. The five families with the largest number of species are Asteraceae, Cyperaceae, Fabaceae, Poaceae, and Rosaceae. *Carex*, *Quercus*, *Rubus*, *Symphyotrichum* and *Viola* are the largest genera. This checklist recognizes 1347 species of Angiosperms, 17 species of Gymnosperms, and 54 species of Pteridophytes. There are 346 non-native species that have been introduced mainly from Europe and Eurasia. Seventy-six species have global or state ranking.

Of the 76 plants that have global or state ranking, three have a global ranking of G3 or vulnerable status. The remaining plants are either a G4 or G5 status, indicating an apparently secure or secure condition globally.

Delphinium exaltatum has a global ranking of G3 or vulnerable status. *Delphinium exaltatum* contains alternate leaves palmately divided into 3 to 5 parted segments, 15 cm long, silvery-green abaxially and pubescent above and below. The basal lobes of some of the larger leaves are divided again and make the blade appear 5-lobed. The flowers are in terminal racemes. The 4 purplish-blue petals are dimorphic with the upper two petals expanded at the base and forming a spur. The lateral petals are reflexed in the apical half with long white hairs. The stamens are approximately 30 in number with yellow pollen. The 5 sepals are irregular. The species can be confused with *Delphinium tricorne*; however *D. tricorne* is a smaller plant and flowers much earlier than *D. exaltatum*, May to early June. By July, when *D. exaltatum* is beginning to flower, *D. tricorne* already has set fruit. Most of the collections are from rich shaded woods and on rocky limestone bluffs. This species is quite conspicuous and may be subject to casual picking or may be dug for gardens.

Poa paludigena also has a global ranking of G3 or vulnerable status. Little known about *Poa paludigena* range. It may easily be overlooked or misidentified due to its close resemblance to related species. It is a wetland species found in bogs, swamps, wet woods, wet meadows, and along streams. It has no rhizomes, only fibrous roots, and the weak and slender stem often falls over. It normally grows to a height of 2–6 dm tall. The leaves are narrow 1–2 mm wide and 10 cm long. The inflorescence has only 2 panicle branches per node, the spikelets borne at the middle to end of the branches. The distinguishing characteristics are within the flowers, spikelets with cobweb-like hairs at their bases situated above the middle of the paired branches, when it blooms in late May and into June. Identification often requires microscopic evaluation to distinguish it from its close relatives.

With a status of G3 or vulnerable status, is *Scutellaria saxatilis* (Rock Skullcap). These plants are slender and decumbent with glabrous or eglandular stems. The leaves are glabrous, petioled, ovate-shaped and rounded at the base. The margins have fewer than 10 rounded teeth on each side. This species has a distinctive prominent protuberance on the upper corolla. The flowers are in terminal few-flowered racemes and have bracts underneath the calyx. This species can be confused with *Scutellaria ovata*, but this species has much longer leaves and is not decumbent.

There are 9 taxa in the Westmoreland County flora that are listed by the Pennsylvania Department of Agriculture (2007) as noxious weeds. It is therefore illegal to propagate, sell or transport the following taxa in the commonwealth: *Carduus nutans* (Musk thistle), *Cirsium arvense* (Canada thistle), *Cirsium vulgare* (Bull thistle), *Datura stramonium* (Jimson weed), *Lythrum salicaria* (Purple loosestrife), *Polygonum perfoliation* (Mile-a-minute), *Pueraria lobata* (kudzuvine), *Rosa multiflora* (Multiflora rose) and *Sorghum halepense* (Johnson grass).

Other species considered serious invasives in Pennsylvania's native ecosystems are: *Acer platanoides* (Norway maple), *Aegopodium podagraria* (goutweed), *Ailanthus altissima* (tree-of-heaven), *Alliaria petiolata* (garlic mustard), *Berberis thunbergii* (Japanese barberry), *Bromus tectorum* (Cheatgrass), *Celastrus orbiculatus* (Oriental bittersweet), *Elaeagnus umbellata* (autumn olive), *Euonymus alatus* (Winged Euonoymus), *Fallopia japonica* (Japanese knotweed), *Hesperis matronalis* (Dame's rocket), *Ligustrum vulgare* (Common privet), *Lonicera japonica* (Japanese honeysuckle), *Lonicera maackii* (Amur honeysuckle), *Lonicera morrowii* (Morrow's honeysuckle), *Lonicera tatarica* (tartarian honeysuckle), *Microstegium vimineum* (Japanese stilt grass), *Myriophyllum spicatum* (Eurasian water-milfoil), *Ornithogallum umbellatum* (Star-of Bethlehem), *Pastinaca sativa* (wild parsnip), *Phalaris arundinacea* (reed canary grass), *Phragmites australis* (Common reed), *Rhamnus catharticus* (common buckthorn), *Rubus phoenicolasium* (Wineberry), *Spiraea japonica* (Japanese spiraea), and *Viburnum opulus* var. *opulus* (Guelder rose) (DCNR 2004).

While this checklist is probably not all-inclusive of every species in Westmoreland County, it is the most comprehensive list presently available.

ANNOTATED CHECKLIST OF THE SPECIES OF WESTMORELAND COUNTY, PENNSYLVANIA

Taxa are listed according to the following format: taxon name, author(s), {(year) collector and number} global: state ranking [Synonyms] and non-native source. We follow the state (S) and global (G) ranking systems developed by The Nature Conservancy (1996 version). The global numbers are designated from 1 (critically imperiled) to 5 (secure). Other notations include SH, which denotes historical occurrence. Synonyms are included for names not in common usage in the state or regional manuals. Nonnative status and country of origin is from Rhoads and Block (2007). In cases where there was more than one specimen present in the collection, recent collections of current collectors for the western Pennsylvania region were cited.

Families, genera, and specific and infraspecific taxa are arranged alphabetically within vascular plant groups Angiosperms, Gymnosperms and Pteridophytes.

ANGIOSPERMS

Acanthaceae

Justicia americana (L.) Vahl, 2010 Speedy, L. 10-669

Aceraceae

Acer negundo L. var. *negundo*, 2008 Speedy, L. 08-0244

Acer nigrum Michx. f., 1983 Utech, F.H. and Ohara, M. 83-510 [*Acer saccharum* Marsh. var. *nigrum* (Michx. f.) Britton]

Acer pensylvanicum L., 2008 Speedy, M.L. 08-322

Acer platanoides L., 2008 Speedy, L. 08-0228 Europe

Acer rubrum L. var. *rubrum*, 2008 Speedy, L. 08-0095

Acer saccharinum L., 2008 Speedy, L. 08-0243

Acer saccharum Marsh. var. *saccharum*, 2008 Speedy, L. 08-0242

Acer spicatum Lam., 1996 Utech, F.H. 96-411

Acoraceae

Acorus calamus L., 1985 Thompson, S.A., Nishida, J.H. and MacDonald, M. 2478 Europe

Agavaceae

Yucca filamentosa L., 1995 Utech, F.H. 95-158

Alismataceae

Alisma subcordatum Raf., 1977 Polechko, M. s.n. [*Alisma plantago-aquatica* L. var. *parviflorum* (Pursh) Torr.]

Sagittaria australis (J.G. Sm.) Small, 1881 Block, P.D. s.n. [*Sagittaria engelmanniana* J.G. Sm. ssp. *longirostra* auct. non Micheli]

Sagittaria latifolia Willd., 2010 Speedy, L. and Speedy, J. 10-579 [*Sagittaria latifolia* Willd. var. *pubescens* (Muhl. ex Nutt.) J.G. Sm.]

Amaranthaceae

Amaranthus albus L., 1992 Utech, F.H. 92-2689

Amaranthus blitum L. var. *emarginatus* (Moq. ex Uline & Bray) comb. nov. ined., 1990 Utech, F.H. 90-1282 [*Amaranthus lividus* auct. non L.]

Amaranthus hybridus L., 1994 Utech, F.H. 94-2211 Tropical America

Amaranthus palmeri S. Wats., 1988 Utech, F.H. 88-1128

Amaranthus powellii S. Wats. ssp. *powellii*, 1992 Utech, F.H. 92-2937

Amaranthus retroflexus L., 1994 Utech, F.H. 94-2000 Tropical America

Atriplex prostrata Boucher ex DC., 1960 Shaw, Mrs. Charles E. s.n. Eurasia

Anacardiaceae

Rhus copallinum L., 1994 Paxton, W. s.n. [*Rhus copallinum* L. var. *latifolia* Engl.]

Rhus glabra L., 1994 Utech, F.H. 94-1344

Rhus typhina L., 1997 Utech, F.H. 97-457

Toxicodendron radicans (L.) Kuntze ssp. *negundo* (Greene) Gillis, 2008 Speedy, M.L. 08-483

Annonaceae
Asimina triloba (L.) Dunal, 2008 Speedy, M.L. 08-750-2

Apiaceae
Aegopodium podagraria L., 1994 Utech, F.H. 94-876 Eurasia
Anethum graveolens L., 1988 Utech, F.H. 88-1101 Europe
Angelica atropurpurea L., 1997 Utech, F.H. 97-260
Angelica triquinata Michx., 1991 Utech, F.H. 91-1432
Angelica venenosa (Greenway) Fern., 1927 Grimm, W.C. 254
Anthriscus cerefolium (L.) Hoffmann, 1994 Utech, F.H. 94-394 Europe
Chaerophyllum procumbens (L.) Crantz var. *procumbens*, 2008 Speedy, L. 08-0237
Cicuta maculata L. var. *maculata*, 1998 Utech, F.H. 98-91
Conium maculatum L., 1998 Utech, F.H. 98-119 Europe
Cryptotaenia canadensis (L.) DC., 1998 Utech, F.H. 98-65
Daucus carota L., 1998 Utech, F.H. 98-202 Eurasia
Erigenia bulbosa (Michx.) Nutt., 2008 Speedy, M.L. 08-0015 **G5:S4**
Heracleum maximum Bartr., 2008 Speedy, M.L. 08-734 [*Heracleum lanatum* Michx.]
Hydrocotyle americana L., 2010 Speedy, L. 10-442
Osmorhiza claytonii (Michx.) C.B. Clarke, 1997 Utech, F.H. 97-200
Osmorhiza longistylis (Torr.) DC., 2008 Speedy, L. 08-0232
Oxypolis rigidior (L.) Raf., 2010 Speedy, L., Metzgar, T. and Davis, J. 10-615 **G5:S2**
Pastinaca sativa L., 1997 Utech, F.H. 97-322 Eurasia
Peucedanum ostruthium (L.) W.D.J. Koch, 1938 Jennings, O.E. s.n. Europe
Sanicula canadensis L. var. *grandis* Fern., 1994 Utech, F.H. 94-1309
Sanicula marilandica L., 2008 Speedy, L. 08-0234
Sanicula odorata (Raf.) K.M. Pryer & L.R. Phillippe, 1998 Utech, F.H. 98-79 [*Sanicula gregaria* Bickn.]
Sanicula trifoliata Bickn., 2008 Speedy, M.L. 08-538
Taenidia integerrima (L.) Drude, 2009 Speedy, L. 09-0479
Thaspium barbinode (Michx.) Nutt., 2009 Speedy, L. and Stout, L. 09-0139
Thaspium trifoliatum (L.) A. Gray var. *aureum* Britt., 2010 Speedy, L. 10-296 [*Thaspium trifoliatum* (L.) A. Gray var. *flavum* Blake]
Thaspium trifoliatum (L.) A. Gray var. *trifoliatum*, 1997 Utech, F.H. 97-348
Zizia aptera (A. Gray) Fern., 1916 Jennings, O.E. s.n.
Zizia aurea (L.) W.D.J. Koch, 1994 Utech, F.H. 94-559

Apocynaceae
Apocynum androsaemifolium L., 1994 Utech, F.H. 94-1251
Apocynum cannabinum L., 1998 Utech, F.H. 98-67
Apocynum x floribundum Greene (pro sp.), 1993 Utech, F.H. 93-1701 [*Apocynum medium* Greene]
Asclepias purpurascens L., 1936 Duman, OSB, Rev. Maximilian s.n.
Vinca minor L., 1995 Utech, F.H. 95-94 Europe

Aquifoliaceae
Ilex montana Torr. & A. Gray ex A. Gray, 2010 Speedy, L. 10-246
Ilex opaca Ait., 2009 Speedy, M.L. and Metzgar, T. 09-977
Ilex verticillata (L.) A. Gray, 1997 Utech, F.H. 97-976

Araceae
Arisaema triphyllum (L.) Schott, 2002 Isaac, B.L. and Isaac, J.A. 14427 [*Arisaema triphyllum* ssp. *pusillum* (Peck) Huttleston; *Arisaema triphyllum* ssp. *stewardsonii* (Britt.) Huttleston]
Orontium aquaticum L., 1919 Jennings, O.E. s.n. **G5:S4**
Symplocarpus foetidus (L.) Salisb. ex Nutt., 1995 Utech, F.H. 95-112

Araliaceae
Aralia hispida Vent., 1983 Mulvihill, R.S. s.n.
Aralia nudicaulis L., 1994 Utech, F.H. 94-546
Aralia racemosa L. ssp. *racemosa*, 1997 Utech, F.H. 97-924
Aralia spinosa L., 1996 Utech, F.H. 96-408
Panax quinquefolius L., 2010 Speedy, L., Metzgar, T. and Davis, J. 10-596
Panax trifolius L., 1994 Utech, F.H. and Kawano, S. 94-306

Aristolochiaceae
Asarum canadense L., 1997 Utech, F.H. 97-208
Endodeca serpentaria (L.) Raf., 2005 Isaac, B.L., Isaac, J.A. and Paxton, W. 18638 [*Aristolochia serpentaria* L.]
Isotrema macrophyllum (Lam.) C.F. Reed, 2008 Speedy, L. 08-0307 [*Aristolochia macrophylla* Lam.]

Asclepiadaceae
Asclepias exaltata L., 1997 Utech, F.H. 97-489
Asclepias incarnata L. ssp. *incarnata*, 1998 Utech, F.H. 98-304
Asclepias quadrifolia Jacq., 1994 Utech, F.H. 94-843
Asclepias syriaca L., 1998 Utech, F.H. 98-68
Asclepias tuberosa L. ssp. *tuberosa*, 1998 Utech, F.H. 98-132
Asclepias viridiflora Raf., 1946 Henry, L.K. s.n.

Asteraceae
Achillea millefolium L., 1998 Utech, F.H. 98-200
Ageratina altissima (L.) King & H.E. Robins. var. *altissima*, 1997 Utech, F.H. 97-991 [*Eupatorium rugosum* Houtt.]
Ambrosia artemisiifolia L., 1997 Utech, F.H. 97-961
Ambrosia trifida L., 1996 Utech, F.H. 96-371
Anaphalis margaritacea (L.) Benth. & Hook. f., 1983 Utech, F.H. 83-535
Antennaria howellii Greene ssp. *neodioica* (Greene) Bayer, 2010 Speedy, L. and Metzgar, T. 10-083 [*Antennaria neodioica* Greene]
Antennaria neglecta Greene, 2010 Speedy, L. and Metzgar, T. 10-187
Antennaria parlinii Fern. ssp. *parlinii*, 2010 Metzgar, T. 4-MET
Antennaria plantaginifolia (L.) Richards., 1902 Shafer, J. A. s.n.
Antennaria virginica Stebbins, 1973 Duman, M.G. 73-6 **G4:S3**
Anthemis arvensis L., 1994 Utech, F.H. 94-905 Europe
Anthemis cotula L., 1998 Utech, F.H. 98-234 Europe
Arctium lappa L., 1998 Utech, F.H. 98-268 Eurasia
Arctium minus (Hill) Bernh., 1996 Utech, F.H. 96-368 Eurasia
Arnoglossum atriplicifolium (L.) H.E. Robins., 1995 Utech, F.H. 95-720 [*Cacalia atriplicifolia* L.]
Artemisia vulgaris L., 1997 Utech, F.H. 97-925 Eurasia
Bellis perennis L., 1994 Utech, F.H. 94-877 Europe
Bidens aristosa (Michx) Britt., 2009 Speedy, M.L. 09-1063 [*Bidens polylepsis* Blake]
Bidens bipinnata L., 1919 Rowe, A.L. s.n.
Bidens cernua L., 1992 Utech, F.H. and Utech, R.J. 92-3135
Bidens frondosa L., 1997 Utech, F.H. 97-994
Bidens trichosperma (Michx.) Britt., 1993 Utech, F.H. 93-3111 [*Bidens coronata* (L.) Britt.]
Bidens tripartita L., 1993 Utech, F.H. 93-3112 [*Bidens connata* Muhl. ex Willd.]
Bidens vulgata Greene, 1991 Utech, F.H. 91-1905
Brickellia eupatorioides (L.) Shinners var. *eupatorioides*, 1947 Mason, E. s.n. [*Kuhnia eupatorioides* L.]
Carduus nutans L., 1998 Utech, F.H. 98-17 Europe
Centaurea cyanus L., 1995 Utech, F.H. 95-162 Europe
Centaurea jacea L., 1997 Utech, F.H. 97-1015 Europe
Centaurea nigra L., 1993 Utech, F.H. 93-2754 Europe
Centaurea nigrescens Willd., 2009 Speedy, M.L., Van de Venne, P. and Van de Venne, T. 09-987 Europe
Centaurea stoebe L. ssp. *micranthos* (Gmel. ex Gugler) Hayek, 1998 Utech, F.H. 98-274 Europe [*Centaurea maculosa* auct. non Lam.]
Cichorium intybus L., 1997 Utech, F.H. 97-451 Europe
Cirsium altissimum (L.) Spreng., 2010 Speedy, L., Davis, J., Byers, D. and Davis, G. 10-651
Cirsium arvense (L.) Scop., 1997 Utech, F.H. 97-323 Eurasia
Cirsium discolor (Muhl. ex Willd.) Spreng., 1936 Demoise, C.W. s.n.

Cirsium muticum Michx., 2010 Speedy, L., Metzgar, T. and Davis, J. 10-601

Cirsium pumilum Spreng., 2009 Speedy, L. and Metzgar, T. 09-727

Cirsium vulgare (Savi) Ten., 1993 Utech, F.H. 93-3280 Eurasia

Conoclinium coelestinum (L.) DC., 1988 Utech, F.H. 88-1097 **G5:S4** [*Eupatorium coelestinum* L.]

Conyza canadensis (L.) Cronq., 1993 Utech, F.H. 93-3234

Coreopsis lanceolata L., 1995 Utech, F.H. 95-163

Coreopsis tripteris L., 1995 Utech, F.H. 95-701

Cosmos bipinnatus Cav., 1995 Utech, F.H. 95-690 Mexico

Cota tinctoria (L.) J. Gay ex Guss., 1982 Utech, F.H. and Ohara, M. 82-307 Europe [*Anthemis tinctoria* L.]

Crepis capillaris (L.) Wallr., 2010 Speedy, L. 10-426 Europe

Cyclachaena xanthifolia (Nutt.) Fresen., 1923 Jennings, O.E. s.n. [*Iva xanthifolia* Nutt.]

Doellingeria infirma (Michx.) Greene, 1923 Jennings, O.E. s.n. [*Aster infirmus* Michx.]

Doellingeria umbellata (P. Mill.) Nees var. *umbellata*, 1997 Utech, F.H. 97-1016 [*Aster umbellatus* P. Mill.]

Erechtites hieraciifolius (L.) Raf. ex DC. var. *hieraciifolius*, 1993 Utech, F.H. 93-3228

Erigeron annuus (L.) Pers., 1997 Utech, F.H. 97-439

Erigeron philadelphicus L. var. *philadelphicus*, 1997 Utech, F.H. 97-379

Erigeron pulchellus Michx. var. *pulchellus*, 2010 Speedy, L. and Metzgar, T. 10-181

Erigeron strigosus Muhl. ex Willd. var. *strigosus*, 1994 Utech, F.H. 94-706

Eupatorium altissimum L., 1995 Utech, F.H. 95-927

Eupatorium capillifolium (Lam.) Small, 2002 Isaac, B.L., Isaac, J.A., Morton, C.M. and Carter, P. 15793

Eupatorium perfoliatum L., 1998 Utech, F.H. 98-313

Eupatorium serotinum Michx., 1974 Sordahl, M. s.n.

Eupatorium sessilifolium L., 2009 Speedy, L. and Metzgar, T. 09-724

Eurybia divaricata (L.) Nesom, 1997 Utech, F.H. 97-992 [*Aster divaricatus* L.]

Eurybia macrophylla (L.) Cass., 1996 Utech, F.H. 96-383 [*Aster macrophyllus* L.]

Eurybia radula (Ait.) Nesom, 1948 Buker, W.E. s.n. **G5:S2** [*Aster radula* Ait.]

Eurybia schreberi (Nees) Nees, 1992 Utech, F.H. 92-2048 [*Aster schreberi* Nees]

Euthamia graminifolia (L.) Nutt., 1997 Utech, F.H. 97-999 [*Solidago graminifolia* (L.) Salisb.]

Eutrochium fistulosum (Barratt) E. Lamont, 1998 Utech, F.H. 98-314 [*Eupatorium fistulosum* Barratt]

Eutrochium purpureum (L.) E. Lamont var. *purpureum*, 1995 Utech, F.H. 95-818 [*Eupatorium purpureum* L.]

Galinsoga quadriradiata Ruiz & Pavon, 1998 Utech, F.H. 98-182 Central and South America

Gamochaeta purpurea (L.) Cabrera, 1903 Shafer, J.A. and Medsger, O.P. s.n. [*Gnaphalium purpureum* L.]

Gnaphalium uliginosum L., 1907 Jennings, O.E. s.n. Europe

Hasteola suaveolens (L.) Pojark., 1900 Shafer, J.A. s.n. [*Cacalia suaveolens* L.]

Helenium autumnale L., 1992 Utech, F.H. 92-3164

Helianthus annuus L., 1995 Utech, F.H. 95-719

Helianthus decapetalus L., 1992 Utech, F.H. 92-2316

Helianthus divaricatus L., 1998 Utech, F.H. 98-203

Helianthus giganteus L., 1992 Utech, F.H. 92-3044

Helianthus grosseserratus Martens, 1917 Jennings, O.E. s.n.

Helianthus hirsutus Raf., 1936 Demoise, C.W. s.n. **G5:S2**

Helianthus microcephalus Torr. & A. Gray, 1928 Jennings, O.E. and Jennings, G.K. s.n. **G5:S4**

Helianthus mollis Lam., 1896 Shafer, J.A. s.n.

Helianthus strumosus L., 1995 Utech, F.H. 95-822

Helianthus tuberosus L., 1998 Utech, F.H. 98-213

Heliopsis helianthoides (L.) Sweet var. *helianthoides*, 1993 Utech, F.H. 93-3205

Hieracium aurantiacum L., 1997 Utech, F.H. 97-384 Europe

Hieracium caespitosum Dumort., 1997 Utech, F.H. 97-382 Europe

Hieracium gronovii L., 1970 Henry, L.K. s.n.

Hieracium paniculatum L., 1997 Utech, F.H. 97-993

Hieracium scabrum Michx., 1988 Mulvihill, R.S. 123

Hieracium venosum L., 1994 Utech, F.H. 94-873

Hypochaeris radicata L., 1993 Utech, F.H. 93-1677 Eurasia

Inula helenium L., 1947 Mason, E. s.n. Europe

Krigia biflora (Walt.) Blake, 1991 Utech, F.H. 91-621

Lactuca biennis (Moench) Fern., 1997 Utech, F.H. 97-956

Lactuca canadensis L., 1993 Utech, F.H. 93-2266

Lactuca saligna L., 2009 Speedy, M.L. and Metzgar, T. 09-950 Europe

Lactuca sativa L., 1937 Demoise, C.W. s.n. Europe

Lactuca serriola L., 1992 Utech, F.H. and Utech, R.J. 92-3119 Europe

Lapsana communis L., 1994 Utech, F.H. 94-355 Europe

Leucanthemum vulgare Lam., 1997 Utech, F.H. 97-446 Europe [*Chrysanthemum leucanthemum* L.]

Matricaria discoidea DC., 1994 Utech, F.H. 94-919 North America and Northeast Asia [*Matricaria matricarioides* auct. non (Less.) Porter]

Oclemena acuminata (Michx.) Greene, 2010 Speedy, L., Bowers, M. and White, D. 10-679 [*Aster acuminatus* Michx.]

Packera aurea (L.) A. & D. Löve, 2008 Speedy, M.L. 08-380 [*Senecio aureus* L.]

Packera obovata (Muhl. ex Willd.) W.A. Weber & A. Löve, 2008 Speedy, L. 08-0241 [*Senecio obovatus* Muhl. ex Willd.]

Picris hieracioides L. ssp. *hieracioides*, 1995 Utech, F.H. 95-699 Eurasia

Prenanthes alba L., 1966 Leberman, R.C. s.n.

Prenanthes altissima L., 1992 Utech, F.H. 92-3204

Prenanthes crepidinea Michx., 2003 Isaac, B.L. and Isaac, J.A. 16094 **G4:S4**

Prenanthes trifoliolata (Cass.) Fern., 2010 Speedy, L. 10-586

Pseudognaphalium macounii (Greene) Kartesz, 2009 Speedy, M.L., Davis, J. and Byers, D. 09-889

Pseudognaphalium obtusifolium (L.) Hilliard & Burtt ssp. *obtusifolium*, 1992 Utech, F.H. 92-3302 [*Gnaphalium obtusifolium* L.]

Rudbeckia hirta L. var. *hirta*, 1993 Utech, F.H. 93-2294 [*Rudbeckia hirta* L. var. *pulcherrima* Farw.]

Rudbeckia laciniata L. var. *laciniata*, 1998 Utech, F.H. 98-166

Rudbeckia triloba L. var. *triloba*, 1998 Utech, F.H. 98-306

Senecio vulgaris L., 1994 Utech, F.H. 94-396 Eurasia

Sericocarpus asteroides (L.) B.S.P., 1941 Jennings, O.E. s.n. [*Aster paternus* Cronq.]

Silphium asteriscus L. var. *trifoliatum* (L.) J.A. Clevinger, 1995 Utech, F.H. 95-702 [*Silphium trifoliatum* L.]

Smallanthus uvedalius (L.) Mackenzie ex Small, 2004 Coxe, R. s.n. **G4G5:S3** [*Polymnia uvedalia* (L.) L.]

Solidago altissima L. ssp. *altissima*, 1980 Utech, F.H. 80-149 [*Solidago canadensis* L. var. *scabra* Torr. & A. Gray]

Solidago arguta Ait. var. *arguta*, 1981 Utech, F.H. 81-413

Solidago bicolor L., 1997 Utech, F.H. 97-1009

Solidago caesia L. var. *caesia*, 1997 Utech, F.H. 97-996

Solidago canadensis L. var. *canadensis*, 1996 Utech, F.H. 96-382

Solidago canadensis L. var. *hargeri* Fern., 1943 Little, R.W. s.n.

Solidago flexicaulis L., 1993 Utech, F.H. 93-3244

Solidago gigantea Ait., 2009 Speedy, L. 09-704

Solidago juncea Ait., 1995 Utech, F.H. 95-916

Solidago nemoralis Ait. var. *nemoralis*, 1991 Utech, F.H. 91-1663

Solidago patula Muhl. ex Willd. var. *patula*, 1995 Utech, F.H. 95-915

Solidago rugosa P. Mill. ssp. *aspera var. aspera* (Ait.) Cronq., 2009 Speedy, M.L. and Metzgar, T. 09-946

Solidago rugosa P. Mill. ssp. *rugosa var. rugosa*, 1997 Utech, F.H. 97-998

Solidago squarrosa Muhl., 1924 Bright, J. s.n.

Solidago ulmifolia Muhl. ex Willd. var. *ulmifolia*, 1991 Utech, F.H. 91-1729

Sonchus arvensis L. ssp. *uliginosus* (Bieb.) Nyman, 1992 Utech, F.H. 92-3206 Europe

Sonchus asper (L.) Hill, 1993 Utech, F.H. 93-2319 Europe

Sonchus oleraceus L., 1993 Utech, F.H. 93-3159 Europe

Symphyotrichum cordifolium (L.) Nesom, 2009 Speedy, M.L. and Metzgar, T. 09-1101 [*Aster cordifolius* L.]

Symphyotrichum laeve (L.) A.& D. Love var. *laeve*, 1960 Shaw, Phyllis A. s.n. [*Aster laevis* L. var. *laevis]*

Symphyotrichum lanceolatum (Willd.) Nesom ssp. *lanceolatum var. interior* (Wieg.) Nesom, 1900 Shafer, J.A. s.n. [*Aster lanceolatus* Willd. ssp. *interior* (Wieg.) A.G. Jones]

Symphyotrichum lanceolatum (Willd.) Nesom ssp. *lanceolatum var. lanceolatum*, 1997 Utech, F.H. 97-1005 [*Aster simplex* Willd.]

Symphyotrichum lateriflorum (L.) A. & D. Löve var. *horizontale* (Desf.) Nesom, 1936 Churchill, J.A. 163 [*Aster lateriflorus* (L.) Britt. var. *pendulus* (Ait.) Burgess]

Symphyotrichum lateriflorum (L.) A. & D. Löve var. *lateriflorum*, 1997 Utech, F.H. 97-951 [*Aster lateriflorus* (L.) Britt.]

Symphyotrichum novae-angliae (L.) Nesom, 1997 Utech, F.H. 97-948 [*Aster novae-angliae* L.]

Symphyotrichum phlogifolium (Muhl. ex Willd.) Nesom, 1924 Jennings, O.E. s.n. [*Aster patens* Ait. var. *phlogifolius* (Muhl. ex Willd.) Nees]

Symphyotrichum pilosum (Willd.) Nesom var. *pilosum*, 1993 Utech, F.H. 93-3303 [*Aster pilosus* Willd.]

Symphyotrichum pilosum (Willd.) Nesom var. *pringlei* (A. Gray) Nesom, 1937 Jennings, O.E. s.n. [*Aster pilosus* Willd. var. *demotus* Blake]

Symphyotrichum praealtum (Poir.) Nesom var. *praealtum*, 2009 Speedy, M.L. 09-988 **G5:S3** [*Aster praealtus* Poir.]

Symphyotrichum prenanthoides (Muhl. ex Willd.) Nesom, 1997 Utech, F.H. 97-949 [*Aster prenanthoides* Muhl. ex Willd.]

Symphyotrichum puniceum (L.) A. & D. Löve var. *puniceum*, 1997 Utech, F.H. 97-954 [*Aster puniceus* L.]

Symphyotrichum shortii (Lindl.) Nesom, 1994 Utech, F.H. 94-2183 [*Aster shortii* Lindl.]

Symphyotrichum undulatum (L.) Nesom, 1981 Utech, F.H. 81-463 [*Aster undulatus* L.]

Symphyotrichum urophyllum (Lindl.) Nesom, 2009 Speedy, M.L. 09-1036 [*Aster urophyllus* Lindl.]

Tanacetum parthenium (L.) Schultz-Bip., 1937 Demoise, C.W. s.n. Europe [*Chrysanthemum parthenium* (L.) Bernh.]

Tanacetum vulgare L., 1968 Leberman, R.C. s.n. Europe

Taraxacum laevigatum (Willd.) DC., 1904 Jennings, O.E. s.n. Eurasia

Taraxacum officinale G.H. Weber ex Wiggers, 1997 Utech, F.H. 97-221 Eurasia

Tragopogon dubius Scop., 1994 Utech, F.H. 94-793 Europe

Tragopogon porrifolius L., 1991 Utech, F.H. 91-686 Europe

Tripleurospermum maritimum (L.) W.D.J. Koch ssp. *inodora* (L.) Appleq., 1960 Shaw, Mrs. Charles E. s.n. Europe [*Tripleurospermum inodorum* (L.) Schultz-Bip.]

Tussilago farfara L., 1993 Utech, F.H. 93-865 Eurasia

Verbesina alternifolia (L.) Britt. ex Kearney, 1998 Utech, F.H. 98-318

Vernonia gigantea (Walt.) Trel. ex Branner & Coville, 1997 Utech, F.H. 97-1006

Vernonia noveboracensis (L.) Michx., 2010 Speedy, L., Metzgar, T. and Davis, J. 10-611

Xanthium strumarium L., 1992 Utech, F.H. 92-2763

Balsaminaceae

Impatiens capensis Meerb., 1997 Utech, F.H. 97-422

Impatiens pallida Nutt., 1998 Utech, F.H. 98-81

Berberidaceae

Berberis thunbergii DC., 2002 Isaac, B.L. and Isaac, J.A. 14441 Japan

Caulophyllum thalictroides (L.) Michx., 2008 Speedy, M.L. 08-540

Jeffersonia diphylla (L.) Pers., 2008 Speedy, M.L. 08-0027

Podophyllum peltatum L., 1997 Utech, F.H. 97-333

Betulaceae

Alnus incana (L.) Moench ssp. *rugosa* (Du Roi) Clausen, 2010 Speedy, L., Metzgar, T. and Davis, J. 10-612-1

Alnus serrulata (Ait.) Willd., 1995 Utech, F.H. 95-99

Betula alleghaniensis Britt., 2008 Speedy, M.L. 08-742

Betula lenta L., 2008 Speedy, M.L. 08-0006

Betula pendula Roth, 1994 Utech, F.H. 94-1355 Europe

Betula populifolia Marsh., 2009 Speedy, L. and Metzgar, T. 09-737

Carpinus caroliniana Walt. ssp. *virginiana* (Marsh.) Furlow, 1998 Utech, F.H. 98-89

Corylus americana Marsh., 1991 Utech, F.H. 91-1823

Corylus cornuta Marsh., 2010 Speedy, L. 10-495

Ostrya virginiana (P. Mill.) K. Koch, 2008 Speedy, L. 08-0156

Bignoniaceae

Campsis radicans (L.) Seem. ex Bureau, 1998 Utech, F.H. 98-161

Catalpa bignonioides Walt., 1994 Utech, F.H. 94-993

Catalpa speciosa Warder ex Engelm., 2004 Paxton, W. s.n.

Boraginaceae

Buglossoides arvensis (L.) I.M. Johnston, 2008 Speedy, L. 08-0098 Eurasia

Cynoglossum officinale L., 1901 Holmes, K.R. s.n. Eurasia

Cynoglossum virginianum L. var. *virginianum*, 1993 Utech, F.H. 93-1577

Echium vulgare L., 1998 Utech, F.H. 98-84 Europe

Hackelia virginiana (L.) I.M. Johnston, 1998 Utech, F.H. 98-178

Lithospermum latifolium Michx., 2010 Speedy, L. 10-279 **G4:S4**

Mertensia virginica (L.) Pers. ex Link, 1993 Utech, F.H. 93-489

Myosotis arvensis (L.) Hill, 1994 Utech, F.H. 94-711 Eurasia

Myosotis laxa Lehm., 1993 Utech, F.H. 93-1989

Myosotis scorpioides L., 1993 Utech, F.H. 93-2197 Europe

Symphytum officinale L., 1998 Utech, F.H. 98-113 Eurasia

Brassicaceae

Alliaria petiolata (Bieb.) Cavara & Grande, 1997 Utech, F.H. 97-033 Europe

Arabidopsis lyrata (L.) O'Kane & Al-Shehbaz ssp. *lyrata*, 2010 Speedy, L. 10-142 [*Arabis lyrata* L.]

Arabidopsis thaliana (L.) Heynh., 1995 Utech, F.H. 95-141 Eurasia

Arabis pycnocarpa M. Hopkins, 2010 Speedy, L. and Metzgar, T. 10-180 **G5:S1** [*Arabis hirsuta* (L.) Scop. var. *adpressipilis* (M. Hopkins) Rollins]

Armoracia rusticana P.G. Gaertn., B. Mey. & Scherb., 1936 Demoise, C.W. s.n. Eurasia

Barbarea vulgaris Ait. f., 1997 Utech, F.H. 97-380 Eurasia

Boechera canadensis Al-Shehbaz, 1998 Utech, F.H. 98-31 [*Arabis canadensis* L.]

Boechera laevigata (Muhl. ex Willd.) Al-Shehbaz, 1994 Utech, F.H. 94-211 [*Arabis laevigata* (Muhl. ex Willd.) Poir.]

Boechera shortii (Fern.) Al-Shehbaz, 1924 Bright, J. s.n. [*Arabis shortii* (Fern.) Gleason]

Brassica juncea (L.) Czern., 1998 Utech, F.H. 98-18 Eurasia

Brassica nigra (L.) W.D.J. Koch, 1997 Utech, F.H. 97-264 Eurasia

Brassica rapa L. var. *rapa*, 1994 Utech, F.H. 94-785 Europe

Camelina microcarpa Andrz. ex DC., 1994 Utech, F.H. 94-625 Eurasia

Capsella bursa-pastoris (L.) Medik., 1997 Utech, F.H. 97-266 Eurasia

Cardamine angustata O.E. Schulz, 2002 Isaac, B.L. and Isaac, J.A. 14454

Cardamine bulbosa (Schreb. ex Muhl.) B.S.P., 2008 Speedy, L. 08-0194

Cardamine concatenata (Michx.) Sw., 1993 Utech, F.H. 93-577

Cardamine diphylla (Michx.) Wood, 1994 Utech, F.H. 94-97

Cardamine douglassii Britt., 1993 Utech, F.H., Kawano, S., Ohara, S., Kudoh, H. and Shibaike, H. 93-343

Cardamine hirsuta L., 2008 Speedy, M.L. 08-0068 Europe

Cardamine impatiens L., 1994 Utech, F.H. 94-915 Europe

Cardamine parviflora L. var. *arenicola* (Britt.) O.E. Schulz, 1963 Henry, L.K. s.n.

Cardamine pensylvanica Muhl. ex Willd., 2008 Speedy, L. 08-0155

Cardamine rotundifolia Michx., 1984 Mulvihill, R.S. and Leberman, R.C. s.n.

Coincya monensis (L.) Greuter & Burdet ssp. *recurvata* (All.) Leadley, 1996 Cusick, A.W. and Shelton, C. 33099 Europe

Descurainia sophia (L.) Webb ex Prantl, 1994 Utech, F.H. 94-1052 Eurasia

Diplotaxis tenuifolia (L.) DC., 1994 Utech, F.H. 94-749 Europe

Draba verna L., 1994 Utech, F.H., Ohara, M., Takasu, H. and Kudoh, H. 94-85 Europe

Erysimum cheiranthoides L., 1993 Utech, F.H. 93-2093 Eurasia

Erysimum repandum L., 1994 Utech, F.H. 94-1021 Eurasia

Hesperis matronalis L., 1997 Utech, F.H. 97-362 Europe

Iodanthus pinnatifidus (Michx.) Steud., 2010 Speedy, L. and Bowers, M. 10-229 **G5:S1**

Lepidium campestre (L.) Ait. f., 1997 Utech, F.H. 97-271 Eurasia

Lepidium draba L., 2009 Speedy, L. 09-0176 Eurasia [*Cardaria draba* (L.) Desv.]

Lepidium virginicum L. var. *virginicum*, 1994 Utech, F.H. 94-578

Lunaria annua L., 2008 Speedy, M.L. 08-0065 Europe

Nasturtium officinale Ait. f., 1994 Utech, F.H. 94-872 Europe

Raphanus raphanistrum L., 1994 Utech, F.H. 94-1071 Mediterranean

Raphanus sativus L., 1903 Shafer, J.A. and Medsger, O.P. s.n. Mediterranean

Rorippa palustris (L.) Bess. ssp. *palustris*, 2010 Speedy, L. 10-571 [*Rorippa palustris* (L.) Besser ssp. *fernaldiana* (Butters & Abbe) Jonsell]

Rorippa sylvestris (L.) Bess., 1936 Demoise, C.W. s.n. Europe

Sinapis alba L., 1967 Duman, M.G. s.n. Mediterranean

Sinapis arvensis L., 1997 Utech, F.H. 97-227 Mediterranean

Sisymbrium altissimum L., 1994 Utech, F.H. 94-1184 Eurasia

Sisymbrium officinale (L.) Scop., 1993 Utech, F.H. 93-1564 Europe

Thlaspi arvense L., 1998 Utech, F.H. 98-27 Europe

Turritis glabra L., 1920 Jennings, O.E. s.n. [*Arabis glabra* (L.) Bernh.]

Buddlejaceae

Buddleja davidii Franch., 1995 Utech, F.H. 95-914 China

Buxaceae

Pachysandra terminalis Sieb. & Zucc., 2010 Speedy, L. 10-671 Japan

Callitrichaceae

Callitriche heterophylla Pursh ssp. *heterophylla*, 1968 Leberman, R.C. s.n.

Callitriche palustris L., 1977 Polechko, M. s.n.

Callitriche terrestris Raf., 1939 Jennings, O.E. s.n.

Calycanthaceae

Calycanthus floridus L., 1882 White, D.J., 1007-10

Campanulaceae

Campanula rapunculoides L., 1936 Demoise, C.W. s.n. Eurasia

Campanulastrum americanum (L.) Small, 1998 Utech, F.H. 98-262 [*Campanula americana* L.]

Lobelia cardinalis L., 1995 Mulvihill, R.S. and Leberman, R.C. s.n.

Lobelia inflata L., 1996 Utech, F.H. 96-358

Lobelia siphilitica L., 1997 Utech, F.H. 97-927

Lobelia spicata Lam. var. *spicata*, 1916 Jennings, O.E. and Jennings, G.K. s.n.

Triodanis perfoliata (L.) Nieuwl., 1994 Utech, F.H. 94-951

Cannabaceae

Humulus japonicus Sieb. & Zucc., 1994 Utech, F.H. 94-1937 Asia

Humulus lupulus L., 1995 Utech, F.H. 95-742 Europe

Capparaceae

Polanisia dodecandra (L.) DC. ssp. *dodecandra*, 1992 Utech, F.H. 92-2825

Caprifoliaceae

Diervilla lonicera P. Mill., 1997 Utech, F.H. 97-324

Lonicera canadensis Bartr. ex Marsh., 1933 Agostini, C.T. s.n.

Lonicera dioica L., 1914 Jennings, O.E. s.n.

Lonicera japonica Thunb., 1998 Utech, F.H. 98-23 Asia

Lonicera maackii (Rupr.) Herder, 2008 Speedy, M.L. 08-314 Asia

Lonicera morrowii A. Gray, 2008 Speedy, L. 08-0152 Japan

Lonicera tatarica L., 1997 Utech, F.H. 97-009 Eurasia

Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli, 2008 Speedy, M.L. 08-470 [*Sambucus canadensis* L.]

Sambucus racemosa L. var. *racemosa*, 2008 Speedy, L. 08-0193 [*Sambucus racemosa* L. ssp. *pubens* (Michx.) House]

Symphoricarpos albus (L.) Blake var. *laevigatus* (Fern.) Blake, 1936 Demoise, C.W. s.n.

Symphoricarpos orbiculatus Moench, 1993 Utech, F.H. 93-3110

Triosteum aurantiacum Bickn. var. *aurantiacum*, 1994 Utech, F.H. 94-1292

Triosteum aurantiacum Bickn. var. *glaucescens* Wieg., 1907 Jennings, O.E. s.n.

Triosteum aurantiacum Bickn. var. *illinoense* (Wieg.) Palmer & Steyermark, 1935 Demoise, C.W. s.n.

Triosteum perfoliatum L., 1992 Utech, F.H. 92-2149

Viburnum acerifolium L., 2008 Speedy, M.L. 08-548

Viburnum dentatum L. var. *lucidum* Ait., 2008 Speedy, M.L. 08-743 [*Viburnum recognitum* Fern.]

Viburnum dilatatum Thunb., 2008 Speedy, M.L. and Bowers, M. 08-1267 Asia

Viburnum lantanoides Michx., 2009 Speedy, M.L., Davis, J. and Byers, D. 09-882 [*Viburnum alnifolium* Marsh.]

Viburnum lentago L., 1997 Utech, F.H. 97-029

Viburnum nudum L. var. *cassinoides* (L.) Torr. & A. Gray, 1972 Leberman, R.C. s.n. [*Viburnum cassinoides* L.]

Viburnum opulus L. var. *opulus*, 1994 Utech, F.H. 94-175 Eurasia

Viburnum plicatum Thunb., 1994 Utech, F.H. and Kawano, S. 94-324 Asia

Viburnum prunifolium L., 1996 Utech, F.H. 96-16

Caryophyllaceae

Agrostemma githago L., 1979 Utech, F.H. 79-318 Europe

Arenaria serpyllifolia L. var. *serpyllifolia*, 1994 Utech, F.H. 94-842 Europe

Cerastium fontanum Baumg. ssp. *vulgare* (Hartman) Greuter & Burdet, 1997 Utech, F.H. 97-349 Eurasia [*Cerastium fontanum* Baumg. ssp. *triviale* (Link) Jalas]

Cerastium nutans Raf. var. *nutans*, 2002 Mulvihill, R.S. s.n.

Cerastium tomentosum L., 1994 Utech, F.H. 80-112 Europe

Dianthus armeria L., 1998 Utech, F.H. 98-56 Europe

Dianthus barbatus L., 1965 Farnsworth, N.R. WP-1100 Eurasia

Dianthus deltoides L., 1994 Utech, F.H. 94-880 Europe

Moehringia lateriflora (L.) Fenzl, 2010 Speedy, L. 10-331

Myosoton aquaticum (L.) Moench, 1993 Utech, F.H. 93-1856 Europe

Paronychia canadensis (L.) Wood, 1994 Utech, F.H. 94-928

Paronychia fastigiata (Raf.) Fern. var. *fastigiata*, 1992 Utech, F.H. 92-2826

Sagina procumbens L., 1993 Utech, F.H. 93-734
Saponaria officinalis L., 1998 Utech, F.H. 98-315 Europe
Silene antirrhina L., 2002 Isaac, J.A. 14486
Silene armeria L., 1995 Utech, F.H. 95-161 Europe
Silene caroliniana Walt. ssp. *pensylvanica* (Michx.) Clausen, 1942 Knauz, M. s.n.
Silene latifolia Poir., 1998 Utech, F.H. 98-198 Europe
Silene nivea (Nutt.) Muhl. ex Otth, 1897 Shafer, J.A. s.n.
Silene noctiflora L., 1993 Utech, F.H. 93-1943 Europe
Silene stellata (L.) Ait. f., 2009 Speedy, M.L. and Metzgar, T. 09-953
Silene virginica L., 1997 Utech, F.H. 97-286
Silene vulgaris (Moench) Garcke, 1997 Utech, F.H. 97-500 Europe
Spergularia media (L.) K. Presl ex Griseb., 2009 Speedy, M.L. 09-1004 Europe
Stellaria corei Shinners, 2008 Speedy, L. 08-0231
Stellaria graminea L., 1994 Utech, F.H. 94-832 Europe
Stellaria longifolia Muhl. ex Willd., 1994 Utech, F.H. 94-365
Stellaria media (L.) Vill., 1994 Utech, F.H. 94-871 Europe
Stellaria pubera Michx., 2008 Speedy, L. 08-0101

Celastraceae

Celastrus orbiculatus Thunb., 1998 Utech, F.H. 98-293 Japan and China
Celastrus scandens L., 1965 Henry, L.K. s.n.
Euonymus alatus (Thunb.) Sieb. var. *alatus*, 2008 Speedy, L. 08-0236 Japan and China
Euonymus americanus L., 1959 Henry, L.K. s.n. **G5:S3S4**
Euonymus atropurpureus Jacq. var. *atropurpureus*, 2010 Speedy, L. and Bowers, M. 10-695
Euonymus obovatus Nutt., 1968 Leberman, R.C. s.n.

Chenopodiaceae

Atriplex patula L., 1992 Utech, F.H. 92-2975 Eurasia
Bassia scoparia (L.) A.J. Scott, 1995 Utech, F.H. 95-717 Eurasia [*Kochia scoparia* (L.) Schrad.]
Chenopodium album L. var. *album*, 1983 Utech, F.H. 83-573 Europe
Chenopodium album L. var. *missouriense* (Aellen) I.J. Bassett & C.W. Crompton, 1935 Boardman, C.M. s.n. [*Chenopodium missouriense* Aellen]
Chenopodium pratericola Rydb., 1995 Utech, F.H. 95-718
Chenopodium simplex (Torr.) Raf., 2010 Speedy, L. 10-288 [*Chenopodium gigantospermum* Aellen]
Chenopodium urbicum L., 1924 Rowe, A.L. s.n. Europe
Dysphania ambrosioides (L.) Mosyakin & Clemants, 1992 Utech, F.H. 92-3266 Central America [*Chenopodium ambrosioides* L.]
Dysphania botrys (L.) Mosyakin & Clemants, 1993 Utech, F.H. 93-3254 Europe [*Chenopodium botrys* L.]
Salsola tragus L., 1919 Rowe, A.L. s.n. Eurasia

Cistaceae

Helianthemum bicknellii Fern., 1897 Shafer, J.A. s.n. **G5:S2**
Lechea intermedia Leggett ex Britt. var. *intermedia*, 1869 Wolle, J., herbarium s.n.
Lechea racemulosa Michx., 1935 Demoise, C.W. s.n.

Clusiaceae

Hypericum canadense L., 1995 Grund, S.P. 1338
Hypericum densiflorum Pursh, 2005 Isaac, J.A. 18640 **G5:S3**
Hypericum ellipticum Hook., 2008 Speedy, M.L., Isaac, J.A., Isaac, B.L. & BSPW 08-1018
Hypericum gentianoides (L.) B.S.P., 2008 Speedy, M.L. 08-844
Hypericum mutilum L., 1996 Utech, F.H. 96-409
Hypericum perforatum L., 1998 Utech, F.H. 98-190 Europe
Hypericum prolificum L., 1995 Utech, F.H. 95-917
Hypericum punctatum Lam., 1996 Utech, F.H. 96-398
Triadenum fraseri (Spach) Gleason, 2010 Speedy, L. 10-691
Triadenum virginicum (L.) Raf., 1992 Utech, F.H. 92-2971

Commelinaceae

Commelina communis L., 1998 Utech, F.H. 98-265 Asia [*Commelina communis* L. var. *ludens* (Miq.) C.B. Clarke]
Tradescantia ohiensis Raf., 2009 Speedy, L. 09-0134 **G5:S4**
Tradescantia virginiana L., 1995 Utech, F.H. 95-142

Convolvulaceae

Calystegia sepium (L.) R. Br. ssp. *americana* (Sims) Brummitt, 1995 Utech, F.H. 95-667
Calystegia sepium (L.) R. Br. ssp. *angulata* Brummitt, 1994 Utech, F.H. 94-1324
Calystegia sepium (L.) R. Br. ssp. *appalachiana* Brummitt, 1998 Utech, F.H. 98-279
Calystegia sepium (L.) R. Br. ssp. *erratica* Brummitt, 1998 Utech, F.H. 98-136
Calystegia silvatica (Kit.) Griseb. ssp. *fraterniflora* (Mackenzie & Bush) Brummitt, 1998 Utech, F.H. 98-316
Calystegia spithamaea (L.) Pursh ssp. *spithamaea*, 1997 Utech, F.H. 97-317
Convolvulus arvensis L., 1994 Utech, F.H. 94-952 Europe
Ipomoea hederacea Jacq., 1992 Utech, F.H. 92-3313
Ipomoea pandurata (L.) G.F.W. Mey., 1994 Utech, F.H. 94-1912

Cornaceae

Cornus alba L. var. *alba*, 1994 Utech, F.H. 94-293 [*Cornus sericea* L.]
Cornus alternifolia L. f., 2008 Speedy, M.L. 08-839
Cornus amomum P. Mill., 1998 Utech, F.H. 98-92
Cornus florida L., 1997 Utech, F.H. 97-048
Cornus obliqua Raf., 2008 Speedy, M.L. 08-731 [*Cornus amomum* P. Mill. ssp. *obliqua* (Raf.) J.S. Wilson]
Cornus racemosa Lam., 1997 Utech, F.H. 97-980
Nyssa sylvatica Marsh., 2002 Isaac, B.L. and Isaac, J.A. 14474

Crassulaceae

Hylotelephium telephium (L.) H. Ohba ssp. *telephium*, 1995 Utech, F.H. 95-938 Europe [*Sedum telephium* L.]
Penthorum sedoides L., 1992 Utech, F.H. 92-2314
Sedum sarmentosum Bunge, 1995 Utech, F.H. 95-154 China
Sedum ternatum Michx., 1997 Utech, F.H. 97-212

Cucurbitaceae

Citrullus lanatus (Thunb.) Matsumura & Nakai var. *lanatus*, 1935 Demoise, C.W. s.n. Tropical Africa
Cucurbita pepo L. var. *pepo*, 1923 Graham, E.H. s.n. Central America
Echinocystis lobata (Michx.) Torr. & A. Gray, 1995 Utech, F.H. 95-693
Sicyos angulatus L., 2004 Tracey, C. 2004-0028

Cuscutaceae

Cuscuta cephalanthi Engelm., 1923 Jennings, O.E. s.n. **G5:S2**
Cuscuta gronovii Willd. ex J.A. Schultes var. *gronovii*, 1995 Utech, F.H. 95-738
Cuscuta pentagona Engelm. var. *pentagona*, 1995 Grund, S.P. 1366 **G5:S2**

Cyperaceae

Bulbostylis capillaris (L.) Kunth ex C.B. Clarke ssp. *capillaris*, 1995 Utech, F.H. 95-698
Carex aestivalis M.A. Curtis ex A. Gray, 2010 Speedy, L. 10-492
Carex albicans Willd.ex Spreng. var. *albicans*, 1940 Henry, L.K. s.n. [*Carex artitecta* Mackenzie]
Carex albolutescens Schwein., 1925 Jennings, O.E. s.n.
Carex albursina Scheldon, 2010 Speedy, L. 10-398
Carex amphibola Steud., 2008 Speedy, M.L. 08-557
Carex annectens (Bickn.) Bickn., 2008 Speedy, M.L. 08-833
Carex appalachica J. Webber & P.W. Ball, 2008 Speedy, M.L. 08-558
Carex argyrantha Tuckerman, 2009 Speedy, M.L., Davis, J. and Byers, D. 09-887

Carex atlantica Bailey ssp. *atlantica*, 2004 Isaac, B.L. and Isaac, J.A. 17551

Carex baileyi Britt., 2009 Speedy, M.L. 09-994

Carex blanda Dewey, 1993 Utech, F.H. 93-1330

Carex bromoides Schkuhr ex. Wild., 2010 Speedy, L. 10-334

Carex brunnescens (Pers.) Poir. ssp. *sphaerostachya* (Tuckerman) Kalela, 1996 Wagner, J.D. and Smith, L.L. 1265

Carex bushii Mackenzie, 2008 Speedy, M.L. 08-489

Carex canescens L., 2010 Speedy, L., Davis, J., Byers, D. and Vechter, T. 10-344

Carex cephalophora Muhl. ex Willd., 2008 Speedy, M.L. 08-481

Carex communis Baily var. *communis*, 2002 Isaac, B.L. and Isaac, J.A. 14470

Carex crinita Lam. var. *crinita*, 1996 Mulvihill, R.S. and Mulvihill, B.J. s.n.

Carex cristatella Britt., 1953 Henry, L.K. and Beer, F.H. s.n.

Carex debilis Michx. var. *debilis*, 2008 Speedy, M.L. 08-741

Carex debilis Michx. var. *rudgei* Bailey, 2008 Speedy, M.L. 08-473 [*Carex debilis* Michx. ssp. *pubera* (A. Gray) A.& D. Love]

Carex digitalis Willd. var. *digitalis*, 2008 Speedy, M.L. 08-555

Carex festucacea Schkuhr ex Willd., 2009 Speedy, L. and Metzgar, T. 09-731

Carex foenea Willd., 1925 Jennings, O.E. s.n. **G5:S1**

Carex folliculata L., 1995 Grund, S.P. 1325

Carex frankii Kunth, 2008 Speedy, M.L. 08-758

Carex glaucodea Tuckerman ex Olney, 2004 Isaac, B.L. and Isaac, J.A. 17560

Carex gracilescens Steud., 1994 Utech, F.H. 94-598

Carex gracillima Schwein., 2002 Isaac, B.L., Isaac, J.A., Pearson, T. and Byers, D. 14479

Carex granularis Muhl. ex Willd., 2010 Speedy, L. 10-300

Carex grisea Wahlenb., 2009 Speedy, L. 09-0486

Carex gynandra Schwein., 2004 Isaac, B.L. and Isaac, J.A. 17556

Carex hirsutella Mackenzie, 2008 Speedy, M.L. 08-547

Carex hirtifolia Mackenzie, 2009 Speedy, L. 09-0301

Carex hystericina Muhl. ex Willd., 1923 Jennings, O.E. s.n.

Carex intumescens Rudge, 2002 Isaac, B.L. and Isaac, J.A. 14422

Carex jamesii Schwein., 2010 Speedy, L. and Bowers, M. 10-231 **G5:S4**

Carex laevivaginata (Kükenth.) Mackenzie, 2002 Isaac, B.L., Isaac, J.A., Pearson, T. and Byers, D. 14481

Carex laxiculmis Schwein. var. *laxiculmis*, 2010 Speedy, L. 10-322

Carex laxiflora Lam., 2008 Speedy, M.L. 08-539

Carex leptalea Wahlenb. ssp. *leptalea*, 2002 Isaac, B.L., Isaac, J.A., Pearson, T. and Byers, D. 14478

Carex leptonervia (Fern.) Fern., 2010 Speedy, L. 10-265

Carex lupulina Muhl. ex Willd., 1994 Utech, F.H. 94-1297

Carex lurida Wahlenb., 2002 Isaac, B.L. and Isaac, J.A. 14462

Carex molesta Mackenzie ex Bright, 1923 Jennings, O.E. s.n. **G4:S4**

Carex normalis Mackenzie, 1997 Utech, F.H. 97-411

Carex oligocarpa Schkuhr ex. Wild., 2009 Speedy, L. 09-0482

Carex pedunculata Muhl. ex Willd., 1901 Holmes, K.R. s.n.

Carex pensylvanica Lam., 2002 Bowers, M. s.n.

Carex plantaginea Lam., 1996 Wagner, J.D. and Smith, L.L. 1262

Carex platyphylla Carey, 2002 Isaac, B.L. and Isaac, J.A. 14450

Carex prasina Wahlenb., 2010 Speedy, L. 10-303

Carex projecta Mackenzie, 2008 Speedy, M.L. 08-752

Carex radiata (Wahlenb.) Small, 2008 Speedy, M.L. 08-554

Carex rosea Schkuhr ex Willd., 1997 Utech, F.H. 97-374 [*Carex convoluta* Mackenzie]

Carex scabrata Schwein., 1995 Wagner, J.D. and Smith, L.L. 930

Carex scoparia Schkuhr ex Willd. var. *scoparia*, 2004 Isaac, B.L., Isaac, J.A., Pearson, T., Byers, D. and Hess, L. 17569

Carex sparganioides Muhl. ex Willd., 1997 Utech, F.H. 97-198

Carex squarrosa L., 2009 Speedy, M.L. 09-865

Carex stipata Muhl. Ex Willd. var. *maxima* Chapman, 2008 Speedy, M.L. 08-728

Carex stipata Muhl. ex Willd. var. *stipata*, 1997 Utech, F.H. 97-257

Carex striatula Michx., 1919 Gress, E.M. s.n.

Carex stricta Lam., 1993 Utech, F.H. 93-1489

Carex swanii (Fern.) Mackenzie, 2008 Speedy, M.L. 08-480

Carex torta Boott ex Tuckerman, 2008 Speedy, L. 08-0154

Carex tribuloides Wahlenb. var. *tribuloides*, 1994 Utech, F.H. 94-1232

Carex trichocarpa Muhl. ex Wild., 2010 Speedy, L. 10-335

Carex trisperma Dewey, 1996 Smith, L.L. and Wagner, J. 67

Carex virescens Muhl. ex Willd., 1993 Utech, F.H. 93-1261

Carex vulpinoidea Michx., 2008 Speedy, M.L. 08-491

Carex willdenowii Schkuhr ex Willd., 2008 Speedy, M.L. 08-551

Carex woodii Dewey, 1996 Grund, S., McKenna, K., Jones, S., and Hill, R. 1508

Cyperus bipartitus Torr., 1992 Utech, F.H. 92-2559

Cyperus esculentus L. var. *leptostachyus* Boeckl., 1991 Utech, F.H. 91-620

Cyperus filiculmis Vahl, 1992 Utech, F.H. 92-2813

Cyperus flavescens L., 1991 Utech, F.H. 91-1576

Cyperus strigosus L., 1998 Utech, F.H. 98-295

Dulichium arundinaceum (L.) Britt. var. *arundinaceum*, 2009 Speedy, L. and Metzgar, T. 09-0500

Eleocharis acicularis (L.) Roemer & J.A. Schultes, 2008 Speedy, M.L., Isaac, J.A., Isaac, B.L. & BSPW 08-1021

Eleocharis obtusa (Willd.) J.A. Schultes, 1995 Grund, S.P. 1370

Eleocharis palustris (L.) Roemer & J.A. Schultes, 1900 Shafer, J.A. s.n. [*Eleocharis erythropoda* Steud.]

Eleocharis tenuis (Willd.) J.A. Schultes var. *tenuis*, 1994 Utech, F.H. 94-442

Eriophorum virginicum L., 1996 Smith, L.L. and Wagner, J. 69

Fimbristylis autumnalis (L.) Roemer & J.A. Schultes, 1937 Jennings, O.E. s.n.

Rhynchospora alba (L.) Vahl, 1996 Smith, L.L. and Wagner, J. 68

Schoenoplectus pungens (Vahl) Palla var. *pungens*, 1947 Henry, L.K. s.n. [*Scirpus pungens* Vahl]

Schoenoplectus purshianus (Fern.) M.T. Strong, 1990 Isaac, B.L. and Isaac, J.A. 3279 [*Scirpus purshianus* Fern.]

Schoenoplectus tabernaemontani (K.C. Gmel.) Palla, 2010 Speedy, L. 10-386 [*Scirpus validus* Vahl]

Scirpus atrocinctus Fern., 1982 Mulvihill, R.S. and Leberman, R.C. s.n.

Scirpus atrovirens Willd., 1998 Utech, F.H. 98-62

Scirpus cyperinus (L.) Kunth, 1994 Utech, F.H. 94-1879

Scirpus georgianus Harper, 2009 Speedy, L. and Metzgar, T. 09-0519

Scirpus hattorianus Makino, 1994 Utech, F.H. 94-1390

Scirpus microcarpus J. & K. Presl, 1996 Wagner, J.D. and Smith, L.L. 1290

Scirpus pendulus Muhl., 2008 Speedy, M.L. 08-830

Scirpus polyphyllus Vahl, 1990 Isaac, B.L. and Isaac, J.A. 3276

Trichophorum planifolium (Spreng.) Palla, 1929 Van Dersal, W.R. 1346 [*Scirpus verecundus* Fern.]

Dioscoreaceae

Dioscorea villosa L., 1998 Utech, F.H. 98-36 [*Dioscorea quaternata* J.F. Gmel.]

Dipsacaceae

Dipsacus fullonum L., 1998 Utech, F.H. 98-317 Europe [*Dipsacus sylvestris* Huds.]

Droseraceae

Drosera rotundifolia L. var. *rotundifolia*, 1983 Utech, F.H. 83-539

Elaeagnaceae

Elaeagnus umbellata Thunb., 2008 Speedy, L. 08-0099 Asia

Ericaceae

Epigaea repens L., 1998 Utech, F.H. 98-39
Gaultheria procumbens L., 2008 Speedy, M.L. 08-477
Gaylussacia baccata (Wangenh.) K. Koch, 1993 Utech, F.H. 93-995
Kalmia latifolia L., 2008 Speedy, M.L. 08-479
Lyonia ligustrina (L.) DC. var. *ligustrina*, 1933 McClelland, E.H. s.n.
Oxydendrum arboreum (L.) DC., 1941 Jennings, O.E. s.n. **G5:S3S4**
Rhododendron arborescens (Pursh) Torr., 1997 Leberman, R.C. and Mulvihill, R.S. s.n.
Rhododendron maximum L., 2008 Speedy, M.L. 08-474
Rhododendron periclymenoides (Michx.) Shinners, 1998 Utech, F.H. 98-35
Rhododendron prinophyllum (Small) Millais, 2010 Metzgar, T. 6-MET
Vaccinium angustifolium Ait., 2010 Speedy, L., Davis, J., Byers, D. and Vechter, T. 10-342
Vaccinium corymbosum L., 1994 Utech, F.H. 94-523
Vaccinium macrocarpon Ait., 2010 Speedy, L., Davis, J., Byers, D. and Vechter, T. 10-343
Vaccinium pallidum Ait., 2008 Speedy, M.L. 08-549
Vaccinium stamineum L., 1998 Utech, F.H. 98-42

Euphorbiaceae

Acalypha rhomboidea Raf., 1993 Utech, F.H. 93-3271
Chamaesyce maculata (L.) Small, 1994 Utech, F.H. 94-1035 [*Euphorbia maculata* L.]
Chamaesyce nutans (Lag.) Small, 1995 Grund, S.P. 1362 [*Euphorbia nutans* Lag.]
Chamaesyce vermiculata (Raf.) House, 1993 Utech, F.H. 93-2278 [*Euphorbia vermiculata* Raf.]
Euphorbia commutata Engelm. ex A. Gray, 1961 Henry, L.K. s.n.
Euphorbia corollata L., 1995 Utech, F.H. 95-697
Euphorbia cyparissias L., 1995 Utech, F.H. 95-111 Eurasia
Euphorbia dentata Michx. var. *dentata*, 1992 Utech, F.H. 92-3262
Euphorbia esula L. var. *esula*, 1994 Utech, F.H. 94-607 Eurasia
Euphorbia lathyris L., 1919 Jennings, O.E. and Rowe, A.L. s.n. Europe

Fabaceae

Amphicarpaea bracteata (L.) Fern. var. *bracteata*, 1994 Utech, F.H. 94-2226
Amphicarpaea bracteata (L.) Fern. var. *comosa* (L.) C.F. Reed, 1919 Jennings, O.E. s.n.
Apios americana Medik., 1997 Shapira, F. s.n.
Astragalus canadensis L. var. *canadensis*, 1902 Holmes, K.R. s.n. **G5:S2**
Baptisia australis (L.) R. Br. var. *australis*, 1902 Holmes, K.R. s.n. **G5:S2**
Baptisia tinctoria (L.) R. Br. ex Ait. f., 2010 Speedy, L., Metzgar, T. and Byers, D. 10-520
Cercis canadensis L. var. *canadensis*, 1993 Utech, F.H. 93-638
Chamaecrista nictitans (L.) Moench ssp. *nictitans var. nictitans*, 1901 Holmes, K. s.n. [*Cassia nictitans* L.]
Colutea arborescens L., 1993 Utech, F.H. 93-1103 Europe
Dalea leporina (Ait.) Bullock, 1993 Utech, F.H. 93-2775
Desmodium canadense (L.) DC., 1919 Jennings, O.E. and Rowe, A.L. s.n.
Desmodium canescens (L.) DC., 1992 Utech, F.H. 92-2112
Desmodium cuspidatum (Muhl. ex Willd.) DC. ex Loud. var. *cuspidatum*, 1991 Utech, F.H. 91-2048
Desmodium cuspidatum (Muhl. ex Willd.) DC. ex Loud. var. *longifolium* (Torr. & A. Gray) Schub., 1953 Henry, L.K. and Beer, F.H. s.n.
Desmodium glutinosum (Muhl. ex Willd.) Wood, 1998 Utech, F.H. 98-246
Desmodium nudiflorum (L.) DC., 2009 Speedy, M.L. and Metzgar, T. 09-967
Desmodium paniculatum (L.) DC., 1992 Utech, F.H. 92-2834
Desmodium perplexum Schub., 1998 Utech, F.H. 98-308
Desmodium rotundifolium DC., 2009 Speedy, M.L. and Metzgar, T. 09-941
Gleditsia triacanthos L., 1994 Utech, F.H. 94-1909
Glycine max (L.) Merr., 1992 Utech, F.H. 92-3269 Asia
Gymnocladus dioicus (L.) K. Koch, 1953 none s.n.
Kummerowia striata (Thunb.) Schindl., 2003 Paxton, W. s.n. Asia
Lathyrus latifolius L., 1998 Utech, F.H. 98-237 Europe
Lathyrus sylvestris L., 2004 Isaac, B.L. and Isaac, J.A. 17565 Europe
Lespedeza bicolor Turcz., 1967 Netting, J.S. s.n. Japan
Lespedeza capitata Michx., 2009 Speedy, M.L. 09-1061
Lespedeza cuneata (Dum.-Cours.) G. Don, 1993 Utech, F.H. 93-2776 Asia
Lespedeza frutescens (L.) Hornem., 1984 Utech, F.H. 84-932 [*Lespedeza intermedia* (S. Wats.) Britt.]
Lespedeza hirta (L.) Hornem. ssp. *hirta*, 1957 Henry, L.K. s.n.
Lespedeza procumbens Michx., 1992 Utech, F.H. 92-3200
Lespedeza repens (L.) W. Bart., 2009 Speedy, M.L. and Metzgar, T. 09-945
Lespedeza virginica (L.) Britt., 1919 Jennings, O.E. s.n.
Lespedeza x nuttallii Darl. (pro sp.), 1919 Bright, J. s.n.
Lotus corniculatus L., 1997 Utech, F.H. 97-268 Europe
Lupinus perennis L. ssp. *perennis var. perennis*, 1914 Patterson, B.H. s.n. **G5:S3**
Medicago lupulina L., 1997 Utech, F.H. 97-331 Eurasia
Medicago sativa L. ssp. *sativa*, 1998 Utech, F.H. 98-322 Eurasia
Melilotus officinalis (L.) Lam., 1998 Utech, F.H. 98-227 Eurasia [*Melilotus albus* Medik.]
Pueraria montana (Lour.) Merr. var. *lobata* (Willd.) Maesen & S. Almeida, 1992 Utech, F.H. 92-2477 Eastern Asia [*Pueraria lobata* (Willd.) Ohwi]
Robinia hispida L. var. *hispida*, 1997 Utech, F.H. 97-288
Robinia pseudoacacia L., 1997 Utech, F.H. 97-293
Robinia viscosa Vent. var. *viscosa*, 1997 Vincent, M.A. and Lammers, T.G. 7855
Securigera varia (L.) Lassen, 1997 Utech, F.H. 97-448 Europe [*Coronilla varia* L.]
Senna hebecarpa (Fern.) Irwin & Barneby, 2010 Speedy, L., Metzgar, T., Byers, D. and Davis, G. 10-631 [*Cassia hebecarpa* Fern.]
Senna marilandica (L.) Link, 1904 Medsger, O.P. s.n. **G5:S3** [*Cassia medsgeri* Shafer]
Strophostyles helvola (L.) Ell., 1992 Utech, F.H. 92-3254
Tephrosia virginiana (L.) Pers., 1901 Shafer, J.A. 118
Trifolium arvense L., 1900 Shafer, J.A. s.n. Eurasia and N. Africa
Trifolium aureum Pollich, 1998 Utech, F.H. 98-188 Eurasia
Trifolium campestre Schreb., 1997 Utech, F.H. 97-272 Europe
Trifolium hybridum L., 1997 Utech, F.H. 97-310 Eurasia
Trifolium incarnatum L., 1897 Holmes, K.R. s.n. Europe
Trifolium pratense L., 1997 Utech, F.H. 97-444 Europe
Trifolium repens L., 1997 Utech, F.H. 97-270 Europe
Vicia caroliniana Walt., 1941 Henry, L.K. s.n.
Vicia cracca L. ssp. *cracca*, 1936 Demoise, C.W. s.n. Eurasia
Vicia villosa Roth ssp. *varia* (Host) Corb., 1997 Utech, F.H. 97-254 Europe
Vicia villosa Roth ssp. *villosa*, 1993 Utech, F.H. 93-1782 Europe
Wisteria floribunda (Willd.) DC., 1995 Utech, F.H. 95-138 Japan
Wisteria frutescens (L.) Poir., 1994 Utech, F.H. 94-956
Wisteria sinensis (Sims) DC., 2009 Speedy, M.L. and Metzgar, T. 09-978 China

Fagaceae

Castanea dentata (Marsh.) Borkh., 1992 Utech, F.H. 92-2008
Castanea mollissima Blume, 1967 Walker, B. s.n. Asia
Castanea pumila (L.) P. Mill. var. *pumila*, 1925 Gordon, G.W. s.n.
Fagus grandifolia Ehrh., 2008 Speedy, M.L. and Lange, M. 08-1331-2
Quercus acutissima Carruthers, 2009 Speedy, M.L., Bowers, M. and Davis, J. 09-1001 Asia
Quercus alba L., 2008 Speedy, M.L. 08-763

Quercus bicolor Willd., 2008 Speedy, M.L. 08-745-2
Quercus coccinea Muenchh., 1993 Utech, F.H. 93-2238
Quercus ilicifolia Wangenh., 1985 Mulvihill, R.S. and Leberman, R.C. 1
Quercus imbricaria Michx., 2008 Speedy, M.L. 08-821
Quercus macrocarpa Michx. var. *macrocarpa*, 2009 Speedy, M.L. and Bowers, M. 09-1110-1
Quercus marilandica (L.) Muenchh., 2002 Paxton, W. s.n.
Quercus montana Willd., 2008 Speedy, M.L. 08-766 [*Quercus prinus* L.]
Quercus muehlenbergii Engelm., 2002 Paxton, W. and Paxton, G. s.n.
Quercus palustris Muenchh., 1920 Jennings, O.E. s.n.
Quercus prinoides Willd., 1925 Jennings, O.E. s.n.
Quercus rubra L., 2008 Speedy, M.L. 08-311
Quercus velutina Lam., 2008 Speedy, M.L. and Bowers, M. 08-1269-2
Quercus xhawkinsiae Sudworth, 1997 Paxton, W. s.n.
Quercus xleana Nutt. (pro sp.), 1995 Grund, S.P. 1365
Quercus xsaulii Schneid., 1926 Jennings, O.E. and Jennings, G.K. s.n.

Fumariaceae

Capnoides sempervirens (L.) Borkh., 1945 Jennings, O.E. s.n. [*Corydalis sempervirens* (L.) Pers.]
Corydalis flavula (Raf.) DC., 1994 Utech, F.H. 94-925
Dicentra canadensis (Goldie) Walp., 1993 Utech, F.H. 93-614
Dicentra cucullaria (L.) Bernh., 1993 Utech, F.H. 93-538

Gentianaceae

Bartonia virginica (L.) B.S.P., 2010 Speedy, L. 10-659
Centaurium pulchellum (Sw.) Hayek ex Hand.-Maz. et al., 2009 Speedy, M.L., WBNC, BSWP & 3RBC 09-983 Europe
Gentiana andrewsii Griseb. var. *andrewsii*, 1992 Utech, F.H. 92-3178
Gentiana clausa Raf., 1992 Utech, F.H. 92-3078
Obolaria virginica L., 2010 Speedy, L. and Metzgar, T. 10-179
Sabatia angularis (L.) Pursh, 1992 Utech, F.H. 92-1937

Geraniaceae

Geranium carolinianum L. var. *carolinianum*, 1994 Utech, F.H. 94-906
Geranium columbinum L., 1994 Utech, F.H. 94-1011 Eurasia
Geranium maculatum L., 1997 Utech, F.H. 97-207
Geranium molle L., 1933 Boardman, C.M. s.n. Europe
Geranium pusillum L., 1993 Utech, F.H. 93-749 Europe
Geranium robertianum L. ssp. *robertianum*, 1997 Utech, F.H. 97-223
Geranium sibiricum L., 1983 Utech, F.H. 83-553 Eurasia
Geranium thunbergii Sieb. & Zucc. ex Lindl. & Paxton, 1988 Utech, F.H. 88-1091 Eurasia

Grossulariaceae

Ribes americanum P. Mill., 1941 Henry, L.K. s.n.
Ribes cynosbati L., 1994 Utech, F.H. 94-707
Ribes hirtellum Michx., 1982 Leberman, R.C. and Mulvihill, R.S. s.n.
Ribes lacustre (Pers.) Poir., 1949 Grimm, W.C. s.n. **G5:S1**
Ribes rotundifolium Michx., 1993 Utech, F.H. 93-866
Ribes rubrum L., 1995 Utech, F.H. 95-116 Eurasia [*Ribes sativum* Syme]

Haloragaceae

Myriophyllum spicatum L., 1988 Utech, F.H. 88-1105 Eurasia

Hamamelidaceae

Hamamelis virginiana L., 2002 Isaac, B.L. and Isaac, J.A. 14430
Liquidambar styraciflua L., 1936 Demoise, C.W. s.n.

Hippocastanaceae

Aesculus hippocastanum L., 1994 Utech, F.H. 94-334 Eurasia

Hydrangeaceae

Deutzia scabra Thunb., 1991 Utech, F.H. 91-594 Asia
Hydrangea arborescens L., 2008 Speedy, M.L. 08-471
Philadelphus coronarius L., 1998 Utech, F.H. 98-19 Eurasia

Hydrocharitaceae

Elodea canadensis Michx., 2006 Speedy, L., Nusser, J. and Bowers, M. LS-06-601
Elodea nuttallii (Planch.) St. John, 1977 Polechko, M. s.n.
Vallisneria americana Michx., 1970 Henry, L.K. s.n.

Hydrophyllaceae

Hydrophyllum appendiculatum Michx., 1994 Utech, F.H. 94-283
Hydrophyllum canadense L., 2008 Speedy, M.L. 08-545
Hydrophyllum virginianum L. var. *virginianum*, 1997 Utech, F.H. 97-353
Phacelia purshii Buckl., 1994 Utech, F.H. 94-782

Iridaceae

Iris pseudacorus L., 1995 Utech, F.H. 95-145 Europe
Iris versicolor L., 1938 Jennings, O.E. s.n.
Sisyrinchium angustifolium P. Mill., 2002 Isaac, B.L. and Isaac, J.A. 14457
Sisyrinchium atlanticum Bickn., 1982 Utech, F.H. and Ohara, M. 82-197 **G5:S1**
Sisyrinchium montanum Greene var. *montanum*, 1982 Leberman, R.C. and Mulvihill, R.S. s.n.
Sisyrinchium mucronatum Michx., 1936 Demoise, C.W. s.n.

Juglandaceae

Carya alba (L.) Nutt. ex Ell., 2008 Speedy, M.L. and Lange, M. 08-1333-2 [*Carya tomentosa* (Lam. ex Poir.) Nutt.]
Carya cordiformis (Wangenh.) K. Koch, 1959 Henry, L.K. s.n.
Carya glabra (P. Mill.) Sweet, 2009 Speedy, M.L. and Metzgar, T. 09-1106-1
Carya laciniosa (Michx. f.) G. Don, 2004 Paxton, W. s.n. **G5:S3S4**
Carya ovalis (Wangenh.) Sarg., 1967 Henry, L.K. s.n.
Carya ovata (P. Mill.) K. Koch, 1994 Utech, F.H. 94-527
Juglans cinerea L., 2008 Speedy, L. 08-0227 **G4:S4**
Juglans nigra L., 1997 Utech, F.H. 97-196

Juncaceae

Juncus acuminatus Michx., 1993 Utech, F.H. 93-1676
Juncus articulatus L., 1990 Cusick, A.W. 29074
Juncus brevicaudatus (Engelm.) Fern., 1987 Cusick, A.W. 27006
Juncus bufonius L., 1917 Patterson, B.H. s.n.
Juncus canadensis J. Gay ex Laharpe, 1994 Utech, F.H. 94-1880
Juncus dudleyi Wieg., 2009 Speedy, L. and Metzgar, T. 09-741
Juncus effusus L. ssp. *pylaei* (Laharpe) Kartesz comb. nov. ined., 1902 Holmes, K.R. s.n.
Juncus effusus L. ssp. *solutus* (Fern. & Wieg.) Hämet-Ahti, 2002 Mulvihill, R.S. s.n.
Juncus marginatus Rostk., 1990 Isaac, B.L. and Isaac, J.A. 3282
Juncus subcaudatus (Engelm.) Coville & Blake var. *subcaudatus*, 1995 Grund, S.P. 1336
Juncus tenuis Willd., 1994 Utech, F.H. 94-1294
Juncus torreyi Coville, 2008 Speedy, M.L. 08-832 **G5:S3**
Luzula acuminata Raf. ssp. *acuminata*, 2004 Isaac, B.L. and Isaac, J.A. 17555
Luzula acuminata Raf. ssp. *carolinae* (S. Wats.) Z. Kaplan, 1959 Henry, L.K. and Beer, F.H. s.n.
Luzula echinata (Small) F.J. Herm., 1993 Utech, F.H. 93-696
Luzula multiflora (Ehrh.) Lej. ssp. *multiflora var. multiflora*, 2008 Speedy, M.L. 08-559

Lamiaceae

Agastache nepetoides (L.) Kuntze, 1995 Utech, F.H. 95-939
Agastache scrophulariifolia (Willd.) Kuntze, 1902 Holmes, K.R. s.n.
Ajuga reptans L., 1995 Utech, F.H. 95-93 Eurasia
Blephilia ciliata (L.) Benth., 1965 Ross, D.H. 132
Blephilia hirsuta (Pursh) Benth. var. *hirsuta*, 1998 Utech, F.H. 98-193
Clinopodium vulgare L., 1998 Utech, F.H. 98-297 [*Satureja vulgaris* (L.) Fritsch]
Collinsonia canadensis L., 1998 Utech, F.H. 98-229
Dracocephalum parviflorum Nutt., 1953 Wuslich, J. s.n.

Glechoma hederacea L., 1997 Utech, F.H. 97-344 Eurasia
Hedeoma pulegioides (L.) Pers., 1992 Utech, F.H. 92-2855
Lamiastrum galeobdolon (L.) Ehrend. & Polatschek, 1994 Utech, F.H. 94-305 Eurasia
Lamium amplexicaule L., 1966 Duman, M.G. 66-5 Eurasia
Lamium maculatum L., 1994 Utech, F.H. 94-1156 Eurasia
Lamium purpureum L. var. *purpureum*, 1997 Utech, F.H. 97-032 Eurasia
Leonurus cardiaca L. ssp. *cardiaca*, 1994 Utech, F.H. 94-904 Asia
Lycopus americanus Muhl. ex W. Bart., 2004 Paxton, W. s.n.
Lycopus uniflorus Michx. var. *uniflorus*, 1996 Utech, F.H. 96-396
Lycopus virginicus L., 2009 Speedy, M.L. and Metzgar, T. 09-963
Marrubium vulgare L., 1920 Williams, S.H. s.n. Eurasia
Meehania cordata (Nutt.) Britt., 1921 Rowe, A.L. s.n. **G5:S1**
Mentha arvensis L., 1998 Utech, F.H. 98-280 [*Mentha gentilis* L.]
Mentha spicata L., 1998 Utech, F.H. 98-201 Europe [*Mentha longifolia* auct. non (L.) Huds.]
Mentha x piperita L. (pro sp.), 1995 Utech, F.H. 95-700 Eurasia
Mentha x rotundifolia (L.) Huds. (pro sp.), 1992 Utech, F.H. 92-2894 Eurasia
Mentha x villosa Huds. (pro sp.), 1963 Chamberlain, S. s.n. Eurasia
Monarda clinopodia L., 1998 Utech, F.H. 98-320
Monarda didyma L., 1992 Utech, F.H. 92-1995
Monarda fistulosa L. ssp. *fistulosa var. fistulosa*, 1992 Utech, F.H. 92-2701
Monarda fistulosa L. ssp. *fistulosa var. mollis* (L.) Benth., 1900 Shafer, J.A. s.n.
Monarda media Willd., 1979 Utech, F.H. 79-346
Nepeta cataria L., 1995 Utech, F.H. 95-724 Eurasia
Physostegia virginiana (L.) Benth. ssp. *virginiana*, 1998 Utech, F.H. 98-323
Prunella vulgaris L. ssp. *lanceolata* (W. Bart.) Hultén, 1998 Utech, F.H. 98-226
Prunella vulgaris L. ssp. *vulgaris*, 1920 Williams, S.H. s.n. Europe
Pycnanthemum incanum (L.) Michx. var. *incanum*, 2009 Speedy, L. and Metzgar, T. 09-728
Pycnanthemum tenuifolium Schrad., 1941 Jennings, O.E. s.n.
Pycnanthemum verticillatum (Michx.) Pers. var. *verticillatum*, 1900 Thorpe, J. and Shafer, J.A. s.n.
Pycnanthemum virginianum (L.) T. Dur. & B.D. Jackson ex B.L. Robins. & Fern., 1969 Leberman, R.C. s.n.
Salvia lyrata L., 1978 Paxton, W.C. 1
Scutellaria incana Biehler var. *incana*, 1995 Utech, F.H. 95-773
Scutellaria lateriflora L. var. *lateriflora*, 1988 Utech, F.H. 88-1126
Scutellaria nervosa Pursh, 1993 Utech, F.H. 93-1569
Scutellaria parvula Michx., 1991 Utech, F.H. 91-1577 [*Scutellaria leonardii* Epling]
Scutellaria saxatilis Riddell, 2009 Speedy, M.L. 09-841 **G3:S1**
Stachys pilosa Nutt. var. *pilosa*, 1963 Chamberlain, S. s.n. [*Stachys palustris* L. ssp. *pilosa* (Nutt.) Epling]
Stachys tenuifolia Willd., 1993 Utech, F.H. 93-2111
Teucrium canadense L. var. *canadense*, 1998 Utech, F.H. 98-305 [*Teucrium canadense* L. var. *virginicum* (L.) Eat.]
Trichostema brachiatum L., 1992 Utech, F.H. 92-2292
Trichostema dichotomum L., 1994 Utech, F.H. 94-2011

Lauraceae

Lindera benzoin (L.) Blume, 2008 Speedy, M.L. 08-0018
Sassafras albidum (Nutt.) Nees, 1998 Utech, F.H. 98-266

Lemnaceae

Lemna minor L., 1993 Utech, F.H. 93-3143
Spirodela polyrhiza (L.) Schleid., 1977 Polechko, M. s.n.

Liliaceae

Allium canadense L. var. *canadense*, 1994 Utech, F.H. 94-1087
Allium cernuum Roth, 1998 Utech, F.H. 98-243
Allium tricoccum Ait., 1993 Utech, F.H. 93-608
Allium vineale L. ssp. *vineale*, 2002 Isaac, J.A. 14485 Europe
Asparagus officinalis L., 1994 Utech, F.H. 94-447 Europe
Chamaelirium luteum (L.) A. Gray, 2009 Speedy, L. and Metzgar, T. 09-0364
Clintonia borealis (Ait.) Raf., 2010 Speedy, L. 10-253
Clintonia umbellulata (Michx.) Morong, 2009 Speedy, M.L. and Metzgar, T. 09-971
Convallaria majalis L., 1987 Utech, F.H. 87-065 Europe
Erythronium albidum Nutt., 2008 Speedy, M.L. 08-0026 **G5:S3**
Erythronium americanum Ker-Gawl. ssp. *americanum*, 1997 Utech, F.H. 97-004
Hemerocallis fulva (L.) L., 1998 Utech, F.H. 98-94 Asia
Hemerocallis lilioasphodelus L., 1995 Utech, F.H. 95-140 Europe
Hyacinthoides non-scripta (L.) Chouard ex Rothm., 1992 Utech, F.H. 92-555 Europe [*Endymion non-scripta* (L.) Garcke]
Hypoxis hirsuta (L.) Coville, 2010 Speedy, L. and Metzgar, T. 10-177
Lilium canadense L. ssp. *editorum* (Fern.) Wherry, 2009 Speedy, L. and Metzgar, T. 09-752
Lilium philadelphicum L. var. *philadelphicum*, 1922 Bright, J. s.n.
Lilium superbum L., 1998 Utech, F.H. 98-272
Maianthemum canadense Desf., 2002 Isaac, B.L. and Isaac, J.A. 14431
Maianthemum racemosum (L.) Link ssp. *racemosum*, 1998 Utech, F.H. 98-83 [*Smilacina racemosa* (L.) Desf.]
Maianthemum stellatum (L.) Link, 2010 Speedy, L. 10-125 [*Smilacina stellata* (L.) Desf.]
Medeola virginiana L., 2002 Isaac, B.L. and Isaac, J.A. 14438
Muscari botryoides (L.) P. Mill., 1946 Demoise, C.W. s.n. Europe
Muscari comosum (L.) P. Mill., 1994 Utech, F.H. 94-303 Europe
Ornithogalum umbellatum L., 1997 Utech, F.H. 97-149 Europe
Polygonatum biflorum (Walt.) Ell. var. *commutatum* (J.A. & J.H. Schultes) Morong, 2008 Speedy, M.L. 08-733
Polygonatum pubescens (Willd.) Pursh, 2008 Speedy, L. 08-0235
Prosartes lanuginosa (Michx.) D. Don, 1997 Utech, F.H. 97-491 [*Disporum lanuginosum* (Michx.) Nichols.]
Streptopus lanceolatus (Ait.) Reveal var. *lanceolatus*, 2010 Speedy, L. 10-494 [*Streptopus roseus* Michx. var. *perspectus* Fassett]
Trillium erectum L., 2008 Speedy, L. 08-0190
Trillium flexipes Raf., 1994 Utech, F.H., Ohara, M., Takasu, H. and Kudoh, H. 94-88 **G5:S2**
Trillium grandiflorum (Michx.) Salisb., 2008 Speedy, M.L. 08-325
Trillium nivale Riddell, 2008 Speedy, M.L. 08-0021 **G4:S3**
Trillium sessile L., 1992 Utech, F.H. 92-123
Trillium undulatum Willd., 2008 Speedy, M.L. 08-321
Uvularia grandiflora Sm., 1995 Wagner, J.D. and Smith, L.L. 913
Uvularia perfoliata L., 2008 Speedy, M.L. 08-536
Uvularia sessilifolia L., 1997 Utech, F.H. 97-336
Veratrum viride Ait. var. *viride*, 2010 Speedy, L. 10-332

Limnanthaceae

Floerkea proserpinacoides Willd., 1996 Utech, F.H. 96-17

Linaceae

Linum striatum Walt., 1991 Utech, F.H. 91-622
Linum usitatissimum L., 1994 Utech, F.H. 94-500 Europe
Linum virginianum L., 1998 Utech, F.H. 98-120

Lythraceae

Cuphea viscosissima Jacq., 1992 Utech, F.H. and Utech, R.J. 92-3122
Lythrum salicaria L., 1998 Utech, F.H. 98-137 Europe

Magnoliaceae

Liriodendron tulipifera L., 2002 Isaac, B.L. and Isaac, J.A. 14428
Magnolia acuminata (L.) L., 2002 Isaac, B.L. and Isaac, J.A. 14440

Malvaceae

Abutilon theophrasti Medik., 1997 Utech, F.H. 97-929 Asia

Althaea officinalis L., 2008 Speedy, M.L. 08-848 Europe

Hibiscus syriacus L., 1995 Utech, F.H. 95-727 Asia

Hibiscus trionum L., 1991 Utech, F.H. 91-2010 Europe

Malva moschata L., 1997 Utech, F.H. 97-507 Europe

Malva neglecta Wallr., 1994 Utech, F.H. 94-964 Eurasia and N. Africa

Sida spinosa L., 1919 Jennings, O.E. s.n. Tropics

Melastromataceae

Rhexia virginica L., 1947 Mason, E. s.n.

Menispermaceae

Menispermum canadense L., 1998 Utech, F.H. 98-71

Molluginaceae

Mollugo verticillata L., 1995 Utech, F.H. 95-691

Monotropaceae

Monotropa hypopithys L., 1947 McDowell, K. s.n.

Monotropa uniflora L., 1993 Utech, F.H. 93-2214

Moraceae

Maclura pomifera (Raf.) Schneid., 1994 Utech, F.H. 94-897

Morus alba L., 1994 Utech, F.H. 94-934 Asia

Morus rubra L. var. *rubra*, 2004 Paxton, W. s.n.

Myricaceae

Comptonia peregrina (L.) Coult., 1919 Jennings, O.E., Jennings, G.K., et al. s.n.

Morella pensylvanica (Mirbel) Kartesz, 1988 Utech, F.H. 88-1109 [*Myrica pensylvanica* Mirbel]

Najadaceae

Najas flexilis (Willd.) Rostk. & Schmidt, 1977 Polechko, M. s.n.

Najas minor All., 1977 Polechko, M. s.n. Europe

Nelumbonaceae

Nelumbo lutea Willd., 1953 Henry, L.K. and Beer, F.H. s.n.

Nyctaginaceae

Mirabilis nyctaginea (Michx.) MacM., 1994 Utech, F.H. 94-900

Nymphaeaceae

Nuphar advena (Ait.) Ait. F. ssp. *advena*, 1922 Jennings, O.E. s.n. [*Nuphar lutea* (L.) Sm. ssp. *advena* (Ait.) Kartesz & Gandhi]

Nymphaea odorata Ait. ssp. *tuberosa* (Paine) Wiersma & Hellquist, 1985 Nishida, J.H. and Keplinger, R. 756

Oleaceae

Forsythia viridissima Lindl., 1988 Utech, F.H. 88-058 China

Fraxinus americana L., 1997 Utech, F.H. 97-934

Fraxinus nigra Marsh., 1958 Henry, L.K. s.n.

Fraxinus pennsylvanica Marsh., 1995 Grund, S.P. 1368

Ligustrum obtusifolium Sieb. & Zucc., 2009 Speedy, L. and Metzgar, T. 09-0361 Japan

Ligustrum ovalifolium Hassk., 1943 Jennings, O.E. s.n. Japan

Ligustrum vulgare L., 1998 Utech, F.H. 98-290 Europe

Onagraceae

Chamerion angustifolium (L.) Holub ssp. *circumvagum* (Mosquin) Hoch, 1981 Utech, F.H. 81-101

Circaea alpina L. ssp. *alpina*, 1987 Mulvihill, R.S. 47

Circaea canadensis (L.) Hill, 2008 Speedy, M.L. 08-482 [*Circaea lutetiana* auct. non L. ssp. *canadensis* (L.) Aschers. & Magnus]

Circaea x sterilis D.E. Boufford, 1957 Henry, L.K. s.n. [*Circaea intermedia* Ehrh.]

Epilobium ciliatum Raf. ssp. *ciliatum*, 1919 Jennings, O.E., Jennings, G.K. and Bright, J. s.n.

Epilobium coloratum Biehler, 1997 Utech, F.H. 97-953

Epilobium parviflorum Schreb., 2010 Speedy, L., Metzgar, T. and Davis, J. 10-604 Europe

Gaura biennis L., 1994 Utech, F.H. 94-2008

Ludwigia alternifolia L., 1998 Utech, F.H. 98-301

Ludwigia palustris (L.) Ell., 1988 Utech, F.H. 88-1104

Oenothera biennis L., 1992 Utech, F.H. 92-2562

Oenothera fruticosa L. ssp. *glauca* (Michx.) Straley, 1994 Utech, F.H. 94-1300

Oenothera nutans Atkinson & Bartlett, 1940 Henry, L.K. s.n.

Oenothera perennis L., 2008 Speedy, M.L. 08-490

Oenothera villosa Thunb. ssp. *villosa*, 1998 Utech, F.H. 98-126

Ophioglossaceae

Ophioglossum pusillum Raf., 1934 Kirk, H. B. & E. M. Gress s.n.

Orchidaceae

Corallorhiza maculata (Raf.) Raf. var. *maculata*, 1934 VanDersal, W.R. s.n.

Corallorhiza odontorhiza (Willd.) Poir., 1947 McDowell, K. s.n.

Cypripedium acaule Ait., 1998 Utech, F.H. 98-38

Cypripedium parviflorum Salisb. var. *parviflorum*, 1922 Jennings, O.E. s.n. **G5:S1** [*Cypripedium calceolus* L. var. *parviflorum* (Salisb.) Fern.]

Cypripedium parviflorum Salisb. var. *pubescens* (Willd.) Knight, 1930 Van Dersal, W.R. 1387 [*Cypripedium calceolus* L. var. *pubescens* (Willd.) Correll]

Epipactis helleborine (L.) Crantz, 1997 Utech, F.H. 97-461 Europe

Galearis spectabilis (L.) Raf., 2010 Speedy, L. and Metzgar, T. 10-185

Goodyera pubescens (Willd.) R. Br. ex Ait. f., 1997 Shriver, J.S., Shriver, A., Kotsenas, B. and Smith, C. 1020

Isotria verticillata Raf., 1998 Utech, F.H. 98-44

Liparis liliifolia (L.) L.C. Rich. ex Ker-Gawl., 1995 Milliron, G.V. s.n.

Liparis loeselii (L.) L.C. Rich., 1993 Koch, D. s.n.

Platanthera ciliaris (L.) Lindl., 1955 Henry, L.K. s.n. **G5:S2**

Platanthera clavellata (Michx.) Luer, 2010 Speedy, L. 10-587

Platanthera fissa (R. Br.) Lindl., 1996 Smith, L.L. and Wagner, J. 64 **G5:S2** [*Platanthera peramoena* (A. Gray) A. Gray]

Platanthera flava (L.) Lindl. var. *herbiola* (R. Br. ex Ait. f.) Luer, 1996 Leberman, R.C. and Mulvihill, R.S. s.n.

Platanthera grandiflora (Bigelow) Lindl., 1957 Henry, L.K. s.n.

Platanthera lacera (Michx.) G. Don, 1982 Mulvihill, R.S. s.n.

Platanthera orbiculata (Pursh) Lindl., 1982 Leberman, R.C. and Mulvihill, R.S. s.n.

Platanthera psycodes (L.) Lindl., 1925 Jennings, O.E. s.n.

Spiranthes cernua (L.) L.C. Rich., 1992 Utech, F.H. 92-3309

Spiranthes lacera (Raf.) Raf. var. *gracilis* (Bigelow) Luer, 1967 Leberman, R.C. s.n.

Spiranthes lucida (H.H. Eat.) Ames, 1970 Leberman, R.C. s.n. **G5:S3**

Spiranthes ochroleuca (Rydb.) Rydb., 1937 Jennings, O.E. s.n.

Orobanchaceae

Conopholis americana (L.) Wallr., 2002 Isaac, B.L. and Isaac, J.A. 14475

Epifagus virginiana (L.) W. Bart., 2002 Isaac, B.L. and Isaac, J.A. 14442

Orobanche uniflora L., 2010 Speedy, L. and Zabowski, S. 10-254

Oxalidaceae

Oxalis corniculata L., 1994 Utech, F.H. 94-556

Oxalis dillenii Jacq., 1994 Utech, F.H. 94-727

Oxalis grandis Small, 2010 Speedy, L. 10-280

Oxalis montana Raf., 1982 Utech, F.H. 82-192 [*Oxalis acetosella* auct. non L.]

Oxalis stricta L., 2002 Isaac, B.L. and Isaac, J.A. 14449

Oxalis violacea L., 1995 Utech, F.H. 95-136

Papaveraceae

Chelidonium majus L. var. *majus*, 1997 Utech, F.H. 97-306 Eurasia

Macleaya cordata (Willd.) R. Br., 1995 Utech, F.H. 95-703 Eastern Asia

Papaver rhoeas L., 1995 Utech, F.H. 95-160 Eurasia and N. Africa
Sanguinaria canadensis L., 1994 Utech, F.H. 94-415

Passifloraceae

Passiflora lutea L., 1993 Utech, F.H. 93-1578 **G5:S2**

Phytolaccaceae

Phytolacca americana L. var. *americana*, 1998 Utech, F.H. 98-312

Plantaginaceae

Plantago aristata Michx., 1993 Utech, F.H. 93-1518
Plantago lanceolata L., 1998 Utech, F.H. 98-130 Europe
Plantago major L., 1993 Utech, F.H. 93-1649 Europe
Plantago rugelii Dcne., 1998 Utech, F.H. 98-195
Plantago virginica L., 1946 Henry, L.K. s.n.

Platanaceae

Platanus occidentalis L., 1994 Utech, F.H. 94-647

Poaceae

Agrostis gigantea Roth, 2008 Speedy, M.L. 08-653 Europe [*Agrostis alba* auct. non L.]
Agrostis hyemalis (Walt.) B.S.P., 1994 Utech, F.H. 94-791
Agrostis perennans (Walt.) Tuckerman, 1992 Utech, F.H. 92-3072
Agrostis scabra Willd., 2010 Speedy, L., Metzgar, T. and Davis, J. 10-594
Agrostis stolonifera L., 2008 Speedy, M.L. 08-496
Andropogon gerardii Vitman, 1992 Utech, F.H. 92-3102
Andropogon glomeratus (Walt.) B.S.P. var. *glomeratus*, 2008 Speedy, M.L. 08-1307 **G5:S3** [*Andropogon virginicus* L. var. *abbreviatus* (Hack.) Fern. & Grisc.]
Andropogon virginicus L. var. *virginicus*, 1992 Utech, F.H. 92-3165
Anthoxanthum odoratum L., 1997 Utech, F.H. 97-345 Eurasia
Aristida dichotoma Michx. var. *dichotoma*, 1992 Utech, F.H. 92-2821
Aristida oligantha Michx., 1995 Utech, F.H. 95-825
Arrhenatherum elatius (L.) Beauv. ex J. & K. Presl var. *elatius*, 1997 Utech, F.H. 97-249 Europe
Avena sativa L., 1994 Utech, F.H. 94-1412 Europe
Brachyelytrum aristosum (Michx.) Beauv. ex Branner & Coville, 2004 Isaac, B.L. and Isaac, J.A. 17563
Brachyelytrum erectum (Schreb. ex Spreng.) Beauv., 2008 Speedy, M.L. 08-544
Bromus arvensis L., 1995 Utech, F.H. 95-159 Southern Europe [*Bromus japonicus* Thunb.]
Bromus ciliatus L., 1991 Utech, F.H. 91-1817
Bromus inermis Leyss., 1997 Utech, F.H. 97-495 Europe
Bromus latiglumis (Scribn. ex Shear) A.S. Hitchc., 1994 Utech, F.H. 94-1351 [*Bromus altissimus* Pursh]
Bromus pubescens Muhl. ex Willd., 1993 Utech, F.H. 93-1777
Bromus racemosus L., 1997 Utech, F.H. 97-248 Europe [*Bromus commutatus* Schrad.]
Bromus sterilis L., 1994 Utech, F.H. 94-911 Europe
Bromus tectorum L., 1994 Utech, F.H. 94-766 Europe
Calamagrostis coarctata (Torr.) Torr. ex Eat., 1928 Jennings, O.E. s.n. [*Calamagrostis cinnoides* auct. non (Muhl.) W. Bart.]
Cinna arundinacea L., 1995 Mulvihill, R.S. s.n.
Cynodon dactylon (L.) Pers., 1994 Paxton, W. s.n. Old World Tropics
Dactylis glomerata L. ssp. *glomerata*, 1998 Utech, F.H. 98-22 Europe
Danthonia compressa Austin, 2008 Speedy, M.L. 08-561
Danthonia spicata (L.) Beauv. ex Roemer & J.A. Schultes, 1994 Utech, F.H. 94-1167
Diarrhena americana Beauv., 2004 Coxe, R. s.n. **G4G5:S1**
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *acuminatum* (Torr.) Freckmann, 2008 Speedy, M.L. 08-487 [*Panicum lanuginosum* Ell., non Bosc ex Spreng.]
Dichanthelium boscii (Poir.) Gould & C.A. Clark, 2010 Speedy, L. 10-278 [*Panicum boscii* Poir.]
Dichanthelium clandestinum (L.) Gould, 1993 Utech, F.H. 93-2170 [*Panicum clandestinum* L.]
Dichanthelium commutatum (J.A. Schultes) Gould, 2002 Isaac, B.L. and Isaac, J.A. 14465 [*Panicum commutatum* J.A. Schultes]
Dichanthelium dichotomum (L.) Gould var. *dichotomum*, 2008 Speedy, M.L. 08-550 [*Panicum dichotomum* L.]
Dichanthelium latifolium (L.) Harville, 2002 Isaac, B.L. and Isaac, J.A. 14448 [*Panicum latifolium* L.]
Dichanthelium linearifolium (Scribn. ex Nash) Gould, 1993 Utech, F.H. 93-1327 [*Panicum linearifolium* Scribn. ex Nash]
Dichanthelium sphaerocarpon (Ell.) Gould var. *isophyllum* (Scribn.) Gould & C.A. Clark, 2010 Speedy, L. 10-397 **G5:SNR**
Dichanthelium sphaerocarpon (Ell.) Gould var. *sphaerocarpon*, 1922 Bright, J. s.n. [*Panicum sphaerocarpon* Ell.]
Digitaria ischaemum (Schreb. ex Schweig.) Schreb. ex Muhl., 1997 Utech, F.H. 97-960 Eurasia
Digitaria sanguinalis (L.) Scop., 1995 Utech, F.H. 95-730 Europe
Echinochloa crus-galli (L.) Beauv., 1995 Mulvihill, R.S. s.n. Eurasia
Echinochloa muricata (Beauv.) Fern. var. *muricata*, 1919 Jennings, O.E. s.n.
Eleusine indica (L.) Gaertn., 1995 Utech, F.H. 95-710 Old World Tropics
Elymus canadensis L., 1979 Utech, F.H. 79-364
Elymus hystrix L. var. *hystrix*, 1997 Utech, F.H. 97-455 [*Hystrix patula* Moench]
Elymus repens (L.) Gould, 1997 Utech, F.H. 97-505 Eurasia [*Elytrigia repens* (L.) Desv. ex Nevski]
Elymus riparius Wieg., 1998 Utech, F.H. 98-310
Elymus villosus Muhl. ex Willd., 2008 Speedy, M.L. 08-643
Elymus virginicus L. var. *virginicus*, 1994 Utech, F.H. 94-1401
Eragrostis capillaris (L.) Nees, 1995 Utech, F.H. 95-920
Eragrostis cilianensis (All.) Vign. ex Janchen, 1960 Shaw, Phyllis A. s.n. Europe
Eragrostis frankii C.A. Mey. ex Steud., 1962 Henry, L.K. s.n.
Eragrostis hypnoides (Lam.) B.S.P., 1977 Polechko, M. s.n.
Eragrostis minor Host, 1994 Utech, F.H. 94-2005 Europe
Eragrostis pectinacea (Michx.) Nees ex Steud. var. *pectinacea*, 1997 Utech, F.H. 97-958
Eragrostis spectabilis (Pursh) Steud., 1995 Utech, F.H. 95-928
Festuca arundinacea Schreb., 1994 Utech, F.H. 94-945 Europe [*Schedonorus arundinaceus* (Schreb.) Dumort.]
Festuca ovina L., 1992 Utech, F.H. 92-2802 Europe
Festuca pratensis Huds., 1997 Utech, F.H. 97-410 Europe [*Festuca elatior* L. p.p.]
Festuca subverticillata (Pers.) Alexeev, 2008 Speedy, M.L. 08-560 [*Festuca obtusa* Biehler]
Glyceria canadensis (Michx.) Trin., 2010 Speedy, L. and Bowers, M. 10-666
Glyceria melicaria (Michx.) F.T. Hubbard, 2002 Mulvihill, R.S. s.n.
Glyceria septentrionalis A.S. Hitchc., 1904 Jennings, O.E. s.n.
Glyceria striata (Lam.) A.S. Hitchc., 2008 Speedy, M.L. 08-739
Holcus lanatus L., 1998 Utech, F.H. 98-25 Europe
Hordeum jubatum L. ssp. *jubatum*, 1993 Utech, F.H. 93-2028 [*Critesion jubatum* (L.) Nevski]
Hordeum vulgare L., 1995 Utech, F.H. 95-156 Eurasia
Leersia oryzoides (L.) Sw., 1992 Utech, F.H. 92-3193
Leersia virginica Willd., 1995 Utech, F.H. 95-817
Leptochloa fusca (L.) Kunth ssp. *fascicularis* (Lam.) N. Snow, 1986 Cusick, A.W. 26094 [*Leptochloa fascicularis* (Lam.) A. Gray var. *acuminata* (Nash) Gleason]
Lolium perenne L. ssp. *multiflorum* (Lam.) Husnot, 1997 Utech, F.H. 97-453 Europe [*Lolium multiflorum* Lam.]
Lolium perenne L. ssp. *perenne*, 1997 Utech, F.H. 97-305 Europe
Microstegium vimineum (Trin.) A. Camus, 1993 Utech, F.H. 93-3130 Tropical Asia

Muhlenbergia frondosa (Poir.) Fern., 1992 Utech, F.H. 92-730

Muhlenbergia schreberi J.F. Gmel., 1995 Utech, F.H. 95-924

Muhlenbergia sylvatica (Torr.) Torr. ex A. Gray, 2010 Speedy, L., Metzgar, T. and Davis, J. 10-616

Muhlenbergia tenuiflora (Wild.) B.S.P., 2010 Speedy, L., Metzgar, T. and Davis, J. 10-593

Panicum capillare L., 1992 Utech, F.H. and Utech, R.J. 92-3112

Panicum dichotomiflorum Michx. var. *dichotomiflorum*, 1997 Utech, F.H. 97-959

Panicum gattingeri Nash, 1994 Utech, F.H. 94-2227

Panicum miliaceum L. ssp. *miliaceum*, 1983 Utech, F.H. 83-575 Eurasia

Panicum philadelphicum Bernh. ex Trin., 1936 De Moise, C.U. s.n.

Panicum rigidulum Bosc ex Nees var. *elongatum* (Pursh) Lelong, 1900 Shafer, J.A. s.n. [*Panicum stipitatum* Nash]

Panicum virgatum L. var. *virgatum*, 1995 Utech, F.H. 95-824

Paspalum setaceum Michx., 1964 Henry, L.K. s.n.

Phalaris arundinacea L., 1998 Utech, F.H. 98-223

Phleum pratense L., 1997 Utech, F.H. 97-506 Europe

Phragmites australis (Cav.) Trin. ex Steud. ssp. *australis*, 1995 Utech, F.H. 95-715 Eurasia

Poa alsodes A. Gray, 2008 Speedy, M.L. 08-541

Poa annua L., 2002 Mulvihill, R.S. s.n. Eurasia

Poa compressa L., 2002 Isaac, B.L. and Isaac, J.A. 14460 Europe

Poa cuspidata Nutt., 2008 Speedy, M.L. 08-0066

Poa paludigena Fern. & Wieg., 1995 Wagner, J.D. and Smith, L.L. 928 **G3:S3**

Poa palustris L., 1994 Utech, F.H. 94-729

Poa pratensis L. ssp. *pratensis*, 2008 Speedy, M.L. 08-310 Europe

Poa saltuensis Fern. & Wieg. ssp. *saltuensis*, 2009 Speedy, L. 09-0460

Poa sylvestris A. Gray, 2008 Speedy, M.L. 08-632

Poa trivialis L., 2008 Speedy, L., M. Bowers and D. White 08-0308 Europe

Puccinellia distans (Jacq.) Parl. ssp. *hauptiana* (Trin. ex Krecz.) W.E. Hughes, 1994 Utech, F.H. 94-701

Schizachyrium scoparium (Michx.) Nash var. *scoparium*, 1993 Utech, F.H. 93-3260

Secale cereale L., 1997 Utech, F.H. 97-343 Eurasia

Setaria faberi Herrm., 1996 Utech, F.H. 96-406 Eastern Asia

Setaria italica (L.) Beauv., 1907 Holmes, K.R. s.n. Eurasia

Setaria pumila (Poir) Roemer & J.A. Schultes ssp. *pumila*, 1996 Utech, F.H. 96-364 Europe [*Setaria glauca* (L.) Beauv.]

Setaria verticillata (L.) Beauv., 1981 Utech, F.H. 81-391 Eurasia

Setaria viridis (L.) Beauv. var. *viridis*, 1995 Utech, F.H. 95-737 Eurasia

Sorghastrum nutans (L.) Nash, 1994 Utech, F.H. 94-2217

Sorghum halepense (L.) Pers., 1994 Utech, F.H. 94-2208 Mediterranean

Spartina pectinata Bosc ex Link, 1900 Shafer, J.A. and Thorpe, J. s.n.

Sphenopholis intermedia (Rydb.) Rydb., 1994 Utech, F.H. 94-948 [*Sphenopholis obtusata* (Michx.) Scribn. var. *major* (Torr.) K.S. Erdman]

Sphenopholis nitida (Biehler) Scribn., 2009 Speedy, L. and Metzgar, T. 09-0338

Sphenopholis obtusata (Michx.) Scribn., 1994 Utech, F.H. 94-613

Sphenopholis pensylvanica (L.) A.S. Hitchc., 1993 Utech, F.H. 93-1142

Sporobolus vaginiflorus (Torr. ex A. Gray) Wood var. *vaginiflorus*, 1994 Utech, F.H. 94-2223

Tridens flavus (L.) A.S. Hitchc. var. *flavus*, 1994 Utech, F.H. 94-2216

Triticum aestivum L., 1995 Utech, F.H. 95-146 Eurasia

Vulpia octoflora (Walt.) Rydb. var. *tenella* (Willd.) Fern., 1903 Shafer, J.A. and Medsger, O.P. s.n.

Zea mays L. ssp. *mays*, 1992 Utech, F.H. 92-3101 Tropical America

Podostemaceae

Podostemum ceratophyllum Michx., 1898 Britton, N.L. s.n. **G5:S4**

Polemoniaceae

Phlox divaricata L. ssp. *divaricata*, 1997 Utech, F.H. 97-285

Phlox maculata L. ssp. *maculata*, 1992 Utech, F.H. 92-1958

Phlox maculata L. ssp. *pyramidalis* (Sm.) Wherry, 1957 Henry, L.K. s.n.

Phlox paniculata L., 2008 Speedy, M.L. 08-845

Phlox stolonifera Sims, 1994 Utech, F.H. and Kawano, S. 94-307

Phlox subulata L. ssp. *subulata*, 1994 Utech, F.H. 94-561

Polemonium reptans L. var. *reptans*, 1994 Utech, F.H., Ohara, M., Takasu, H. and Kudoh, H. 94-77

Polygalaceae

Polygala ambigua Nutt., 1919 Knauz, M.B. s.n. [*Polygala verticillata* L. var. *ambigua* (Nutt.) Wood]

Polygala paucifolia Willd., 2002 Isaac, B.L. and Isaac, J.A. 14463

Polygala sanguinea L., 2008 Speedy, M.L. 08-842

Polygala verticillata L. var. *verticillata*, 2008 Speedy, M.L. 08-841 [*Polygala verticillata* L. var. *isocycla* Fern.]

Polygonaceae

Fagopyrum esculentum Moench, 1935 Demoise, C.W. s.n. Asia

Fallopia cilinodis (Michx.) Holub, 1995 Utech, F.H. 95-913 [*Polygonum cilinode* Michx.]

Fallopia convolvulus (L.) A. Löve, 1988 Utech, F.H. 88-1095 Europe [*Polygonum convolvulus* L.]

Fallopia japonica (Houtt.) R. Decr., 1999 Smith, L.L. and Wagner, J. 90 Japan [*Polygonum cuspidatum* Sieb. & Zucc.]

Fallopia sachalinensis (F. Schmidt) R. Decr., 1994 Utech, F.H. 94-2015 Asia [*Polygonum sachalinense* F. Schmidt]

Fallopia scandens (L.) Holub, 1998 Utech, F.H. 98-235 [*Polygonum scandens* L.]

Persicaria amphibia (L.) S.F. Gray p.p., 2010 Speedy, L. and Speedy, J. 10-580 [*Polygonum amphibium* L.]

Persicaria arifolia (L.) Harolds., 2008 Speedy, M.L. 08-744 [*Polygonum arifolium* L.]

Persicaria hydropiper (L.) Delarbre, 1993 Utech, F.H. 93-3072 Europe [*Polygonum hydropiper* L.]

Persicaria hydropiperoides (Michx.) Small, 1992 Utech, F.H. 92-2992 [*Polygonum hydropiperoides* Michx.]

Persicaria lapathifolia (L.) S.F. Gray, 1960 Shaw, Phyllis A. s.n. Europe [*Polygonum lapathifolium* L.]

Persicaria longiseta (Bruijn) Kitagawa, 1994 Utech, F.H. 94-2218 Asia [*Polygonum caespitosum* Blume var. *longisetum* (Bruijn) A.N. Steward]

Persicaria maculosa S.F. Gray, 1998 Utech, F.H. 98-292 Europe [*Polygonum persicaria* L.]

Persicaria orientalis (L.) Spach, 1931 McClintock, N. s.n. India [*Polygonum orientale* L.]

Persicaria pensylvanica (L.) M. Gómez, 1998 Utech, F.H. 98-321 [*Polygonum pensylvanicum* L.]

Persicaria perfoliatum (L.) H. Gross, 2010 Speedy, L., McCluskey, K. and Turano, K. 10-620 Europe [*Polygonum perfoliatum* L.]

Persicaria posumbu (Buch.-Ham. ex D. Don) H. Gross, 1997 Utech, F.H. 97-436 Eastern Asia [*Polygonum caespitosum* Blume]

Persicaria punctata (Ell.) Small, 1992 Utech, F.H. 92-3291 [*Polygonum punctatum* Ell.]

Persicaria sagittata (L.) Gross., 1997 Utech, F.H. 97-955 [*Polygonum sagittatum* L.]

Persicaria virginiana (L.) Gaertn., 1998 Utech, F.H. 98-307 [*Polygonum virginianum* L.]

Polygonum aviculare L. ssp. *aviculare*, 1993 Utech, F.H. 93-2021 Europe

Polygonum erectum L., 1902 Holmes, K.R. s.n.

Rumex acetosella L., 1997 Utech, F.H. 97-347 Eurasia

Rumex altissimus Wood, 1994 Utech, F.H. 94-789

Rumex crispus L. ssp. *crispus*, 1997 Utech, F.H. 97-236 Europe

Rumex mexicanus Meisn., 1919 Williams, S.H. s.n.
Rumex obtusifolius L., 1998 Utech, F.H. 98-124 Europe
Rumex patientia L., 1936 Demoise, C.W. s.n. Europe
Rumex verticillatus L., 1993 Utech, F.H. 93-1363

Polypodiaceae

Phegopteris connectilis (Michx.) Watt, 1877 Peirron, P.E. 148

Portulacaceae

Claytonia caroliniana Michx., 2008 Speedy, M.L. 08-0016
Claytonia virginica L. var. *virginica*, 1997 Utech, F.H. 97-040
Portulaca oleracea L., 1992 Utech, F.H. 92-2899

Potamogetonaceae

Potamogeton crispus L., 1977 Polechko, M. s.n. Europe
Potamogeton diversifolius Raf., 2010 Speedy, L. and Speedy, J. 10-578
Potamogeton epihydrus Raf., 2008 Speedy, M.L. 08-747
Potamogeton foliosus Raf. ssp. *foliosus*, 1977 Polechko, M. s.n.
Potamogeton natans L., 1977 Polechko, M. s.n.
Potamogeton pusillus L. ssp. *tenuissimus* (Mert. & Koch) Haynes & C.E. Hellquist, 1977 Polechko, M. s.n.

Primulaceae

Lysimachia arvensis (L.) U. Manns & A. Anderb., 1999 Paxton, W. s.n. Europe [*Anagallis arvensis* L.]
Lysimachia ciliata L., 1997 Utech, F.H. 97-460
Lysimachia nummularia L., 1994 Utech, F.H. 94-1237 Europe
Lysimachia quadrifolia L., 1998 Utech, F.H. 98-32
Lysimachia terrestris (L.) B.S.P., 1996 Wagner, J.D. and Smith, L.L. 1289
Lysimachia vulgaris L., 2008 Speedy, M.L. and Bowers, M. 08-939 Eurasia
Trientalis borealis Raf. ssp. *borealis*, 2008 Speedy, M.L. 08-324

Pyrolaceae

Chimaphila maculata (L.) Pursh, 1988 Mulvihill, R.S. and Leberman, R.C. 50
Chimaphila umbellata (L.) W. Bart. ssp. *cisatlantica* (Blake) Hultén, 1900 Miller, W.N. s.n.
Pyrola americana Sweet, 1936 Demoise, C.W. s.n.

Ranunculaceae

Aconitum uncinatum L., 2009 Speedy, M.L. 09-1031 **G4:S2**
Actaea pachypoda Ell., 1993 Utech, F.H. 93-3081 [*Actaea alba* auct. non (L.) P. Mill.]
Actaea podocarpa DC., 2010 Speedy, L., Bowers, M. and White, D. 10-677 **G4:S3** [*Cimicifuga americana* Michx.]
Actaea racemosa L., 1998 Utech, F.H. 98-95 [*Cimicifuga racemosa* (L.) Nutt.]
Anemone quinquefolia L. var. *quinquefolia*, 1993 Utech, F.H. 93-540
Anemone virginiana L. var. *virginiana*, 1998 Utech, F.H. 98-219
Aquilegia canadensis L., 2008 Speedy, M.L. 08-495
Aquilegia vulgaris L., 1994 Utech, F.H. 94-488 Europe
Caltha palustris L. var. *palustris*, 1993 Utech, F.H. 93-596
Clematis virginiana L., 1995 Utech, F.H. 95-739
Consolida ajacis (L.) Schur, 1884 Hill, C. s.n. Europe [*Consolida ambigua* (L.) P. W. Ball & Heywood]
Coptis trifolia (L.) Salisb., 1983 Utech, F.H. 83-540
Delphinium exaltatum Ait., 1995 Koch, D. s.n. **G3:S1**
Delphinium tricorne Michx., 1994 Utech, F.H. 94-268
Helleborus viridis L., 1968 Netting, J. s.n. Europe
Hepatica nobilis Schreber var. *acuta* (Pursh) Steyermark, 2008 Speedy, M.L. 08-0017 [*Hepatica acutiloba* DC.]
Hepatica nobilis Schreber var. *obtusa* (Pursh) Steyermark, 2010 Speedy, L. and Metzgar, T. 10-176 [*Hepatica americana* (DC.) Ker-Gawl.]
Hydrastis canadensis L., 2008 Speedy, M.L. 08-634 **G4:S4**
Ranunculus abortivus L., 1996 Utech, F.H. 96-3
Ranunculus acris L. var. *acris*, 1995 Utech, F.H. 95-155 Europe
Ranunculus allegheniensis Britt., 1997 Utech, F.H. 97-031
Ranunculus ambigens S. Wats., 1903 Medsger, O.P. s.n. **G4:S3**
Ranunculus bulbosus L., 1993 Utech, F.H. 93-834 Europe
Ranunculus hispidus Michx. var. *caricetorum* (Greene) T. Duncan, 2010 Speedy, L. 10-147
Ranunculus hispidus Michx. var. *hispidus*, 2009 Speedy, L. 09-0071
Ranunculus hispidus Michx. var. *nitidus* (Chapman) T. Duncan, 1994 Utech, F.H. 94-418 [*Ranunculus septentrionalis* Poir.]
Ranunculus micranthus Nutt., 1996 Grund, S. and Smith, L.L. 1441
Ranunculus pensylvanicus L. f., 1994 Utech, F.H. 94-275
Ranunculus recurvatus Poir. var. *recurvatus*, 1997 Utech, F.H. 97-497
Ranunculus repens L., 1997 Utech, F.H. 97-360 Europe
Ranunculus sceleratus L. var. *sceleratus*, 1992 Utech, F.H. 92-842
Thalictrum coriaceum (Britt.) Small, 2010 Speedy, L. 10-298-2 **G4:S2**
Thalictrum dioicum L., 1994 Utech, F.H., Ohara, M., Takasu, H. and Kudoh, H. 94-64
Thalictrum pubescens Pursh, 1998 Utech, F.H. 98-207
Thalictrum revolutum DC., 1919 Jennings, O.E. and Rowe, A.L. s.n.
Thalictrum thalictroides (L.) Eames & Boivin, 2008 Speedy, M.L. 08-0024

Resedaceae

Reseda lutea L., 1994 Utech, F.H. 94-954 Europe

Rhamnaceae

Ceanothus americanus L., 1946 Mozingo, H.N. s.n.
Frangula alnus P. Mill., 2006 Paxton, W., Poglein. B. and Ryba, R. s.n. Europe
Rhamnus cathartica L., 1995 Utech, F.H. 95-930 Europe

Rosaceae

Agrimonia gryposepala Wallr., 1996 Utech, F.H. 96-400
Agrimonia parviflora Ait., 1998 Utech, F.H. 98-311
Agrimonia pubescens Wallr., 1993 Utech, F.H. 93-2744
Agrimonia striata Michx., 2009 Speedy, M.L. and Metzgar, T. 09-959
Amelanchier arborea (Michx. f.) Fern., 1995 Utech, F.H. 95-90
Amelanchier laevis Wieg., 2008 Speedy, M.L. 08-319
Amelanchier sanguinea (Pursh) DC. var. *sanguinea*, 1928 Bright, J. 431 **G5:S2** [*Amelanchier humilis* Wieg.]
Amelanchier spicata (Lam.) K. Koch, 2010 Speedy, L. 10-430 [*Amelanchier stolonifera* Wieg.]
Amelanchier x intermedia Spach (pro sp.), 1972 Leberman, R.C. s.n.
Aruncus dioicus (Walt.) Fern. var. *dioicus*, 1998 Utech, F.H. 98-86
Chaenomeles speciosa (Sweet) Nakai, 1997 Utech, F.H. 97-027 China
Crataegus calpodendron (Ehrh.) Medik., 1912 Jennings, O.E. s.n.
Crataegus chrysocarpa Ashe var. *chrysocarpa*, 2010 Speedy, L. and Bowers, M. 10-085 [*Crataegus coccinea* L. p.p.]
Crataegus crus-galli L., 1997 Utech, F.H. 97-355
Crataegus dissona Sarg., 1907 Jennings, O.E. s.n.
Crataegus dodgei Ashe, 1917 Jennings, O.E. s.n.
Crataegus flabellata (Spach) Kirchn., 2010 Speedy, L., Metzgar, T., Byers, D. and Davis, G. 10-627-1
Crataegus holmesiana Ashe, 1994 Utech, F.H. 94-165
Crataegus intricata Lange, 1917 Jennings, O.E. and Jennings, G.K. s.n.
Crataegus macrosperma Ashe, 2010 Speedy, L., Metzgar, T., Byers, D. and Davis, G. 10-628-1
Crataegus pedicellata Sarg., 1997 Utech, F.H. 97-016
Crataegus pruinosa (Wendl. f.) K. Koch, 1989 Utech, F.H. 89-174
Crataegus punctata Jacq., 1994 Utech, F.H. 94-368
Crataegus succulenta Schrad. ex Link, 1994 Utech, F.H. 94-502
Crataegus x disperma Ashe, 1907 Jennings, O.E. tree 86 [*Crataegus punctata* Jacq. var. *pausiaca* (Ashe) Palmer]
Cydonia oblonga P. Mill., 1954 Henry, L.K. s.n. Eurasia
Filipendula rubra (Hill) B.L. Robins., 1981 Utech, F.H. 81-059 **G4G5:S1S2**
Fragaria vesca L. ssp. *americana* (Porter) Staudt, 1919 Jennings, O.E. s.n.

Fragaria vesca L. ssp. *vesca*, 1997 Utech, F.H. 97-383 Europe
Fragaria virginiana Duchesne ssp. *virginiana*, 1995 Utech, F.H. 95-83
Geum canadense Jacq. var. *canadense*, 1998 Utech, F.H. 98-80
Geum laciniatum Murr. var. *laciniatum*, 1904 Jennings, O.E. s.n.
Geum vernum (Raf.) Torr. & A. Gray, 1997 Utech, F.H. 97-213
Geum virginianum L., 1936 Demoise, C.W. s.n.
Gillenia trifoliata (L.) Moench, 1994 Utech, F.H. 94-1126 [*Porteranthus trifoliatus* (L.) Britt.]
Malus baccata (L.) Borkh., 2008 Speedy, L. and Van de Venne, P. 08-0189 Eurasia
Malus coronaria (L.) P. Mill., 1995 Paxton, W. s.n. [*Malus glaucescens* Rehd.]
Malus pumila P. Mill., 2008 Speedy, M.L. 08-469 Eurasia
Photinia floribunda (Lindl.) Robertson & Phipps, 1972 Leberman, R.C. s.n. [*Aronia prunifolia* (Marsh.) Rehd.]
Photinia melanocarpa (Michx.) Robertson & Phipps, 1993 Utech, F.H. 93-1228 [*Aronia melanocarpa* (Michx.) Ell.]
Photinia pyrifolia (Lam.) Robertson & Phipps, 2010 Speedy, L., Davis, J., Byers, D. and Vechter, T. 10-340 [*Aronia arbutifolia* (L.) Pers.]
Physocarpus opulifolius (L.) Maxim. var. *opulifolius*, 1998 Utech, F.H. 98-309
Potentilla canadensis L. var. *canadensis*, 1992 Utech, F.H. 92-501
Potentilla norvegica L. ssp. *monspeliensis* (L.) Aschers. & Graebn., 1994 Utech, F.H. 94-1411
Potentilla recta L., 1997 Utech, F.H. 97-309 Europe
Potentilla simplex Michx., 2002 Isaac, B.L. and Isaac, J.A. 14425
Prunus alleghaniensis Porter var. *alleghaniensis*, 1923 Jennings, O.E. s.n. **G4:S2S3**
Prunus americana Marsh., 1997 Utech, F.H. 97-049
Prunus avium (L.) L., 1995 Utech, F.H. 95-126 Eurasia
Prunus domestica L. var. *domestica*, 1993 Utech, F.H. 93-196 Eurasia
Prunus mahaleb L., 1975 None 75-13 Europe
Prunus munsoniana W. Wight & Hedrick, 1991 Leberman, R.C. and Mulvihill, R.S. s.n.
Prunus pensylvanica L. f. var. *pensylvanica*, 1995 Utech, F.H. 95-87
Prunus persica (L.) Batsch, 1937 Demoise, C.W. s.n. Asia
Prunus serotina Ehrh. var. *serotina*, 2008 Speedy, M.L. 08-313
Prunus virginiana L., 1996 Utech, F.H. 96-12
Rosa canina L., 2002 Isaac, J.A. 14483 Europe
Rosa carolina L. ssp. *carolina*, 2009 Speedy, L. and Metzgar, T. 09-0329
Rosa gallica L., 1920 Jennings, O.E. s.n. Europe
Rosa multiflora Thunb. ex Murr., 1998 Utech, F.H. 98-180 Asia
Rosa palustris Marsh., 2008 Speedy, M.L. 08-727
Rosa rubiginosa L., 1941 Jennings, O.E. s.n. Europe [*Rosa eglanteria* L.]
Rubus allegheniensis Porter var. *allegheniensis*, 2002 Isaac, B.L. and Isaac, J.A. 14433
Rubus canadensis L., 2009 Speedy, L. and Metzgar, T. 09-0382
Rubus flagellaris Willd., 2008 Speedy, M.L. 08-379 [*Rubus enslenii* Tratt.]
Rubus hispidus L., 2009 Speedy, L. and Metzgar, T. 09-0504
Rubus idaeus L. ssp. *strigosus* (Michx.) Focke, 1936 Demoise, C.W. s.n. [*Rubus strigosus* Michx.]
Rubus illecebrosus Focke, 1964 Buker, W.E. s.n. Japan
Rubus laciniatus Willd., 1994 Utech, F.H. 94-739 Europe
Rubus laudatus Berger, 1962 Henry, L.K. s.n.
Rubus occidentalis L., 1998 Utech, F.H. 98-51
Rubus odoratus L. var. *odoratus*, 1998 Utech, F.H. 98-217
Rubus pensilvanicus Poir., 1993 Utech, F.H. 93-1227
Rubus pergratus Blanch., 1919 Jennings, O.E. s.n.
Rubus phoenicolasius Maxim., 1994 Utech, F.H. 94-738 Asia
Rubus plicatifolius Blanch., 1902 Holmes, K.R. s.n.
Rubus rosa Bailey, 1907 Jennings, O.E. and Jennings, G.K. s.n.
Sorbus americana Marsh., 1929 Van Dersal, W.R. 585
Sorbus aucuparia L., 1929 Graham, E.H. s.n. Europe
Spiraea alba Du Roi var. *alba*, 2008 Speedy, M.L. 08-729
Spiraea alba Du Roi var. *latifolia* (Ait.) Dippel, 1998 Utech, F.H. 98-168
Spiraea japonica L. f. var. *fortunei* (Planch.) Rehd., 1995 Utech, F.H. 95-752 Japan
Spiraea prunifolia Sieb. & Zucc., 1994 Utech, F.H. 94-242 Asia
Spiraea tomentosa L., 1998 Utech, F.H. 98-256
Waldsteinia fragarioides (Michx.) Tratt. ssp. *fragarioides*, 1994 Utech, F.H. 94-1122

Rubiaceae

Cephalanthus occidentalis L., 2008 Speedy, M.L. 08-757
Diodia teres Walt., 1993 Utech, F.H. 93-2159
Galium aparine L., 2008 Speedy, L. 08-0230
Galium asprellum Michx., 1995 Utech, F.H. 95-775
Galium boreale L., 1923 Jennings, O.E. s.n.
Galium circaezans Michx., 1995 Utech, F.H. 95-774 [*Galium circaezans* Michx. var. *hypomalacum* Fern.]
Galium concinnum Torr. & A. Gray, 1992 Utech, F.H. 92-2704
Galium lanceolatum Torr., 2010 Speedy, L. 10-281
Galium mollugo L., 1998 Utech, F.H. 98-118 Eurasia
Galium pilosum Ait., 1936 Demoise, C.W. s.n.
Galium tinctorium (L.) Scop., 2009 Speedy, L. 09-701
Galium triflorum Michx., 1998 Utech, F.H. 98-172
Galium verum L. var. *verum*, 1987 Utech, F.H. 87-189 Eurasia
Houstonia caerulea L., 2008 Speedy, M.L. 08-553
Houstonia canadensis Willd. ex Roemer & J.A. Schultes, 1915 Patterson, B.H. s.n.
Houstonia serpyllifolia Michx., 2003 Isaac, B.L. and Isaac, J.A. 16095 **G4?:S1**
Mitchella repens L., 2002 Isaac, B.L. and Isaac, J.A. 14469

Rutaceae

Ptelea trifoliata L. ssp. *trifoliata var. trifoliata*, 1949 Bot. Soc. of Westmoreland Co. s.n. **G5:S2**

Salicaceae

Populus alba L., 1955 Diehl, A. s.n. Eurasia
Populus balsamifera L. ssp. *balsamifera*, 1926 Jennings, O.E. and Jennings, G.K. s.n. **G5:S1**
Populus deltoides Bartr. ex Marsh. ssp. *deltoides*, 2009 Speedy, L. and Metzgar, T. 09-729
Populus grandidentata Michx., 1994 Utech, F.H. 94-254
Populus tremuloides Michx., 1991 Utech, F.H. 91-707
Populus x jackii Sarg., 1995 Grund, S.P. 1363
Populus x smithii Boivin, 1926 Jennings, O.E. s.n.
Salix babylonica L., 1993 Utech, F.H. 93-946 China
Salix bebbiana Sarg., 1947 Buker, W.E. s.n.
Salix caroliniana Michx., 1901 Holmes, K.R. s.n. **G5:S1**
Salix discolor Muhl., 1915 Bright, J. s.n.
Salix eriocephala Michx., 1994 Utech, F.H. 94-207
Salix fragilis L., 1993 Utech, F.H. 93-1043 Europe
Salix humilis Marsh. var. *humilis*, 2009 Speedy, L. and Metzgar, T. 09-0381
Salix humilis Marsh. var. *tristis* (Ait.) Griggs, 1913 Jennings, O.E. s.n.
Salix interior Rowlee, 1994 Utech, F.H. 94-123
Salix lucida Muhl., 1994 Utech, F.H. 94-292
Salix nigra Marsh., 2010 Speedy, L. 10-392
Salix petiolaris Sm., 1989 Utech, F.H. 89-170 **G5:S4** [*Salix x subsericea* (Anderss.) Schneid.]
Salix purpurea L., 1936 Demoise, C.W. s.n. Europe
Salix sericea Marsh., 1985 Nishida, J.H., Lua, K. and Lange, L. 755

Santalaceae

Comandra umbellata (L.) Nutt. ssp. *umbellata*, 1937 Churchill, J.A. 176
Pyrularia pubera Michx., 2008 Speedy, M.L. 08-478 **G5:S3**

Saxifragaceae

Chrysosplenium americanum Schwein. ex Hook., 2005 Isaac, B.L., Isaac, J.A. and Paxton, W. 18636
Heuchera americana L. var. *americana*, 1997 Utech, F.H. 97-315
Micranthes micranthidifolia (Haw.) Small, 2008 Isaac, B.L. and Isaac, J.A. 19542 **G5:S4** [*Saxifraga micranthidifolia* (Haw.) Steud.]
Micranthes pensylvanica (L.) Haw., 1987 Utech, F.H. 87-186 [*Saxifraga pensylvanica* L.]
Micranthes virginiensis (Michx.) Small, 1997 Utech, F.H. 97-023 [*Saxifraga virginiensis* Michx.]
Mitella diphylla L., 2008 Speedy, L. 08-0197
Tiarella cordifolia L. var. *cordifolia*, 1994 Utech, F.H. 94-487

Scrophulariaceae

Agalinis purpurea (L.) Pennell, 1900 Holmes, K.R. s.n.
Agalinis tenuifolia (Vahl) Raf. var. *tenuifolia*, 1929 Van Dersal, W.R. 467
Aureolaria flava (L.) Farw. var. *flava*, 1925 Jennings, O.E. s.n.
Aureolaria laevigata (Raf.) Raf., 1995 Utech, F.H. 95-811
Aureolaria pedicularia (L.) Raf. var. *intercedens* Pennell, 1919 Jennings, O.E., Jennings, G.K., Bright, J. and McKee, A.E. s.n.
Aureolaria virginica (L.) Pennell, 1900 Shafer, J.A. s.n.
Chaenorhinum minus (L.) Lange, 1998 Utech, F.H. 98-26 Europe
Chelone glabra L., 1995 Utech, F.H. 95-761
Collinsia verna Nutt., 2010 Speedy, L. and Bowers, M. 10-086 **G5:S4**
Digitalis purpurea L., 1993 Utech, F.H. 93-1355 Europe
Gratiola neglecta Torr., 2010 Speedy, L. 10-369
Linaria vulgaris P. Mill., 1998 Utech, F.H. 98-191 Eurasia
Lindernia dubia (L.) Pennell var. *dubia*, 1995 Grund, S.P. 1358
Melampyrum lineare Desr. var. *lineare*, 2010 Speedy, L. 10-329 [*Melampyrum lineare* Desr. var. *americanum* (Michx.) Beauverd]
Mimulus alatus Ait., 1949 Buker, W.E. s.n.
Mimulus ringens L. var. *ringens*, 1998 Utech, F.H. 98-300
Nuttallanthus canadensis (L.) D.A. Sutton, 1995 Utech, F.H. 95-157 [*Linaria canadensis* (L.) Chaz.]
Pedicularis canadensis L. ssp. *canadensis*, 1994 Utech, F.H. 94-591
Penstemon digitalis Nutt. ex Sims, 2008 Speedy, M.L. 08-494
Penstemon hirsutus (L.) Willd., 1994 Utech, F.H. 94-903
Penstemon laevigatus Ait., 1995 Utech, F.H. 95-166 **G5:S3**
Scrophularia lanceolata Pursh, 1995 Wagner, J.D. and Smith, L.L. 945
Scrophularia marilandica L., 1998 Utech, F.H. 98-205
Verbascum blattaria L., 1998 Utech, F.H. 98-121 Eurasia
Verbascum thapsus L., 1994 Utech, F.H. 94-1414 Europe
Veronica americana Schwein. ex Benth., 1994 Utech, F.H. 94-1124
Veronica arvensis L., 1997 Utech, F.H. 97-378 Eurasia
Veronica filiformis Sm., 2008 Speedy, L. 08-0195 Eurasia
Veronica hederifolia L., 1903 Holmes, K.R. s.n. Eurasia
Veronica officinalis L., 1998 Utech, F.H. 98-244
Veronica peregrina L. ssp. *peregrina*, 1889 Mellor, C.C. s.n.
Veronica persica Poir., 1993 Utech, F.H. 93-784 Eurasia
Veronica serpyllifolia L. ssp. *serpyllifolia*, 1993 Utech, F.H. 93-829 Europe
Veronicastrum virginicum (L.) Farw., 1991 Utech, F.H. 91-676

Simaroubaceae

Ailanthus altissima (P. Mill.) Swingle, 1993 Utech, F.H. 93-2313 Asia

Smilacaceae

Smilax glauca Walt., 2009 Speedy, M.L. 09-867
Smilax herbacea L., 1997 Utech, F.H. 97-490
Smilax hispida Muhl. ex Torr., 1992 Utech, F.H. 92-3171
Smilax rotundifolia L., 2008 Speedy, M.L. 08-320

Solanaceae

Datura stramonium L., 1994 Utech, F.H. 94-1999
Lycium barbarum L., 1992 Utech, F.H. 92-3260 Eurasia
Physalis heterophylla Nees var. *heterophylla*, 1982 Mulvihill, R.S. and Leberman, R.C. s.n.
Physalis longifolia Nutt. var. *subglabrata* (Mackenzie & Bush) Cronq., 1994 Utech, F.H. 94-2209 [*Physalis subglabrata* Mackenzie & Bush]
Physalis pubescens L. var. *integrifolia* (Dunal) Waterfall, 1960 Shaw s.n.
Solanum carolinense L. var. *carolinense*, 1998 Utech, F.H. 98-82
Solanum dulcamara L. var. *dulcamara*, 1998 Utech, F.H. 98-248 Eurasia
Solanum lycopersicum L. var. *lycopersicum*, 1992 Utech, F.H. 92-2764 South America [*Lycopersicon esculentum* P. Mill.]
Solanum nigrum L., 1992 Utech, F.H. 92-2780 Europe
Solanum rostratum Dunal, 1952 Wuslich, J. s.n. [*Solanum cornutum* auct. non Lam.]

Sparganiaceae

Sparganium americanum Nutt., 1995 Grund, S.P. 1367
Sparganium eurycarpum Engelm. ex A. Gray, 1904 Jennings, O.E. s.n.

Staphyleaceae

Staphylea trifolia L., 2008 Speedy, L. 08-0153

Thymelaeaceae

Dirca palustris L., 2010 Speedy, L. and Metzgar, T. 10-191

Tiliaceae

Tilia americana L. var. *americana*, 1998 Utech, F.H. 98-90
Tilia americana L. var. *heterophylla* (Vent.) Loud., 1992 Utech, F.H. 92-1953

Typhaceae

Typha angustifolia L., 1993 Utech, F.H. 93-2287 Chile
Typha latifolia L., 1998 Utech, F.H. 98-286

Ulmaceae

Celtis occidentalis L., 2010 Speedy, L. 10-568
Celtis tenuifolia Nutt., 1902 Shafer, J.A. s.n.
Ulmus americana L., 2008 Speedy, M.L. 08-0014
Ulmus rubra Muhl., 2008 Speedy, M.L. 08-0009

Urticaceae

Boehmeria cylindrica (L.) Sw., 1994 Utech, F.H. 94-1997
Laportea canadensis (L.) Weddell, 1994 Utech, F.H. 94-1924
Parietaria pensylvanica Muhl. ex Willd., 1991 Utech, F.H. 91-648
Pilea pumila (L.) A. Gray, 1996 Utech, F.H. 96-370
Urtica dioica L. ssp. *dioica*, 1994 Utech, F.H. 94-2013 Europe
Urtica dioica L. ssp. *gracilis* (Ait.) Seland., 1897 Shafer, J.A. s.n.

Valerianaceae

Valeriana pauciflora Michx., 1995 Wagner, J.D. and Smith, L.L. 915
Valerianella chenopodiifolia (Pursh) DC., 1996 Utech, F.H. 96-4
Valerianella locusta (L.) Lat., 1980 Utech, F.H. 80-100 Europe
Valerianella umbilicata (Sullivant) Wood, 2010 Speedy, L. 10-122

Verbenaceae

Phryma leptostachya L., 2010 Speedy, L., Metzgar, T. and Byers, D. 10-506
Verbena hastata L., 1998 Utech, F.H. 98-288
Verbena simplex Lehm., 1993 Utech, F.H. 93-1523
Verbena stricta Vent., 1992 Utech, F.H. 92-2406
Verbena urticifolia L., 1998 Utech, F.H. 98-282

Violaceae

Hybanthus concolor (T.F. Forst.) Spreng., 1996 Mulvihill, R.S. s.n.
Viola affinis Le Conte, 1992 Utech, F.H. 92-665
Viola arvensis Murr., 1994 Utech, F.H. 94-1182 Europe
Viola bicolor Pursh, 1994 Utech, F.H. 94-290
Viola blanda Willd. var. *blanda*, 1995 Utech, F.H. 95-88
Viola canadensis L. var. *canadensis*, 1996 Grund, S., Jones, S., and Hill, R. 1510
Viola cucullata Ait., 1995 Wagner, J.D. and Smith, L.L. 933

Viola hastata Michx., 2002 Isaac, B.L. and Isaac, J.A. 14437
Viola hirsutula Brainerd, 1956 Henry, L.K. s.n.
Viola labradorica Schrank, 2010 Speedy, L. 10-211
Viola lanceolata L. ssp. *lanceolata*, 1902 Holmes, K.R. s.n.
Viola macloskeyi Lloyd ssp. *pallens* (Banks ex DC.) M.S. Baker, 2010 Speedy, L. and Metzgar, T. 10-166 [*Viola pallens* (Banks ex Ging) Brainerd]
Viola odorata L., 1984 Capp, M.S. s.n. Europe
Viola palmata L., 2010 Speedy, L., Metzgar, T., Shapira, E., Shapira, D. and Nixon, A. 10-066 [*Viola triloba* Schwein. var. *dilata* auct. non (Ell.) Brainerd p.p.]
Viola pubescens Ait., 2008 Speedy, L. 08-0192 [*Viola pubescens* Ait. var. *scabriuscula* Schwein. ex Torr. & A. Gray]
Viola rostrata Pursh, 1994 Utech, F.H. and Kawano, S. 94-310
Viola rotundifolia Michx., 2008 Speedy, M.L. 08-323
Viola sagittata Ait. var. *ovata* (Nutt.) Torr. & A. Gray, 1984 McKinney, L.E. 1031-4
Viola sagittata Ait. var. *sagittata*, 1984 Mulvihill, R.S. s.n.
Viola sororia Willd., 1997 Utech, F.H. 97-370
Viola striata Ait., 2008 Speedy, L. 08-0196
Viola tripartita Ell., 1909 Jennings, O.E. s.n. **G5:SH**
Viola walteri House var. *appalachiensis* (Henry) McKinney ex S.P. Grund & B.L. Issac, 2010 Speedy, L., Davis, J., Metheny, K. and Byers, D. 10-040 **G4:S3S4**
Viola x bissellii House, 1956 Henry, L.K. s.n. [*Viola x conturbata* House]
Viola x eclipes H.E. Ballard, 1992 Utech, F.H. 92-666
Viola x porteriana Pollard (pro sp.), 1930 VanDersal, W.R. 1429
Viola x primulifolia L. (pro sp.), 1988 Leberman, R.C. and Mulvihill, R.S. s.n.
Viola x subsinuata Greene, 1909 Jennings, G.K. s.n.

Vitaceae

Parthenocissus quinquefolia (L.) Planch., 1993 Utech, F.H. 93-2208
Parthenocissus tricuspidata (Sieb. & Zucc.) Planch., 1994 Utech, F.H. 94-756 China and Japan
Vitis aestivalis Michx. var. *bicolor* Deam, 1997 Utech, F.H. 97-399
Vitis cinerea (Engelm.) Engelm. ex Millard var. *baileyana* (Munson) Comeaux, 1994 Utech, F.H. 94-792 **G4G5TNR:SH**
Vitis labrusca L., 1997 Utech, F.H. 97-303
Vitis riparia Michx., 1994 Isaac, J.A. 6059
Vitis vulpina L., 1994 Isaac, J.A. 6062
Vitis x novae-angliae Fern. (pro sp.), 1912 Jennings, O.E. s.n. **G4G5Q:S1**

Zygophyllaceae

Tribulus terrestris L., 1992 Utech, F.H. 92-2690 Mediterranean

GYMNOSPERMS

Cupressaceae

Chamaecyparis thyoides (L.) B.S.P., 1968 Leberman, R.C. s.n. **G4:SX**
Juniperus communis L. var. *depressa* Pursh, 1991 Utech, F.H. 91-710 **G5T5:S1**
Juniperus virginiana L. var. *virginiana*, 1988 Utech, F.H. 88-1108
Thuja occidentalis L., 1983 Utech, F.H. and Ohara, M. 83-512

Pinaceae

Larix decidua P. Mill., 2010 Speedy, L. 10-661-1 Europe
Larix laricina (Du Roi) K. Koch, 1963 Monk, P. s.n.
Picea abies (L.) Karst., 1995 Grund, S.P. 1399 Europe
Picea glauca (Moench) Voss, 1972 Henry, L.K. s.n.
Picea mariana (P. Mill.) B.S.P., 2010 Speedy, L., Davis, J., Byers, D. and Vechter, T. 10-347-1
Picea pungens Engelm., 1995 Utech, F.H. 95-139
Pinus resinosa Ait., 2010 Speedy, L., Davis, J., Metheny, K. and Byers, D. 10-037-1
Pinus rigida P. Mill., 2010 Speedy, L., Davis, J., Byers, D. and Vechter, T. 10-351-1
Pinus strobus L., 2008 Speedy, M.L. 08-1335-2
Pinus sylvestris L., 2010 Speedy, L., Davis, J., Metheny, K. and Byers, D. 10-042-1 Eurasia
Pinus virginiana P. Mill., 1916 Jennings, O.E. and Jennings, G.K. s.n.
Tsuga canadensis (L.) Carr., 2008 Speedy, M.L. 08-0011

Taxaceae

Taxus canadensis Marsh., 1963 Monk, P. s.n. **G5:S3S4**

PTERIDOPHYTES

Aspleniaceae

Asplenium bradleyi D.C. Eat., 2005 Paxton, W. and Poglein, B. s.n. **G4:S1**
Asplenium montanum Willd., 2010 Speedy, L., Vechter, T. and Westmoreland Bird & Nature Club 10-522
Asplenium platyneuron (L.) B.S.P., 1994 Utech, F.H. 94-1990
Asplenium rhizophyllum L., 2008 Speedy, M.L. 08-0001
Asplenium trichomanes L. ssp. *trichomanes*, 2008 Speedy, M.L. 08-0002

Dennstaedtiaceae

Dennstaedtia punctilobula (Michx.) T. Moore, 2002 Isaac, B.L. and Isaac, J.A. 14429
Pteridium aquilinum (L.) Kuhn var. *latiusculum* (Desv.) Underwood ex Heller, 1997 Utech, F.H. 97-982

Dryopteridaceae

Athyrium angustum (Willd.) K. Presl, 1998 Utech, F.H. 98-263 [*Athyrium filix-femina* (L.) Roth ssp. *angustum* (Willd.) Clausen, *Athyrium filix-femina* (L.) Roth var. *michauxii* (Spreng.) Farw.]
Athyrium asplenioides (Michx.) A.A. Eat., 1920 Jennings, O.E. and Jennings, G.K. s.n. [*Athyrium filix-femina* (L.) Roth ssp. *asplenioides* (Michx.) Hultén]
Cystopteris bulbifera (L.) Bernh., 2009 Speedy, L. 09-0468
Cystopteris protrusa (Weatherby) Blasdell, 2008 Speedy, M.L. 08-749
Cystopteris tenuis (Michx.) Desv., 2008 Speedy, M.L. 08-497
Deparia acrostichoides (Sw.) M. Kato, 1996 Grund, S. 1672 [*Athyrium thelypterioides* (Michx.) Desv.]
Diplazium pycnocarpon (Spreng.) Broun, 1997 Wagner, J.D. and Smith, L.L. 1770 [*Athyrium pycnocarpon* (Spreng.) Tidestrom]
Dryopteris carthusiana (Vill.) H.P. Fuchs, 2002 Isaac, B.L. and Isaac, J.A. 14423
Dryopteris cristata (L.) A. Gray, 2010 Speedy, L. and Nusser, J. 10-482
Dryopteris goldiana (Hook. ex Goldie) A. Gray, 2005 Isaac, B.L., Isaac, J.A. and Paxton, W. 18639
Dryopteris intermedia (Muhl. ex Willd.) A. Gray, 2002 Mulvihill, R.S. s.n.
Dryopteris marginalis (L.) A. Gray, 1994 Utech, F.H. 94-1995
Dryopteris x boottii (Tuckerman) Underwood (pro sp.), 1981 Leberman, R.C. s.n.
Dryopteris xtriploidea Wherry, 1995 Grund, S.P. 1006
Gymnocarpium dryopteris (L.) Newman, 2010 Speedy, L., Vechter, T. and Westmoreland Bird & Nature Club 10-524
Matteuccia struthiopteris (L.) Todaro, 2008 Speedy, M.L. 08-630
Onoclea sensibilis L., 1998 Utech, F.H. 98-289
Polystichum acrostichoides (Michx.) Schott, 2002 Isaac, B.L. and Isaac, J.A. 14453
Woodsia obtusa (Spreng.) Torr. ssp. *obtusa*, 2008 Speedy, M.L. 08-498

Equisetaceae

Equisetum arvense L., 1993 Utech, F.H. 93-246
Equisetum hyemale L. var. *affine* (Engelm.) A.A. Eat., 2010 Speedy, L. and Metzgar, T. 10-084

Isoetaceae

Isoetes engelmannii A. Braun, 2008 Speedy, M.L., Isaac, J.A., Isaac, B.L. & BSPW 08-1020

Lycopodiaceae

Dendrolycopodium dendroideum (Michx.) Haines, 1966 McMenamin, E. s.n. [*Lycopodium dendroideum* Michx.]

Dendrolycopodium hickeyi (W.H. Wagner, Beitel & Moran) Haines, 2002 Isaac, B.L. and Isaac, J.A. 14464 [*Lycopodium hickeyi* W.H. Wagner, Beitel & Moran]

Dendrolycopodium obscurum (L.) Haines, 2002 Isaac, B.L. and Isaac, J.A. 14455 [*Lycopodium obscurum* L.]

Diphasiastrum digitatum (Dill. ex A. Braun) Holub, 2002 Isaac, B.L. and Isaac, J.A. 14458 [*Lycopodium digitatum* Dill. ex A. Braun]

Diphasiastrum tristachyum (Pursh) Holub, 1995 Grund, S.P. 1335 [*Lycopodium tristachyum* Pursh]

Huperzia lucidula (Michx.) Trevisan, 1994 Utech, F.H. 94-538 [*Lycopodium lucidulum* Michx.]

Lycopodium clavatum L., 2008 Speedy, M.L. 08-823

Spinulum annotinum (L.) Haines, 1945 Mozingo, H.N. s.n. [*Lycopodium annotinum* L.]

Lygodiaceae

Lygodium palmatum (Bernh.) Sw., 1973 Little, R.W. s.n. **G4:S4**

Ophioglossaceae

Botrychium lanceolatum (Gmel.) Angstr. var. *angustisegmentum* Pease & Moore, 1937 Jennings, O.E. s.n.

Botrychium matricariifolium (A. Braun ex Dowell) A. Braun ex Koch, 1984 Leberman, R.C. and Mulvihill, R.S. s.n.

Botrypus virginianus (L.) Holub, 2008 Speedy, M.L. 08-755 [*Botrychium virginianum* (L.) Sw.]

Ophioglossum vulgatum L., 2010 Speedy, L. and Bowers, M. 10-232 **G5:S4**

Sceptridium dissectum (Spreng.) Lyon, 1993 Utech, F.H. 93-3293 [*Botrychium dissectum* Spreng.]

Osmundaceae

Osmunda regalis L. var. *spectabilis* (Willd.) A. Gray, 2009 Speedy, L. and Metzgar, T. 09-0493-2

Osmundastrum cinnamomeum (L.) K. Presl, 2008 Speedy, M.L. 08-317 [*Osmunda cinnamomea* L.]

Osmundastrum claytonianum (L.) Tagawa, 1997 Utech, F.H. 97-479 [*Osmunda claytoniana* L.]

Polypodiaceae

Polypodium appalachianum Haufler & Windham, 2009 Speedy, L. and Metzgar, T. 09-0490

Polypodium virginianum L., 2008 Speedy, M.L. 08-760

Pteridaceae

Adiantum pedatum L., 1998 Utech, F.H. 98-88

Cheilanthes lanosa (Michx.) D.C. Eat., 1949 Buker, W.E. s.n.

Pellaea atropurpurea (L.) Link, 2009 Speedy, L. and Metzgar, T. 09-0345

Thelypteridaceae

Parathelypteris noveboracensis (L.) Ching, 2002 Isaac, B.L. and Isaac, J.A. 14426 [*Thelypteris noveboracensis* (L.) Nieuwl.]

Phegopteris hexagonoptera (Michx.) Fée, 1994 Isaac, J.A. 6054

Thelypteris palustris Schott var. *pubescens* (Lawson) Fern., 2010 Speedy, L. 10-381

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We would also like to thank Dorothy E. Pearth and Frederick H. Utech, both former Curators of Botany at the Carnegie Museum of Natural History, for their contributions to the checklist of Westmoreland County. Dorothy E. Pearth obtained a Bachelor of Science degree from the University of Pittsburgh. She began her career at the Carnegie Museum of Natural History as a secretary in the 1940s under Dr. M. Graham Netting. A few years later she transferred to the Botany Section and became Assistant Curator of Botany in 1951 from which she retired in 1978 as Associate Curator of Botany Emeritus. Among her publications are *Additions to the Flowering Plants of Western Pennsylvania* (those not included in the Jennings' Flora of 1953) and *The Flora of Westmoreland County Pennsylvania*. This latter publication is a type-written document that was photocopied and forwarded to selected locations and therefore did not have a wide circulation.

Frederick H. Utech obtained a Ph.D. degree from Washington University in St. Louis, Missouri, in 1973. He started at the Carnegie Museum of Natural History as an Associate Curator in 1976 and was appointed Curator for the Section of Botany in 1988. From 1999 until his retirement in 2011, he was a Principal Research Scientist at the Hunt Institute for Botanical Documentation at Carnegie Mellon University. Among his publications is the *Checklist of the Vascular Plants of Powdermill Nature Reserve, Westmoreland County, Pennsylvania*. Dr. Utech collected extensively in Westmoreland County for 20 years; within the herbarium there are 9,298 specimens from him for this area.

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BOOK NOTICE

Nayely Martínez-Meléndez, Rubén Martínez-Camilo, Miguel Ángel Pérez-Farrera, and Jorge Martínez-Meléndez. 2011. **Las epífitas de la Reserva El Triunfo, Chiapas. Guía ilustrada de las especies más notables.** (ISBN-13: 978-607-7510-94-9, hbk.). Universidad de Ciencias y Artes de Chiapas, 1^a Avenida Sur Poniente número 1460, C.P. 29000, Tuxtla Gutiérrez, Chiapas, México. (**Orders:** www.unicach.mx). $49.95, 208 pp., Spanish language, color throughout, 6.125" × 8.5".

From the Publisher: "La Presente obra es resultado de un enorme esfuerzo de investigación botánica continua, por casi diez años, en una de las áreas naturales más importantes de México, la Reserva de la Biosfera El Triunfo. La gran diversidad floristica de Chiapas, particularmente la de la Reserva y la necesidad de tener libros ilustrados que facilitaron el reconocimiento de este gremio ecológico tan importante, fueron los argumentos principales que dieron origen a esta guía. Actualmente, diversas publicaciones han resuelto parte de esta necesidad al cubrir grupos taxonómicos específicos, por ejemplo: Las epífitas de Veracruz (Hietz y Hietz-Seifert, 1995), Guia ilustrada de la Bromeliaceae de la porción mexicana de la Península de Yucatán (Ramírez, 2004), Orquídeas de México (Hagsater, 2005), Orquídeas y bromelias del Parque Nacional Cañon del Sumidero (Miceli et. al., 2009) y las más reciente, Guía de Orquídeas de Chiapas (Beutelspacher, 2011).

"*Las epífitas de la Reserva El Triunfo, Chiapas* es un producto y una aportación más de un proyecto ambicioso como es el Inventario florístico de la Reserva de la Biosfera El Triunfo, el cual se inició desde el año 1997 por personal del Herbario Eizi Matuda de la Universidad de Ciencias y Artes de Chiapas. Esta investigación ha originado tambien productos tales como, listados florísticos, descripciones de especies nuevas, estudios poblacionales, entre otros. Esta guía que ilustra y describe 126 especies de epífitas está dirigida al público en general, a la comunidad científica, a estudiantes, turistas; y a todas las personas dedicadas al manejo de este recurso forestal no maderable. Finalmente, se espera que esta obra incentive la observación, el aprecio y la conservación tanto de las epífitas, como su hábitat, en esta majestuosa Reserva de la Biosfera El Triunfo."

From the Publisher [Translation]: "This book is the result of a huge botanical research effort continuing, for almost ten years, in one of the most important natural areas of Mexico, the Biosphere Reserve El Triunfo. The great floristic diversity of Chiapas, particularly the Reserve, and the need for picture books that facilitated the recognition of this important ecological guild, were the main arguments that led to this guide. Currently, various publications have solved part of this need for specific taxonomic groups, e.g. *Epiphytes of Veracruz* (Hietz and Hietz-Seifert, 1995), *Illustrated Guide to the Bromeliaceae of the Mexican Portion of the Yucatan Peninsula* (Ramirez, 2004), *Orchids of Mexico* (Hagsater, 2005), *Orchids and Bromeliads of the Sumidero Canyon National Park* (Miceli et. al., 2009), and the most recent, *Guide to Orchids of Chiapas* (Beutelspacher, 2011).

"*Epiphytes of El Triunfo Reserve, Chiapas* is a product and an additional contribution of an ambitious project such as "Floristic Inventory of the Biosphere Reserve El Triunfo," which was launched in 1997 by staff at Eizi Matuda Herbarium at the University of Science and Arts of Chiapas. This research has also led to products such as floristic listings, descriptions of new species, and population studies, among others. This guide illustrates and describes 126 species of epiphytes and is directed to the general public, the scientific community, students, tourists, and all persons engaged in the management of non-timber forest. Finally, it is hoped that this work encourages observation, appreciation, and conservation of both epiphytes and their habitat in this majestic Biosphere Reserve El Triunfo."

NEW PENNSYLVANIA COUNTY OCCURRENCES FOR *BELLIS PERENNIS*, *HIBISCUS MOSCHEUTOS*, *LAMIUM MACULATUM*, AND *ROBINIA HISPIDA*

Jerry G. Chmielewski
Slippery Rock University
Department of Biology
Slippery Rock, Pennsylvania 16057, U.S.A.
jerry.chmielewski@sru.edu

David Krayesky
Slippery Rock University
Department of Biology
Slippery Rock, Pennsylvania 16057, U.S.A.
david.krayesky@sru.edu

ABSTRACT

Range extensions to Butler County for *Bellis perennis* and *Hibiscus moscheutos*, Crawford County for *Lamium maculatum*, and both Butler and Crawford counties for *Robinia hispida* are reported. All populations are well established. The importance of the range extension for *Bellis perennis* rests in the fact that the species can be weedy or invasive. Use of *Hibiscus moscheutos* as a landscape accent in part contributes to its spread. However, its proclivity to set seed as well as to displace other native shoreline species is indicative of the potential for being invasive. The range extension for *Lamium maculatum* potentially represents a very recent introduction to a county that has been botanized since the early 1800s. The importance of the range extension of *Robinia hispida* rests in the fact that the species has been identified as one which invades natural areas in the United States.

RESUMEN

Se citan extensiones de área hasta el condado de Butler de *Bellis perennis* e *Hibiscus moscheutos*, condado de Crawford para *Lamium maculatum*, y condados de Butler y Crawford para *Robinia hispida*. Todas las poblaciones están bien establecidas. La importancia de la extensión del rango para *Bellis perennis* reside en el hecho de que esta especie puede ser una mala hierba o invasiva. El uso de *Hibiscus moscheutos* para realzar el paisaje contribuye en parte a su difusión. Sin embargo, su potencial para producir semillas así como para desplazar a otras especies vecinas es indicativo de su potencial para convertirse en invasiva. El rango de extensión para *Lamium maculatum* representa potencialmente una introducción muy reciente en un condado que ha sido herborizado desde principios de los 1800s. La importancia del rango de extensión de *Robinia hispida* reside en el hecho de que esta especie ha sido identificada como una de las que invaden áreas naturales en los Estados Unidos.

Bellis perennis L., the English daisy, is an invasive (Anonymous 1), low growing, perennial herb in the Asteraceae that is distributed throughout much of eastern North America and parts of western North America to Alaska (Britton & Brown 1913; Magee & Ahles 1999; USDA, NRCS 2011). The species was introduced from its native range of Europe and part of northern Africa and the far eastern regions of the Middle East (Bailey 1949; Magee & Ahles 1999; Euro+Med 2006–2011) and is now naturalized in parts of North America (Britton & Brown 1913; Fernald 1950). In Pennsylvania the species appears to be more common throughout the eastern part of the state than the western part of the state though typically considered to be sparsely scattered and only locally common wherever it occurs (Wherry et al. 1979; Rhoads & Klein 1993; Morton et al. 2007; Morton & Speedy 2008). Despite some recent evidence to the contrary (Morton & Speedy 2007, 2011) for the Pennsylvania counties of Washington and Indiana respectively, the species is probably more common than the published reports would suggest. Essentially all of the populations we have encountered occur in lawns associated with high sunlight, a habitat not routinely surveyed for botanical specimens, though not uncommon for escaped cultivars (Bailey 1949). In some cases entire lawns are infiltrated. The species is deemed weedy and/or invasive in the U.S. though technically not in any specific county (Anonymous 1; Uva et al. 1997; Whitson et al. 1996).

The species forms a low dense tufted mat and stands no more than about 15 cm in height, though typically 7–10 cm. The elliptical to obovate to orbicular leaves are basal, arranged in rosettes, hairy, and with a winged petiole. The flowering heads are solitary with yellow disk and white- to rose-colored ray flowers. The latter are numerous (Britton & Brown 1913; Fernald 1950; Gleason & Cronquist 1963; Rhoads & Block 2000). The flowering heads are nyctinastic, closing from dusk to possibly mid-morning on a daily basis. Flowers also remain closed throughout overcast days. In both of these cases the populations are rendered more inconspicuous.

Several natural populations have been observed in Butler County, Pennsylvania over the past several years, including one in the lawn next to Patterson Hall on the main campus of Slippery Rock University. Like-

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wise, several populations have been observed along Route 8 from Harrisville to Butler, including the grassy median between the sidewalk and roadway in Harrisville proper, in both of the town's cemeteries, in the lawn of the Old Stone House Museum property, a historic 1822 wayside inn owned by the Pennsylvania Historical and Museum Commission though administered by Slippery Rock University, and at residences bordering and in the vicinity of the Jennings Environmental Education Center.

Voucher specimen: **PENNSYLVANIA. Butler Co.:** Harrisville, across the street from Gun World, open, grassy median, 14 Jun 2011, *J. Chmielewski 3218* (SLRO).

Hibiscus moscheutos L., the crimsoneyed rosemallow, is an herbaceous, annual-perennial sub-shrub in the Malvaceae which is native to North America [though listed as naturalized from Europe by Magee and Ahles (1999)] and occurs from Florida to New Mexico and Utah in the south, northeastward to Massachusetts, southwestern Ontario, and Wisconsin, though not Colorado and Arkansas (Britton & Brown 1913; Fernald 1950; USDA, NRCS 2011). The species is not easily confused with others. Though treated as synonyms today, *H. palustris* L. and *H. moscheutos* were in the past separated on the basis of flower color, the pubescence of style branches or lack thereof, and the occurrence or lack of a crimson center (Britton & Brown 1913; Bailey 1949; Fernald 1950; Magee & Ahles 1999). Individuals of *H. moscheutos* are multi-stemmed, erect, and to 2+ m in height. Our specimens were typically less than 1.5 m in height. The large leaves were pubescent on their underside and generally shallowly lobed below. The large pink flowers (10+ cm in width) which occurred at the Moraine State Park site lacked the distinctive crimson center that was historically considered characteristic of the species and in that regard are more typical of the *palustris* (Connecticut Botanical Society 2011) morphotype. The Route 8 population had flowers that were whitish with a conspicuous crimson center.

These represent the first two collections of *H. moscheutos* from Butler County. Previous accounts of the species from western Pennsylvania included two sites from northeastern Erie County, one site from northeastern Allegheny County, and one site from southeastern Fayette County (Rhoads & Klein 1993; USDA, NRCS 2011). The Fayette County site is not currently included in the flora of Pennsylvania website (Pennsylvania Flora Project 2011), nor cited by Morton and Speedy (2008).

Inasmuch as this obligate wetland species occurs in shallow waters associated with ditches, marshes, and swamps occasionally in the southeastern (Berks, Bucks, Chester, Dauphin, Delaware, Lancaster, Lehigh, Northampton, and Philadelphia Counties) and western parts of the state (Wherry et al. 1979; Rhoads & Block 2000), its true significance at the Moraine State Park site rests in the fact that the population consists of hundreds, if not thousands of individual plants and has displaced other native shallow water or shoreline species. The species dominates the shoreline to 5+ m inland around the periphery of the unnamed cove from the terminus of Big Run Road to the Big Run Arm of Lake Arthur. Further, where the cove abuts US 422 the population extends up the elevated gravel berm to the edge of the roadway. The Route 8 population numbers only a single individual with greater than a dozen shoots. Last year=s shoots were fewer in number. The specimen occurs on one of the lower tiers of a man-made retention pond at the edge of a paved parking lot in association with *Coronilla varia* L., *Dipsacus fullonum* L., *Solidago altissima* L., and *Symphyotrichum pilosum* (Willd.) Nesom. Whether the occurrence of the population represents natural colonization or is a consequence of seeding is unknown. Regardless, it has persisted for the last three seasons.

Locally the species is used as a landscape accent and is sold at many nurseries and garden centers affiliated with box stores. Its proclivity to set seed, formation of large colonies and concurrent displacement of other shoreline species, and use as a horticultural plant may result in further spread. The species clearly has the potential to be invasive.

Voucher specimens: PENNSYLVANIA. Butler Co.: Lake Arthur, Moraine State Park, end of Big Run Road, shoreline and into shallow water around the entire unnamed cove, 40°55.344'N, 080°04.759'W; elevation ca. 437 m, 25 Aug 2009, *J. Chmielewski 3209* (SLRO); Butler, Route 8, 0.6 mi E of Mercer Road, in drainage retention area; 40°54.353'N, 079°55.214'W, 19 Sep 2010, *J. Chmielewski 3210* (SLRO).

Lamium maculatum L., the spotted henbit (dead-nettle), is an herbaceous perennial in the Lamiaceae that was introduced from Eurasia though has escaped cultivation to roadsides, cultivated fields, and waste ground from South Carolina and Tennessee north to Ontario, Quebec, and Newfoundland in the east and Idaho, Oregon, Washington, and Alaska in the west (Fernald 1950; USDA, NCRS 2011). The occurrence of the species in western Pennsylvania (Rhoads & Klein 1993), including Fayette county (Morton & Speedy 2008), is apparently a more recent event than was its occurrence in the eastern and central parts of the state (Wherry et al. 1979). Despite the fact that Crawford County has been botanized since the early 1800s Morton et al. (2007) did not report on the occurrence of the species. This would suggest that introduction and establishment are recent events.

The species is easily recognized by the whitish stripe along the midrib of the petiolate, ovoid to deltoid leaves with crenate-dentate margins, as well as the large 2+ cm long pinkish corolla and single toothed lateral lobe. The creeping stems are slender, somewhat hairy, branched and ascending to 60 cm, though commonly less (Britton & Brown 1913; Fernald 1950; Rhoads & Block 2000).

This most northwestern population in Pennsylvania sparsely covered an area several meters in diameter between the edge of a woodlot and roadside and consisted of over 50 erect shoots at various stages of floral development. Based on size alone the population must have persisted for at least a decade despite the impacts of roadside mowing.

Voucher specimen: **PENNSYLVANIA. Crawford Co.:** Linesville, Fries Road, approximately 300 m E of Forest Drive, W of the Pymatuning Laboratory of Ecology housing facility, shaded edge of woods, 13 Jun 2011, *J. Chmielewski 3217* (SLRO).

Robinia hispida L., the bristly locust, is a multi-branched, erect, rhizomatous shrub that is native to dry woods, thickets, and slopes of the more hilly-mountainous regions of Georgia, North Carolina, Tennessee, and Virginia (Britton & Brown 1913; Bailey 1949; Fernald 1950). The species is commonly cultivated north of its home range and is considered to be aggressively invasive in Michigan, New Jersey, Ohio, Pennsylvania, and Washington (Wherry et al. 1979; Rhoads & Klein 1993; Rhoads & Block 2000; USDA, NRCS 2011). In the lower 48 states the species is only absent from Arizona, Idaho, Montana, Nevada, North Dakota, South Dakota, and Wyoming (USDA, NRCS 2011). The species has been introduced to both Nova Scotia (Zinck 1998) and Ontario (Newmaster et al. 1998) in Canada. On numerous occasions the species has escaped cultivation and spreads locally by suckers (Britton & Brown 1913; Fernald 1950). The species is deemed invasive in 614 counties collectively within Michigan, New Jersey, Ohio, Pennsylvania, and Washington (Anonymous 2)

Growing to a height of about 3 m, its most distinctive feature, and that which separates it from other species in the genus is the conspicuous bristly, glandular brown hairs which cover the branches, peduncles, petioles, and rachises. The compound leaves bear 3–6 pairs of rounded leaflets. The 2.5–3 cm long rose-pink colored flowers occur in showy racemes of 3–10 flowers from May–June (Bailey 1949; Fernald 1950; Rhoads & Block 2000)

The species was previously reported from several counties in eastern and more or less central Pennsylvania as well as Allegheny, Armstrong, Beaver Washington, and Westmoreland counties in southwestern Pennsylvania and Erie and Warren counties in the northwestern portion of the state (Wherry et al. 1979; Rhoads & Klein 1993; Morton & Speedy 2007). The two new populations from Butler and Crawford counties respectively adjoin the southwestern and northwestern county groupings mentioned above.

Voucher specimens: **PENNSYLVANIA. Butler Co.:** Lake Arthur, Moraine State Park, Hilltop Trail, open, grassy slope, numerous, 14 Jun 2011, *J. Chmielewski 3216* (SLRO). **Crawford Co.:** Meadville, Ernst Woods Bike Trail on the E side of Mercer Pike, between forest edge and edge of paved trail, several locations; 13 Jun 2011, *J. Chmielewski 3211* (SLRO).

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THE FLORISTIC AND COMMUNITY ECOLOGY OF SEASONALLY WET LIMESTONE GLADE SEEPS OF TENNESSEE AND KENTUCKY

Kimberly Norton Taylor[1] and Dwayne Estes

Austin Peay State University
Department of Biology
and Center of Excellence for Field Biology
Clarksville, Tennessee 37044, U.S.A.
knorton@brit.org, estesl@apsu.edu

ABSTRACT

An open, seasonally wet seep community supporting herbaceous vegetation occurs within the limestone cedar glade complex of the southeastern United States. The purpose of this study is to describe the floristic composition of these limestone glade seeps. A floristic inventory of 9 seasonally wet sites in central Tennessee and south-central Kentucky was performed, documenting 114 species and infraspecific taxa in 91 genera and 43 families. Vegetation analysis identified the dominant taxa as *Eleocharis bifida* (% IV 20.3), *Sporobolus vaginiflorus* (% IV 11.94), *Hypericum sphaerocarpum* (% IV 5.97), *Allium* aff. *stellatum* (% IV 4.71), *Clinopodium glabellum/arkansanum* (% IV 4.15), *Schoenolirion croceum* (% IV 3.89), *Juncus filipendulus* (% IV 3.89), and *Carex crawei* (% IV 3.84). *Gratiola quartermaniae* and *Isoëtes butleri* are also important members of the community and may serve as indicator species. A wetland assessment of the seep community was performed according to the U.S. Army Corps of Engineers Wetland Delineation Manual and appropriate regional supplements. Wetland vegetation requirements are satisfied in 8 of the 9 seasonally wet sites sampled. The limestone glade seeps appear to represent a previously unclassified seasonal wetland type.

RESUMEN

Una comunidad abierta, húmeda estacionalmente por filtración, compuesta por vegetación herbácea se da en el complejo de pantanos calcáreos de cedro del sureste de los Estados Unidos. El propósito de este estudio es describir la composición florística de estos pantanos calcáreos de filtración. Se realizó un inventario florístico de 9 lugares húmedos estacionalmente en el centro de Tennessee y centro-sur de Kentucky, documentándose 114 especies y taxa infraspecíficos de 91 géneros y 43 familias. El análisis de vegetación identificó como taxa dominantes a *Eleocharis bifida* (% IV 20.3), *Sporobolus vaginiflorus* (% IV 11.94), *Hypericum sphaerocarpum* (% IV 5.97), *Allium* aff. *stellatum* (% IV 4.71), *Clinopodium glabellum/arkansanum* (% IV 4.15), *Schoenolirion croceum* (% IV 3.89), *Juncus filipendulus* (% IV 3.89), y *Carex crawei* (% IV 3.84). *Gratiola quartermaniae* y *Isoëtes butleri* son también miembros importantes de la comunidad y pueden server como especies indicadoras. Se realizó un informe de la comunidad de humedal de acuerdo con el U.S. Army Corps of Engineers Wetland Delineation Manual y los suplementos regionales apropiados. Los requerimientos de la vegetación de humedal se satisfacen en 8 de los 9 lugares estacionalmente húmedos que se muestrearon. Los pantanos calcáreos de filtración parecen representar un tipo de humedal estacional que no se había clasificado previamente.

INTRODUCTION

The limestone cedar glade complex is one of the most botanically unique ecosystems in the southeastern United States, supporting a distinct array of vascular plants including many rare and endemic taxa (Somers et al. 1986). The cedar glade complex is composed of a matrix of woodland vegetation, dominated by *Juniperus virginiana*, with areas of thin soil supporting herbaceous vegetation interspersed throughout (Quarterman 1989). While the cedar-woodland is an important component of the complex, the term "cedar glade" refers specifically to the open herb-dominated areas (Baskin & Baskin 2004). These openings are characterized by thin soil and an abundance of exposed Lebanon, Ridley, or Ste. Genevieve/ St. Louis limestones (Harper 1926; Quarterman 1950; Noger 1988).

Impermeable limestone bedrock near the surface, combined with increased winter and spring precipitation, lead to saturated conditions throughout most of the winter and early spring. A decrease in rainfall and increase in temperature from late spring through summer have a drying effect on the thin soil, resulting in drought-like conditions (Harper 1926; Quarterman 1989; Baskin & Baskin 2003). The unique assemblage of plants within the cedar glade community is directly influenced by this shift in moisture extremes (Harper 1926; Quarterman 1989).

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[1] **Present Address: Botanical Research Institute of Texas, 1700 University Dr., Fort Worth, Texas 76107-3400, U.S.A.**

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Spring saturation is highly variable within the cedar glade system. Lateral seepage from adjoining limestone strata surfaces at lower slope positions and pools overtop the limestone bedrock (NatureServe 2011). Spring saturation across the glades is therefore not uniform, resulting in glade seeps with varying degrees and length of inundation. The increased saturation within seepage areas restricts the assemblage of species that can survive, and thus a unique flora is expected within these communities.

The vascular flora and community associations within the drier phases of the cedar glades have been well-documented with several classification systems applied to glade vegetation (Picklesimer 1927, Baskin & Baskin 1996; Freeman 1933; Quarterman 1950; Somers et al. 1986; Rollins 1997). The presence of a unique seep community is suggested by Freeman (1933), Quarterman (1950), and Rollins (1997), who identify cedar glade community types dominated by species typical of wetter conditions (Baskin et al. 2007). NatureServe (2011) also identifies three cedar glade associations characterized by seasonal saturation (Table 1). The Limestone Seep Glade association (CEGL004169) of Tennessee, Alabama, and Georgia and the similar Kentucky Glade Seep (CEGL004669) are described as zonal components of limestone cedar glades characterized by seasonal seepage. The Limestone Glade Streamside Meadow association (CEGL 004292) is also characterized by seasonal saturation, but the source of saturation is overflow from proximal ephemeral streams. Dominant taxa, including many of the same taxa as those noted by Freeman (1933), Quarterman (1950), and Rollins (1997), are listed for each NatureServe association but the complete floristic composition within these associations is not indicated.

With sufficient length of saturation, the limestone glade seeps are expected to support primarily hydrophytic vegetation. The purpose of this study is to determine the vascular plant species composition and abundance within seasonally wet limestone glade seeps, and to evaluate the glade seeps in relation to current wetland delineation requirements.

METHODS

To identify potential study sites, cedar glades with seeps, wet swales, or ephemeral streams were visited in Bedford, Davidson, Decatur, Giles, Lincoln, Marshall, Maury, Meigs, Rutherford, and Wilson counties in Tennessee; Colbert, Franklin, and Lawrence counties in Alabama; and Simpson County, Kentucky. In addition to our own reconnaissance, we also consulted with staff from the Tennessee Natural Heritage Program, Drs. Jerry and Carol Baskin (University of Kentucky), Milo Pyne (NatureServe), Deborah White (Kentucky Nature Preserves Commission), and Dr. David Webb (Tennessee Valley Authority) to identify other high-quality examples of wet glades. Glades with evidence of extreme or continuing disturbance such as tire marks, livestock activity, or large amounts of debris as well as glades adjacent to roads or with other evidence of altered hydrology were excluded. Some high-quality sites located on private property were also excluded because we could not be sure that the study sites would not be disturbed during the duration of the study period.

Of the approximately 30 sites visited, nine of the highest-quality sites were selected for study, including seven sites in central Tennessee and two sites in south-central Kentucky (Fig. 1). An additional dry glade was included in south-central Kentucky (site 3) for comparison purposes. All sites were located in state parks, state forests, or on state natural areas. With the exception of site 3, at least a portion of the area of all sites was covered by a glade seep. Additionally, sites 4, 6, 7, 8, 9, and 10 also had a dry glade component. Most sites included the entire open region with the cedar-woodland edge serving as the site boundary. In cases of large open glades, an artificial boundary was selected and marked with GPS coordinates to include all seep portions of the glade and at least an equal amount of the adjacent dry glade.

Each site was visited one or more times during each of the following sampling periods: May 8–26, 2009; August 12–24, 2009; September 25–October 14, 2009; March 8–April 15, 2010; and May 18–31, 2010. The start of the May 2010 sampling period was postponed from early May to mid May due to torrential flooding in the region. The boundary of each site and the boundary of the glade seep portion within the site were mapped using ArcMap 9.2 (ESRI 2009). There was a clear differentiation in vegetation between dry and saturated areas at most sites. The line representing this shift in vegetative cover combined with the presence of persistent standing

TABLE 1. Dominant vegetation and characteristic species of three seasonally wet limestone cedar glade associations according to NatureServe (2011). All species in the Limestone Seep Glade and Kentucky Glade Seep Communities were documented during this study.

NatureServe Community	Dominant and Characteristic Species
Limestone Seep Glade	*Eleocharis bifida*[1], *Schoenolirion croceum*[1], *Carex crawei*[1], *Allium cernuum*[1], *Nothoscordum bivalve, Isoëtes butleri*[1], *Hypoxis hirsuta*
Kentucky Glade Seep	*Eleocharis bifida*[1], *Nothoscordum bivalve, Isoëtes butleri*[1], *Hypoxis hirsuta*
Limestone Glade Streamside Meadow[2]	*Mecardonia acuminata, Dalea foliosa, Mitreola petiolata, Rudbeckia triloba, Ludwigia microcarpa*

[1]-Determined to be characteristic of glade seep habitat in this study.
[2]-No examples of this community type were surveyed in this study.

water, saturated soil, or other hydrologic indicators (U.S. Army Corps of Engineers 2010) provided a boundary for the glade seep habitat. Each area was assigned a habitat code to indicate a "dry," or typical cedar glade (DG), a limestone glade seep (GS), or the border vegetation (BV) including the ecotone between open glade and adjacent cedar-woodland.

A floristic inventory was conducted of all vascular plants growing at each site, with nomenclature following Chester et al. (2009). Voucher specimens are deposited at the Austin Peay State University Herbarium (APSC). A complete annotated checklist of the seep flora was compiled (Appendix 1), organized by plant family within the four major plant groups (Pteridophytes, Gymnosperms, Angiosperms: Dicots, and Angiosperms: Monocots). Each entry in the checklist includes the scientific name, common name, site number(s) where found, habitat code (DG, GS, or BV), statement of abundance, USACE wetland indicator status code, geographical affinity, and collection number of specimens retained at APSC. Endemic, rare, and exotic species are also noted. Wetland indicator status codes follow the current consensus for the revised USACE wetland plant list, Eastern Mountains and Piedmont Region (Lichvar & Kartesz 2009). For geographical affinity, taxa with an intraneous distribution are those in which their center of distribution includes Tennessee; extraneous taxa are those in which their center of distribution does not include Tennessee; and disjunct taxa are those in which their distribution is not continuous (Kartesz 2003).

During the May 2010 sampling period, 15-meter transects were established in each GS and DG habitat at each of the 10 sites. Twelve GS transects and 7 DG transects were established. Sites 4, 6, 8, 9, and 10 had one DG and one GS transect each; site 7 had two GS transects and one DG transect; sites 1 and 5 had two GS transects each; site 2 had one GS transect; and site 3 had one DG transect. Transects were randomly placed within the boundary of the habitat. Five 0.5-m × 1-m quadrats were randomly selected and placed on alternating sides of each transect with the short edge perpendicular to the transect axis. Quadrat size was chosen so that all quadrats fitted entirely within the boundary of the often-narrow seep habitat. Percent cover values were visually estimated for all vascular plants using the Daubenmire (1959) cover class system as modified by Bailey and Poulton (1968): class 1, 0 to 1%; class 2, >1 to 5%; class 3, >5 to 25%; class 4, >25 to 50%; class 5, >50 to 75%; class 6, >75 to 95%; and class 7, >95 to 100%. Mean percent cover values were determined for each taxon using the mid-point value for each cover class. Percent Importance Values (% IV) [(relative cover + relative frequency)/2] × 100 were calculated for each taxon at each site. Mean across-site % IVs were also calculated for each taxon occurring within each habitat type. All % IVs given indicate the mean across-site % IV unless otherwise noted.

RESULTS

Study Sites.—The mean area of the 10 study sites was 0.37 ha and that of the seep component was 0.12 ha (Table 2). All sites in Kentucky were underlain by Ste. Genevieve/St. Louis Limestones, while all sites in Tennessee were underlain by Lebanon Limestone with the exception of Overbridge Glade State Nature Preserve which was underlain by Ridley Limestone (Noger 1988; Greene & Wolfe 2000). All sites were located at an elevation between 150 and 200 m.

Fig. 1. Locations of study sites in southern Kentucky and central Tennessee. **1, 2, 3**-Flatrock Glade Nature Preserve Glades **1, 2** and **3,** Simpson Co., KY; **4**-Couchville Cedar Glade State Natural Area, Davidson Co., TN; **5**-Cedars of Lebanon State Natural Area Glade S46, Wilson Co., TN; **6**-Cedars of Lebanon State Forest Glade 139, Wilson Co., TN; **7**-Cedars of Lebanon State Forest Glade 137, Wilson Co., TN; **8**-Cedars of Lebanon State Forest Glade 138, Wilson Co., TN; **9**-Sunnybell Glade State Natural Area, Rutherford Co., TN; **10**-Overbridge Cedar Glade State Natural Area, Rutherford Co., TN.

TABLE 2. Summary of study site characteristics including site number, site name, county and state, elevation, bedrock type, and site area. GS=area of glade seep habitat; Total =area of GS and dry glade habitats combined; % Total=percent of total site belonging to the GS habitat.

Site #	Site Name	County, State	Elevation (m)	Bedrock Type	Area (ha)		
					GS	**Total**	**% Total**
1	Flatrock Glade State Nature Preserve 1	Simpson Co., KY	180	Ste. Genevieve/ St. Louis Limestones, undivided[1]	0.08	0.08	100
2	Flatrock Glade State Nature Preserve 2	Simpson Co., KY	180	Ste. Genevieve/ St. Louis Limestones, undivided	0.11	0.11	100
3	Flatrock Glade State Nature Preserve 3	Simpson Co., KY	180	Ste. Genevieve/ St. Louis Limestones, undivided	0.00	0.11	0
4	Couchville Cedar Glade State Natural Area	Davidson Co., TN	200	Lebanon Limestone[2]	0.07	0.38	18.4
5	Cedars of Lebanon State Natural Area, S46	Wilson Co., TN	154	Lebanon Limestone	0.4	0.4	100
6	Cedars of Lebanon State Forest Glade 139	Wilson Co., TN	170	Lebanon Limestone	0.07	0.19	36.8
7	Cedars of Lebanon State Forest Glade 137	Wilson Co., TN	167	Lebanon Limestone	0.1	0.57	17.5
8	Cedars of Lebanon State Forest Glade 138	Wilson Co., TN	158	Lebanon Limestone	0.15	0.48	31.3
9	Sunnybell Glade State Nature Preserve	Rutherford Co., TN	174	Lebanon Limestone	0.35	1.14	30.7
10	Overbridge Glade State Nature Preserve	Rutherford Co., TN	181	Ridley Limestone[2]	0.06	0.21	28.6

[1]-Mississippian in age
[2]-Ordovician in age

Floristic Study.—A total of 114 species and infraspecific taxa were documented from the nine limestone glade seeps, representing 91 genera and 43 families (Appendix 1). The 114 seep taxa were distributed among 2 pteridophytes, 1 gymnosperm, and 111 angiosperms divided into 38 monocots and 73 dicots (Table 3). Of these, 20 taxa were found exclusively in the limestone glade seep habitat and were absent from the surrounding dry glade. Poaceae and Asteraceae were the largest families with 18 and 12 taxa, respectively, followed by Cyperaceae (8), Euphorbiaceae (8), and Fabaceae (6). The largest genus was *Carex* with 4 taxa followed by *Hypericum* and *Dichanthelium* each with 3 taxa. Seven non-native taxa were documented, representing 6 percent of the total flora. Three of these are listed as invasive in Tennessee, Kentucky, or both (Kentucky Exotic Pest Plant Council 2008; Tennessee Exotic Pest Plant Council 2009). Of the 107 native taxa, 63 had an intraneous distribution with 11 of these endemic to cedar glades. A total of 37 taxa had extraneous distributions with 21 extraneous to the west, 11 to the north, and 5 to the south. Seven additional taxa were disjunct from the west, resulting in 24.6 percent of the seep flora having western affinities.

Vegetation Study.—The limestone glade seep community was dominated by *Eleocharis bifida*, which occurred in 55% of the quadrats sampled, with a percent relative cover of 32.7% and a mean across site % IV of 20.3 (Table 4). *Sporobolus vaginiflorus* (% IV 11.94), *Hypericum sphaerocarpum* (% IV 5.97), *Allium* aff. *stellatum* (% IV 4.71), *Clinopodium arkansanum/glabellum*. (% IV 4.15), *Schoenolirion croceum* (% IV 3.89), *Juncus filipendulus* (% IV 3.89), and *Carex crawei* (% IV 3.84) were also important components of the spring seep flora. The dry glade transects were dominated by *Dalea gattingeri* (% IV 23.26), *Sporobolus vaginiflorus* (% IV 19.60), *Diodia teres* (% IV 7.58), *Hypericum sphaerocarpum* (% IV 7.29), *Minuartia patula* (% IV 7.06), and *Pediomelum subacaule* (% IV 6.26).

DISCUSSION

Floristics and Vegetation.—The unique nature of the glade seep flora can be seen by the presence of 14 rare taxa, 11 endemic taxa, and 7 disjunct taxa. Of the 14 rare taxa documented, *Schoenolirion croceum*, *Carex crawei*, *Isoëtes*

Table 3. Summary of taxa documented within limestone glade seeps.

Group	Families	Genera	Taxa
Pteridophytes	2	2	2
Gymnosperms	1	1	1
Angiosperms:			
Monocots	8	26	38
Dicots	32	62	73
Total	43	91	114

Table 4. Frequency, relative cover, and mean across site percent importance values of taxa occurring along limestone glade seep and dry glade transects. Frequency- (number quadrats taxon occurs in/total number of quadrats) × 100; Relative Cover- (total cover for taxon/total cover for all taxa) × 100; Mean %IV- (sum %IVs from all sites)/number of sites.

Taxon	Glade Seep			Dry Glade		
	Freq. (%)	Relative Cover (%)	Mean % IV	Freq. (%)	Relative Cover (%)	Mean % IV
Eleocharis bifida	55.00	32.66	20.30	—[1]	—	—
Sporobolus vaginiflorus	20.00	19.45	11.94	70.00	15.31	19.60
Hypericum sphaerocarpum	35.00	4.61	5.97	36.67	6.56	7.29
Allium aff. *stellatum*	30.00	8.83	4.71	23.33	3.49	5.79
Clinopodium arkansanum/glabellum	22.22	2.34	4.15	—	—	—
Schoenolirion croceum	30.00	6.56	3.89	20.00	3.47	3.53
Juncus filipendulus	23.33	4.18	3.89	—	—	—
Carex crawei	16.67	4.48	3.84	—	—	—
Chrysanthemum leucanthemum	21.67	2.79	3.63	—	—	—
Diodia teres	21.67	4.59	3.43	40.00	5.23	7.58
Scutellaria parvula	18.33	1.68	3.43	—	—	—
Ruellia humilis	25.00	1.72	2.95	23.33	0.60	2.71
Leucospora multifida	20.00	1.87	2.69	—	—	—
Lobelia appendiculata var. *gattingeri*	20.00	0.43	2.21	23.33	0.27	2.50
Houstonia purpurea var. *calycosa*	15.00	0.76	2.04	3.33	0.13	0.38
Muhlenbergia schreberi	16.67	3.18	2.02	13.33	4.67	4.04
Dalea gattingeri	18.33	2.36	2.00	96.67	16.91	23.26
Sisyrinchium albidum	46.67	0.79	1.36	—	—	—
Erigeron strigosus var. *calcicola*	6.67	0.84	1.28	23.33	3.07	3.59
Symphyotrichum priceae	5.00	0.70	1.08	10.00	0.93	1.45
Nostoc commune	6.67	1.62	1.07	6.67	3.34	2.91
Leavenworthia spp.	6.67	1.17	0.87	—	—	—
Isoetes butleri	6.67	0.69	0.79	—	—	—
Nothoscordum bivalve	15.00	0.21	0.67	23.33	4.14	4.83
Croton spp.	6.67	0.10	0.61	30.00	0.76	3.98
Sedum pulchellum	0.00	0.16	0.48	6.67	0.16	0.63
Chamaecrista fasciculata	3.33	0.08	0.48	—	—	—
Carex granularis	1.67	0.35	0.34	—	—	—
Chamaesyce spp.	3.33	0.14	0.26	—	—	—
Hypericum dolabriforme	5.00	0.07	0.25	—	—	—
Delphinium carolinianum ssp. *calciphilum*	1.67	0.07	0.18	—	—	—
Minuartia patula	0.00	0.07	0.18	43.33	2.58	7.06
Ophioglossum engelmannii	1.67	0.01	0.11	—	—	—
Dichanthelium acuminatum	—	—	—	6.67	0.80	0.94
Oenothera macrocarpa	—	—	—	16.67	4.34	4.13
Opuntia humifusa	—	—	—	3.33	1.67	1.08
Packera anonyma	—	—	—	3.33	0.02	0.35
Pediomelum subacaule	—	—	—	33.33	5.07	6.26
Plantago virginica	—	—	—	10.00	2.00	1.80
Verbena simplex	—	—	—	10.00	0.18	0.94

[1]-taxon not documented within any quadrats for the indicated habitat.

butleri, and *Juncus filipendulus* are characteristic members of the glade seeps (Kentucky Rare Plant Database 2006; Crabtree 2008). *Schoenolirion croceum* is restricted to four study sites in Tennessee but is typically locally dominant. *Carex crawei* and *Juncus filipendulus* are often dominant in these communities as well, occurring at all but two sites. *Isoëtes butleri* was less abundant, occurring at only two sites, but it was restricted to the glade seeps. The federally endangered *Dalea foliosa*, found at only one site, did not occur in the wettest portions of glades but was found in close proximity. Due to the time of sampling and major flooding during spring 2010, this study may not have captured the full diversity of winter annuals or early spring ephemerals, including *Leavenworthia* spp. *Gratiola quartermaniae*, and *I. butleri*.

The unique flora of the cedar glades has interested botanists for many years, dating back to the botanical surveys conducted by Gattinger in the mid- to late 19th century (Gattinger 1901). As a result, these areas have been well studied and the vegetation and community structure characterized extensively. Our results on the dominant dry glade taxa agree closely with those described in previous vegetation studies (Freeman 1933; Quarterman 1950, 1989; Somers et al. 1986; Rollins 1997). In particular, the abundance of *Dalea gattingeri* (% IV 23.26, freq. 96.7%) and *Sporobolus vaginiflorus* (% IV 19.60, freq. 66.7%) was consistent with prior studies (Freeman 1933; Quarterman 1950, 1989; Somers et al. 1986; Rollins 1997).

Sporobolus vaginiflorus, a summer annual, which germinates in early spring, had a high % IV in both dry and seep transects (Baskin & Baskin 1973). This suggests it is capable of tolerating a wide range of hydrological conditions. Conversely, the taxa which are primarily restricted to glade seeps require the additional moisture to survive. It is these taxa that characterize the glade seep community and differentiate it from other glade communities: *Eleocharis bifida*, *Allium* aff. *stellatum*, *Clinopodium glabellum/arkansanum*, *Schoenolirion croceum*, *Juncus filipendulus*, *Carex crawei*, *C. granularis*, *Gratiola quartermaniae*, *Leucospora multifida*, and *Isoëtes butleri*. All of them, with the exception of *Allium* aff. *stellatum*, are spring dominants and many disappear by early summer. Though the glade seeps lose much of their floristic uniqueness during summer, the presence of *A.* aff. *stellatum* and the persistence of dead *E. bifida* culms aids in identification of the community during the drier summer months.

The characteristic seep taxa identified by this study are consistent with prior studies. Several of them were identified as important components of glades sampled by Rollins (1997) including *Eleocharis bifida* (=*E. compressa*), *Carex crawei*, and *Clinopodium glabellum* (=*Calamintha glabella*). Baskin et al. (2007) note that some glades may be wet enough to support several "moisture-loving plants" including *E. bifida*, *Isoëtes butleri*, *C. crawei*, and *Schoenolirion croceum*. Quarterman (1950) identified glade regions with spring seep taxa including *Isoëtes butleri* and *S. croceum*. *Isoëtes butleri* was also noted by Freeman (1933).

All species listed in the NatureServe (2011) Kentucky Glade Seep and Limestone Seep Glade associations were documented during our study. Several of our characteristic seep taxa are also listed as dominants within the NatureServe (2011) associations, including *Eleocharis bifida*, *Carex crawei*, *Isoëtes butleri*, *Schoenolirion croceum*, and *Allium* aff. *stellatum* (identified there as *Allium cernuum*). Additional taxa we found to be characteristic of the glade seeps should be included in the NatureServe Limestone Seep Glade association, including *Juncus filipendulus* and *Gratiola quartermaniae*.

All species in the Limestone Glade Streamside Meadow association, with the exception of *Ludwigia microcarpa*, were documented as well, though none of the taxa was abundant at any site (NatureServe 2011). Therefore, it appears the sites we studied are more characteristic of the Limestone Seep Glade and Kentucky Glade Seep associations and do not represent the Streamside Meadow association. Additional study of Streamside Meadow communities and how the vegetation compares to the seep community is needed.

Wetland Assessment.—The stress on vegetation resulting from saturated conditions is reflected in the increase in importance of hydrophytic vegetation within glade seeps. National wetland indicator status codes are assigned to species known to occur in saturated conditions, indicating how frequently these taxa are encountered in wetlands (Lichvar & Kartesz 2009). In our analysis of the glade seep flora, 42 percent of the taxa, including all of the characteristic taxa noted previously except the summer dominant *Allium* aff. *stellatum*, had a designated wetland indicator status code representing hydrophytic vegetation (FAC, FACW, or OBL). The prevalence of vegetation recognized as hydrophytic suggests the persistence of water in the glade seep communities is enough to have a controlling influence over the vegetation.

USDA wetland delineation protocols use species abundance and wetland indicator status codes to determine if the vegetation of a site is hydrophytic or not (U.S. Army Corps of Engineers 2010). When these same protocols are used to assess the 9 glade seep communities studied here, 8 of the 9 GS sites satisfy the requirements. Glade 137 appeared "wetter" than a typical dry glade, but lacked most of the taxa determined to be characteristic of the glade seep. Saturation in this site may be more intermittent and thus not have a substantial effect on the vegetation.

In addition to the presence of hydrophytic vegetation the analyses of soils and hydrology are also necessary for a site to receive wetland status. Physical signs of hydrology that may satisfy the requirement were recorded and photographed throughout the study, including the presence of standing water, aquatic fauna (Fig. 2), water marks, sediment deposits, algal mats, and drift deposits (U.S. Army Corps of Engineers 2010). The very nature of the cedar glade system, with thin soils and near-surface bedrock, makes traditional soil analysis difficult. Limestone seep communities in Texas which are dominated by hydrophytic vegetation (Jue 2010) exhibit some characteristics of hydric soils, but Llado (2010) noted that "hydric properties may be impossible to observe year-round due to the nature of the community." Jue (2010) suggests these Texas "Muhly Seeps" be designated as a new wetland type, "seasonally unstable ephemeral wetlands."

We argue that designation of limestone glade seeps as ephemeral wetlands would be correct. If water exerts a controlling influence over the community, the vegetation will indicate this. This suggests that these 8 sites may meet the standards for wetland delineation protocols, and the glade seep community in general may represent a previously unrecognized wetland community type.

Conservation Status.—The glade seep community is limited in geographic range to within the cedar glade complex (Baskin & Baskin 2003). Reconnaissance field work during the site selection process led to the identification of less than 30 examples of seasonally wet sites, with most of these on public land and the rest on private lands in various states of disturbance. Cedar glades have often been viewed as waste areas and have been used to dump trash, as pasture land, and as a source for limestone paving stones and gravel (Harper 1926). All-terrain vehicle use is also high with wet communities being especially vulnerable to this threat. Development of cedar glade lands poses arguably the greatest threat to these communities with the expansion of Nashville and the surrounding urban area. Recognizing glade seeps as a seasonal wetland may hold important implications for conservation of this rare and floristically unique community.

APPENDIX 1. ANNOTATED CHECKLIST

Taxa are arranged alphabetically by family and species within the three major groups of vascular plants (Pteridophytes, Gymnosperms, and Angiosperms). Nomenclature follows Chester et al. (2009). Statement of abundance follows Murrell and Wofford (1987). Collection numbers indicate vouchers deposited at APSC. Taxa not collected due to rarity are indicated by a caret (^).

The following is a guide to the format and abbreviations associated with each taxon in the checklist. *Taxon* Authority (Common Name)—site numbers where found [habitat code]; statement of abundance; USACE wetland indicator status codes; geographic affinity; (Collector, collection number).

Symbols preceding taxon:

* Cedar glade endemic/near endemic

† Taxon listed as rare at state (Kentucky or Tennessee) or federal level

Site numbers:

1	Flatrock Glade Nature Preserve Glade 1, Simpson Co., KY
2	Flatrock Glade Nature Preserve Glade 2, Simpson Co., KY
3	Flatrock Glade Nature Preserve Glade 3, Simpson Co., KY
4	Couchville Cedar Glade State Natural Area, Davidson Co., TN
5	Cedars of Lebanon State Natural Area Glade S46, Wilson Co., TN

FIG. 2. **Top** – Site 5, Cedars of Lebanon State Natural Area glade S46, in May 2009. Limestone glade seep community dominated by Schoenolirion croceum and Eleocharis bifida showing the presence of standing water over the near-surface limestone bedrock. **Bottom** – Site 4, Couchville Cedar Glade State Natural Area, in March 2009. The presence of standing water and use by aquatic fauna, serves as two signs of hydrology which may satisfy the hydrology indicator necessary for wetland determination.

6 Cedars of Lebanon State Forest Glade 139, Wilson Co., TN
7 Cedars of Lebanon State Forest Glade 137, Wilson Co., TN
8 Cedars of Lebanon State Forest Glade 138, Wilson Co., TN
9 Sunnybell Glade State Natural Area, Rutherford Co., TN
10 Overbridge Cedar Glade State Natural Area, Rutherford Co., TN

Habitat codes:

BV Border Vegetation
DG Dry Glade
GS Glade Seep

Statement of abundance:

V Very rare
R Rare
S Scarce
I Infrequent
O Occasional
F Frequent
C Common

Geographical affinities:

INT Intraneous
WEST Western Extraneous
EAST Eastern Extraneous
NORTH Northern extraneous
SOUTH Southern Extraneous
D Disjunct
NON Non-native

PTERIDOPHYTES

Isoëtaceae

†*Isoëtes butleri* Engelm. (Limestone Quillwort)—2,7 [GS]; I; OBL; WEST; (Norton 504).

Ophioglossaceae

Ophioglossum engelmannii Prantl (Limestone Adders Tongue)—1,6 [BV, GS]; R; FACU; WEST; (Norton 435).

GYMNOSPERMS

Cupressaceae

Juniperus virginiana L. (Eastern Red Cedar)—1,2,3,4,5,6,7,8,9,10 [BV, GS]; C; FACU; INT; (Norton 240).

ANGIOSPERMS – Monocots

Agavaceae

Manfreda virginica (L.) Rose (False Aloe)—2,4,6,7 [DG, GS]; S; NI; INT; (Norton 527).

†*Schoenolirion croceum* (Michx.) Wood (Yellow Sunnybell)—5,6,9,10 [BV, DG, GS]; F; OBL; SOUTH; (Norton 399).

Alliaceae

Allium canadense L. (Meadow Garlic)—3,4,10 [DG, GS]; S; FACU; INT; (Norton 471).

†*Allium* aff. *stellatum* Ker-Gawl.—4,5,6,7,8,10 [DG, GS]; C; NI; D-WEST; (Norton 45).

Nothoscordum bivalve (L.) Britt. (False Garlic)—3,4,6,7,8,9 [DG, GS]; C; FAC; INT; (Norton 221).

Amaryllidaceae

Hypoxis hirsuta (L.) Coville (Star-Grass)—1 [BV, GS]; S; FAC; INT; (Norton 341).

Cyperaceae

†*Carex crawei* Dewey (Crawe's Sedge)—1,2,4,5,6,7,9,10 [BV, DG, GS]; F; OBL; WEST; (Norton 414).

Carex glaucodea Tuck. ex. Olney (Blue Sedge)—1,3 [DG, GS]; R; FAC; INT; (Norton 419).

Carex granularis Muhl. ex Willd. (Limestone Meadow Sedge)—4,5 [DG, GS]; S; FACW; NORTH; (Norton 410).

Carex hirsutella Mack. (Fuzzy Sedge)—3,6,8 [GS]; S; FAC; NORTH; (Norton 428).

Cyperus acuminatus Torr. & Hook. (Taperitip Flat Sedge)—1 [GS]; R; OBL; WEST; (Norton 490).

Cyperus squarrosus L. (Bearded Flat Sedge)—2,3,5,9 [DG, GS]; O; OBL; INT; (Norton 116).

**Eleocharis bifida* S.G. Smith (Glade Spike Rush)—1,2,4,5,6,7,8,10 [GS]; C; FACW; INT; (Norton 397).

Scirpus pendulus Muhl. (Rufous Bulrush)—1,2,3,10 [GS]; I; OBL; NORTH; (Norton 473).

Iridaceae

Sisyrinchium albidum Raf. (White Blue-eyed Grass)—4,5,6,7,8,9 [BV, DG, GS]; F; FACU; INT; (Norton 3).

Juncaceae

Juncus brachycarpus Engelm. (Whiteroot Rush)—2 [GS]; R; FAC; INT; (Norton 502).

†*Juncus filipendulus* Buckl. (Ringseed Rush)—1,2,4,5,6,8,9,10 [GS]; C; FAC; D-WEST; (Norton 31).

Orchidaceae

Liparis liliifolia (L.) Rich. ex Lindl (Lilyleaved Tway Blade)—1 [BV, GS]; R; FACU; NORTH; (Norton 185).

†*Spiranthes magnicamporum* Sheviak (Great Plains Ladies'-Tresses)—1, 5 [GS]; R; FACU; WEST; (Norton 214).

Spiranthes lacera (Raf.) Raf. var. *gracilis* (Bigelow) Luer (Northern Slender Ladies'-Tresses)—1 [BV, GS]; R; FAC; INT; (Norton 1307).

Poaceae

Andropogon gerardii Vitman (Big Bluestem)—10 [DG, GS]; S; FAC; INT; (Norton 160).

†*Bouteloua curtipendula* (Michx.) Torr. (Sideoats Grama)—7 [DG, GS]; S; UPL; WEST; (Norton 76).

Bromus commutatus Schrad. (Meadow Brome)—1 [DG, GS]; R; NI; NON; (Norton 478).

Chasmanthium latifolium (Michx.) Yates (Indian Woodoats)—10 [DG, GS]; R; FAC; INT; (Norton 157).

Danthonia spicata (L.) Beauv. ex Roem. & Schult. (Poverty Oat Grass)—1 [DG, GS]; S; NI; NON; (Norton 195).

Dichanthelium acuminatum (SW.) Gould & C.A. Clark (Tapered Rosette Grass)—1,5,6 [DG, GS]; I; FAC; INT; (Norton 402).

Dichanthelium laxiflorum (Lam.) Gould (Open-Flower Rosette Grass)—1 [GS, DG]; F; FAC; INT; (Norton 197).

Dichanthelium malacophyllum (Nash) Gould (Soft Leaved Panic Grass)—1,5,7 [DG, GS]; O; NI; WEST; (^).

Eragrostis frankii C.A. Mey ex Steud (Sandbar Love-Grass)—1,8 [DG, GS]; I; FACW; NORTH; (Norton 133).

Leersia virginica Willd. (White Grass)—1 [GS, DG]; O: FACW; INT; (Norton 199).

Muhlenbergia schreberi J.F. Gmel. (Nimbleweed)—1 [GS]; R; FAC; INT; (Norton 200).

Panicum flexile (Gatt.) Scribn. (Wiry Panic Grass)—1,3,5,7,8,9,10 [BV, DG, GS]; C; FAC; INT; (Norton 201).

Panicum gattingeri Nash (Gattinger's Panic Grass)—1,2,3,4,5,9 [DG, GS]; C; FAC; NORTH; (Norton 202).

Paspalum setaceum Michx. (Thin Paspalum)—1 [DG, GS]; R; FAC; INT; (Norton 203).

Setaria parviflora (Poir.) Kerguélen (Marsh Bristle Grass)—4,5,8,10 [GS]; O; FAC; INT; (Norton 54).

Setaria pumila (Poir.) Roem. & Schult. (Yellow Bristle Grass)—4, 5, 8, 10 [GS, DG]; O; FAC; NON; (Norton 55).

Sporobolus vaginiflorus (Torr. ex A. Gray) Alph. Wood (Poverty Dropseed)—1,2,3,4,5,6,7,8,9,10 [DG, GS]; C; UPL; INT; (Norton 56).

Tridens flavus (L.) Hitchc. (Purpletop Tridens)—1,8 [GS]; S; FACU; INT; (Norton 137).

ANGIOSPERMS – Dicots

Acanthaceae

Ruellia humilis Nutt. (Fringeleaf Wild Petunia)—1,4,5,6,7,8,9,10 [DG, GS]; C; FACU; WEST; (Norton 151).

Apiaceae

Daucus carota L. (Queen Anne's Lace)—4,8,9 [DG, GS]; S; NI;NON; (Norton 97).

Asclepiadaceae

Asclepias verticillata L. (Whorled Milkweed)—4,5,10 [DG, GS]; I; FACU; INT; (Norton 508).

Asteraceae

Ageratina altissima (L.) R.M. King & H. Rob. (White Snakeroot)—1,4,7,8,10 [DG, GS]; O; FACU; INT; (Norton 192).

Ambrosia artemisiifolia L. (Annual Ragweed)—1,3,4,5,7,8,9,10 [DG, GS]; F; FACU; INT; (Norton 246).

Conoclinium coelestinum (L.) DC. (Blue Mistflower)—1, 2 [GS, DG]; O; FAC; INT; (Norton 208).

**Erigeron strigosus* Muhl. ex Willd. var. *calcicola* J.Allison (Limestone Fleabane)—1,3,4,5,7,8,9,10 [DG, GS]; C; FAC; INT; (Norton 256).

Eupatorium serotinum Michx. (Lateflowering Thoroughwort)—1 [BV, DG, GS]; R; FAC; INT; (Norton 194).

Grindelia lanceolata Nutt. (Narrowleaf Gum Weed)—4,10 [DG, GS]; S; NI; WEST; (Norton 241).

Helenium autumnale L. (Common Sneezeweed)—4 [DG, GS]; R; FACW; INT; (Norton 228).

Leucanthemum vulgare Lam. (Oxeye Daisy)—1,3,4,5,8,10 [BV, DG, GS]; F; UPL; NON; (Norton 416).

Packera anonyma (Wood) Weber & A. Löve (Small's Ragwort)—1,4,5,6,7,8,10 [DG, GS]; C; FACU; INT; (Norton 430).

Ratibida pinnata Barnh. (Pinnate Prairie Coneflower)—10 [GS]; R; NI; WEST; (Norton 475).

†*Symphyotrichum priceae* (Britt.) G.L. Nesom (Lavender Old Field Aster)—1,4,10 [DG, GS]; S; FACU; INT; (Norton 88).

Verbesina virginica L. (White Crownbeard)—9 [BV, DG, GS]; R; FACU; SOUTH; (Norton 1308).

Balsaminaceae

Impatiens capensis Meerb. (Jewelweed)—10 [GS]; R; FACW; INT; (Norton 146).

Boraginaceae

Heliotropium tenellum (Nutt.) Torr. (Pasture Heliotrope)—4,5,7,8,9,10 [DG, GS]; C; NI; WEST; (Norton 155).

Brassicaceae

**Leavenworthia stylosa* A. Gray (Cedar Glade Cress)—4,5,7,8,9 [DG, GS]; O; NI; INT; (Norton 264).

*†*Leavenworthia torulosa* A. Gray (Necklace Glade Cress)—1 [DG, GS]; R; OBL; INT; (^).

Campanulaceae

*†*Lobelia appendiculata* A. DC. var. *gattingeri* (A. Gray) McVaugh (Gattinger's Lobelia)—1,4,5,6,7,8,9,10 [DG, GS]; C; FAC; INT; (Norton 37).

Lobelia inflata L. (Indian-Tobacco)—1 [GS]; V; FACU; INT; (Norton 181).

Triodanis perfoliata (L.) Nieuwl. var. *perfoliata* (Clasping Venus' Looking Glass)—1,4 [DG, GS]; S; FACU; INT; (Norton 479).

Caryophyllaceae

Minuartia patula Michx. (Pitcher's Sandwort)—4,5,6,7,8,9 [DG, GS]; F; FAC; WEST; (Norton 10).

Clusiaceae

Hypericum dolabriforme Vent. (Straggling St. Johnswort)—1,2 [DG, GS]; R; NI; INT; (Norton 176).

Hypericum gentianoides (L.) B.S.P (Orangegrass)—2 [GS]; R; FACU; INT; (Norton 210).

Hypericum sphaerocarpum Michx. (Roundseed St. Johnswort)—1,2,3,4,5,6,7,8,9,10 [DG, GS]; C; FACU; WEST; (Norton 60).

Crassulaceae

Sedum pulchellum Michx. (Widowscross)—1,4,5,7,8,9 [DG, GS]; F; UPL; D-WEST; (Norton 406).

Ebenaceae

Diospyros virginiana L. (Persimmon)—6,10 [BV, GS]; S; FACU; INT; (Norton 1309).

Euphorbiaceae

Acalypha gracilens A.Gray (Slender Three Seed Mercury)—7 [DG, GS]; S; FAC; INT; (Norton 69).

Acalypha virginica L. (Virginia Three-Seed-Mercury)—1[GS, DG]; O; FACU; INT; (Norton 175).

Chamaesyce maculata (L.) Small (Spotted Sandmat)—1,3 [DG, GS]; R; FACU; INT; (Norton 1310).

Chamaesyce nutans (Lag.) Small (Eyebane)—5,7,8,10 [DG, GS]; O; FACU; INT; (Norton 74).

Chamaesyce prostrata (Ait.) Small (Prostrate Sandmat)—1,8,9 [DG, GS]; S; FAC; NON; (Norton 184).

Croton capitatus Michx. (Hogwort)—1,2,3,4,5,7,8,9,10 [DG, GS]; C; NI; WEST; (Norton 166).

Croton monanthogynus Michx. (Prairie Tea)—1,2,3,4,5,6,7,8,9 [DG, GS]; C; NI; WEST; (Norton 247).

Euphorbia dentata Michx. (Toothed Spurge)—1,3,5,8,9 [DG, GS]; F; NI; WEST; (Norton 518).

Fabaceae

Chamaecrista fasciculata (Michx.) Greene (Partridge Pea)—6,8,10 [BV, DG, GS]; I; FACU; INT; (Norton 120).

*†*Dalea foliosa* (A. Gray) Barneby (Leafy Prairie Clover)—5 [DG, GS]; R; NI; INT; (^).

**Dalea gattingeri* (A. Heller) Barneby (Purpletassels)—4,5,6,7,8,9,10 [BV, GS]; R; NI; INT; (Norton 398).

Desmanthus illinoensis (Michx.) MacMill. ex B.L. Rob. & Fern. (Prairie Bundle Flower)—4,10 [DG, GS]; S; FAC; WEST; (Norton 90).

Lespedeza cuneata (Dum.Cours.) G. Don (Chinese Lespedeza)—5,10 [BV, GS]; S; UPL; NON; (Norton 141).

**Pediomelum subacaule* (Torr. & A. Gray) Rydb. (Indian Breadroot)—4,6,7,8,9,10 [DG, GS]; C; NI; INT; (Norton 346).

Lamiaceae

Blephilia ciliata (L.) Benth (Downy Pagoda Plant)—4 [DG, GS]; R; NI; INT; (Norton 455).

Clinopodium arkansanum (Nutt.) House (Limestone Calamint)—6,7,9,10 [DG, GS]; O; FACW; D-WEST; (Norton 472).

Clinopodium glabellum (Michx.) Kuntze (Ozark Calamint)—4,5,8,9 [DG, GS]; O; FACW; INT; (Norton 83).

Isanthus brachiatus (L.) B.S.P (Fluxweed)—1,4,7,10 [DG, GS]; O; NI; NORTH; (Norton 177).

Scutellaria parvula Michx. (Small Scullcap)—1,2,3,4,5,6,7,8,9 [BV, GS]; C; FACU; INT; (Norton 9).

Loganiaceae

Mitreola petiolata (J.F. Gmel.) Torr. & A. Gray (Lax Hornpod)—10 [GS]; R; FACW; SOUTH; (Norton 507).

Lythraceae

Cuphea viscosissima Jacq. (Blue Waxweed)—1,3,7,10 [DG, GS]; O; FACW; NORTH; (Norton 71).

Malvaceae

Malvastrum hispidum (Pursh) Hochr. (Hispid False Mallow)—1,3 [DG, GS]; S; NI; D-WEST; (Norton 173).

Montiaceae

*†*Phemeranthus calcaricus* (S. Ware) Kiger (Limestone Fameflower)—3,4,5,7,9 [DG, GS]; F; NI; INT; (Norton 101).

Oleaceae

†*Forestiera ligustrina* (Michx.) Poir. (Upland Swamp Privet)—1,2,3,4,5,6,7,8,9,10 [BV, GS]; C; FAC; SOUTH; (Norton 213).

Onagraceae

Gaura longiflora Spach (Longflower Beeblossom)—10 [DG, GS]; R; NI; WEST; (Norton 138).

†*Oenothera macrocarpa* Nutt. (Bigfruit Evening Primrose)—10 [DG, GS]; R; NI; D-WEST; (Norton 142).

Plantaginaceae

Leucospora multifida (Michx.) Nutt. (Narrowleaf Paleseed)—1,4,5,7,8,9,10 [DG, GS]; F; OBL; WEST; (Norton 150).

Mecardonia acuminata (Walt.) Small (Axilflower)—1,4,7,8,10 [DG, GS]; O; FACW; SOUTH; (Norton 158).

**Gratiola quartermaniae* D. Estes (Limestone Hedge Hyssop)—6 [GS]; R; FAC; INT; (Norton 342).

Penstemon calycosus Small (Long Sepal Beard Tongue)—10 [BV, DG, GS]; R; FACU; NORTH; (Norton 474).

Plantago virginica L. (Virginia Plantain)—1,3,6,7 [DG, GS]; O; FACU; INT; (Norton 488).

Polygalaceae

Polygala verticillata L. (Whorled Milkwort)—1,7,10 [BV, DG, GS]; I; UPL; INT; (Norton 485).

Portulacaceae

Portulaca oleracea L. (Little Hogweed)—1 [GS]; R; FACU; NON; (^).

Primulaceae

Dodecatheon meadia L. (Shooting Star)—1,7,9,10 [BV, DG, GS]; O; FACU; WEST; (Norton 421).

Ranunculaceae

Aquilegia canadensis L. (Red Columbine)—6,9 [DG, GS]; O; FAC; NORTH; (Norton 437).

*†*Delphinium carolinianum* Walt. ssp. *calciphilum* Warnock (Carolina Larkspur)—4,6,9,10 [BV, GS]; F; NI; INT; (Norton 451).

Rosaceae

Potentilla simplex Michx. (Common Cinquefoil)—5,7,8,9 [BV, DG, GS]; F; FACU; INT; (Norton 13).

Rubiaceae

Diodia teres Walt. (Poorjoe)—1,2,6,7,8,10 [BV, GS]; F; FACU; INT; (Norton 494).

Galium virgatum Nutt. (Southwestern Bedstraw)—6 [DG, GS]; S; NI; D-WEST; (Norton 434).

Hedyotis nigricans (Lam.) Fosberg (Diamond Flowers)—4,6,7,8,10 [DG, GS]; F; NI; WEST; (Norton 510).

Houstonia purpurea L. var. *calycosa* A. Gray (Venus' Pride)—1,4,5,6,7,8,9,10 [DG, GS]; C; NI; INT; (Norton 12).

Solanaceae

Physalis pubescens L. (Husk Tomato)—1 [GS]; R; UPL; INT; (Norton 186).

Solanum ptycanthemum Dunal (West Indian Nightshade)—1 [GS]; R; FACU; INT; (Norton 180).

Urticaceae

Pilea pumila (L.) A. Gray (Canadian Clearweed)—1 [BV, GS]; S; FACW; INT; (Norton 183).

Verbenaceae

Verbena simplex Lehm. (Narrowleaf Vervain)—1,4,5,6,10 [DG, GS]; F; NI; INT; (Norton 439).

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THE VASCULAR FLORA OF THE NORTH CENTRAL TEXAS WALNUT FORMATION

Rebecca K. Swadek
Texas Christian University
Department of Environmental Science
Botanical Research Institute of Texas
1700 University Drive
Fort Worth, Texas 76107-3400, U.S.A.
rswadek@brit.org

Tony L. Burgess
Texas Christian University
Department of Environmental Science
TCU Box 298830
Fort Worth, Texas 76129, U.S.A.
t.burgess@tcu.edu

ABSTRACT

Political boundaries frequently define local floras. This floristic project takes a geological approach inspired by *Dalea reverchonii* (Comanche Peak prairie clover), which is primarily endemic to glades of the Walnut Formation. The Cretaceous Walnut Formation (Comanchean) lies on the drier western edge of the Fort Worth Prairie in North Central Texas. Its shallow limestone soils, formed from alternating layers of hard limestone and clayey marl, support a variety of habitats. Glades of barren limestone typically appear on ridgetops, grassland savannas form on eroding hillslopes, and seeps support diverse hyperseasonal vegetation. Vouchers were collected from January 2010 to June 2012 resulting in 469 infraspecific taxa, 453 species in 286 genera and 79 families. The richest five plant families are Asteraceae (74 taxa), Poaceae (73), Fabaceae (34), Euphorbiaceae (18), and Cyperaceae (17). There are 61 introduced species. Results indicate floristic affinities to limestone cedar glades of the Southeastern United States, the Edwards Plateau of Central Texas, and calcareous Apacherian Savannas of Southwestern North America.

RESUMEN

Las fronteras políticas definen frecuentemente las floras locales. Este proyecto florístico toma una aproximación geológica inspirada en *Dalea reverchonii* (trébol de la paradera de Comanche Peak), que es primariamente endémico de los claros de la formación Walnut. La formación Cretácica Walnut (Comancheana) está en el borde oeste más seco de la pradera de Fort Worth en el Norte-Centro de Texas. Sus suelos calcáreos poco profundos, formados por capas alternas de calizas duras y margas arcillosas, soportan una variedad de hábitats. Aparecen típicos claros de calizas estériles en las cumbres, sabanas herbáceas en las laderas erosionadas, y filtraciones soportan una vegetación hiperestacional diversa. Se colectaron testigos des enero de 2010 a junio de 2012 dando como resultado 469 taxa infraspecíficos, 453 especies in 286 géneros y 79 familias. Las cinco familias de plantas más ricas son Asteraceae (74 taxa), Poaceae (73), Fabaceae (34), Euphorbiaceae (18), y Cyperaceae (17). Hay 47 especies exóticas. Los resultados indican afinidades florísticas con las calizas de cedar glades del sureste de los Estados Unidos, el Edwards Plateau del centro de Texas, y sabanas calcáreas Apacherianas del suroeste de Norte América.

INTRODUCTION

In Texas, few floras have been published, and these traditionally have been defined by political boundaries such as Neill's flora of Madison County, Texas (Neill & Wilson 2000). Correll and Johnston's *Manual of the Vascular Plants of Texas* (1970) is the only statewide flora, published 42 years ago. Floras completed in Texas are seldom published in peer-reviewed journals, and many languish as theses hidden in university libraries. These are often merely checklists of species encountered during the survey, lacking detailed ecological data. While checklists are critical baselines, more useful insights are possible with associated ecological information.

Cuyler (1931) and Tharp (1939) both stated that geology is often a strong determinant for vegetation. Kruckeberg (2004) provides an impeccable argument for the importance of geology and landform on plant communities. Yet, floras and herbarium specimens rarely include geological data—information often valuable for understanding rare and endemic species. This study has a geological context inspired by these works and the endemic *Dalea reverchonii* (Comanche Peak prairie clover).

Dalea reverchonii (Fabaceae), endemic to North Central Texas, was first collected on Comanche Peak in Hood County, 1876 by Julien Reverchon. Originally described as *Petalostemum reverchonii*, it was not found again until the early 1980s (Mahler 1984). Subsequent collections revealed that *D. reverchonii* is almost restricted to rocky glades and barrens of the Walnut Formation (O'Kennon pers. comm.). This contradicts Poole

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et al. (2007), who stated *D. reverchonii* is observed only on Goodland Limestone. There is one exception: at the type locality on the butte of Comanche Peak, the only population found south of the Brazos River, *D. reverchonii* grows on Edwards Limestone; thus it is not strictly endemic to the Walnut Formation. There may be other undiscovered populations south of the Brazos River and on other formations.

While much of North Central Texas geology is limestone or chalk, the extensive glades of the Walnut Formation are structurally and floristically unique to the region. Over a century ago William Bray, an early Texas plant ecologist, stated, "before the flora of Texas suffers further radical changes, the schools of the state ought to cooperate in securing a complete and authentic list of species represented by carefully collected and well-preserved specimens" (Bray 1906). Since then, Texas has witnessed accelerated urban development, yet we still lack basic knowledge of the state's natural history. This vascular flora of the North Central Texas Walnut Formation combines the goals of securing vouchered specimens and generating an ecologically relevant circumscription of a floristic area.

This project had three objectives: 1) Collect, identify, and archive specimens of the vascular plants found on the northern portion of the Walnut Formation as mapped by the Geologic Atlas of Texas (McGowen et al. 1987, 1991); 2) List all species and delineate their preferred habitats, including major plant associations with relevant geological, pedological, and hydrological data; and 3) Analyze the flora for rare, endemic, invading, and disjunct taxa.

Geographical Context

Names among different treatments designating physiographic regions, vegetation areas, and ecoregions differ; thus the area covered by this flora has been included in different geographic contexts which are reviewed below.

Four currently recognized ecoregions dominate North Central Texas north of the Brazos River: running west to east, the West Cross Timbers, Fort Worth or Grand Prairie, East Cross Timbers, and Blackland Prairie (Fig. 1). In his monograph on Texas vegetation east of the 98th parallel, Tharp (1926) did not distinguish the better-known Blackland Prairie, which begins near Dallas, from the Grand Prairie; however, Hill (1901) described key differences between the two prairies. The Grand Prairie is much flatter and has more angular scarps than the gentle rolling plains of the Blackland Prairie. Shallower soils and bedrock of erosion-resistant limestone strata alternating with softer sediments distinguish the Grand Prairie, which is recognized by the name "hard lime rock region," where limestone-topped cuestas and mesas are part of the landscape (Hill 1901). The Blackland Prairie is underlain by chalk and shale, which weather deeply to form characteristic black, calcareous, heavy clay soils (Diggs et al. 1999). The Blackland Prairie is a true tallgrass prairie dominated by *Andropogon gerardii, Panicum virgatum, Schizachyrium scoparium, Sorghastrum nutans,* and *Tripsacum dactyloides,* with wildflowers and occasional mottes. Only the Austin Chalk Formation is capable of forming escarpments in the Blackland Prairie region (Diggs et al. 1999, Hill 1901). The fertile, rich, deep clays, combined with new plowing technologies, allowed cotton farming to proliferate in the Blackland Prairie during the late 1800s, destroying much of the native tallgrass prairie (Diggs et al. 1999).

Hill, a geologist with a keen eye for landforms, defined the Grand Prairie physiographic subprovince as a "northern continuation of the Edwards Plateau" (1901). This subprovince extends from the Red River to the Colorado River, bounded on the east by the Eastern Cross Timbers and, farther south, by the Balcones Fault zone. "The northern and irregular western borders of the Grand Prairie terminate in the low inward-facing escarpment … which overlooks the valley of the Western Cross Timbers" (Hill 1901). This escarpment includes many of the Walnut Formation outcrops north of the Brazos River. Hill recognized two subdivisions of the main body of the Texas Grand Prairie: Fort Worth Type Prairie and Lampasas Cut Plain.

The Lampasas Cut Plain was described as "plains more scarped and dissected into numerous low buttes and mesas" (Hill 1901), starting south of the Trinity River in Parker County along the western edge of the Grand Prairie and increasing in width south of the Brazos River. This includes most of the Walnut outcrops in Parker and Johnson counties.

Hill's Fort Worth Type Prairies extend north and east of the Lampasas Cut Plain to the Red River. Hill

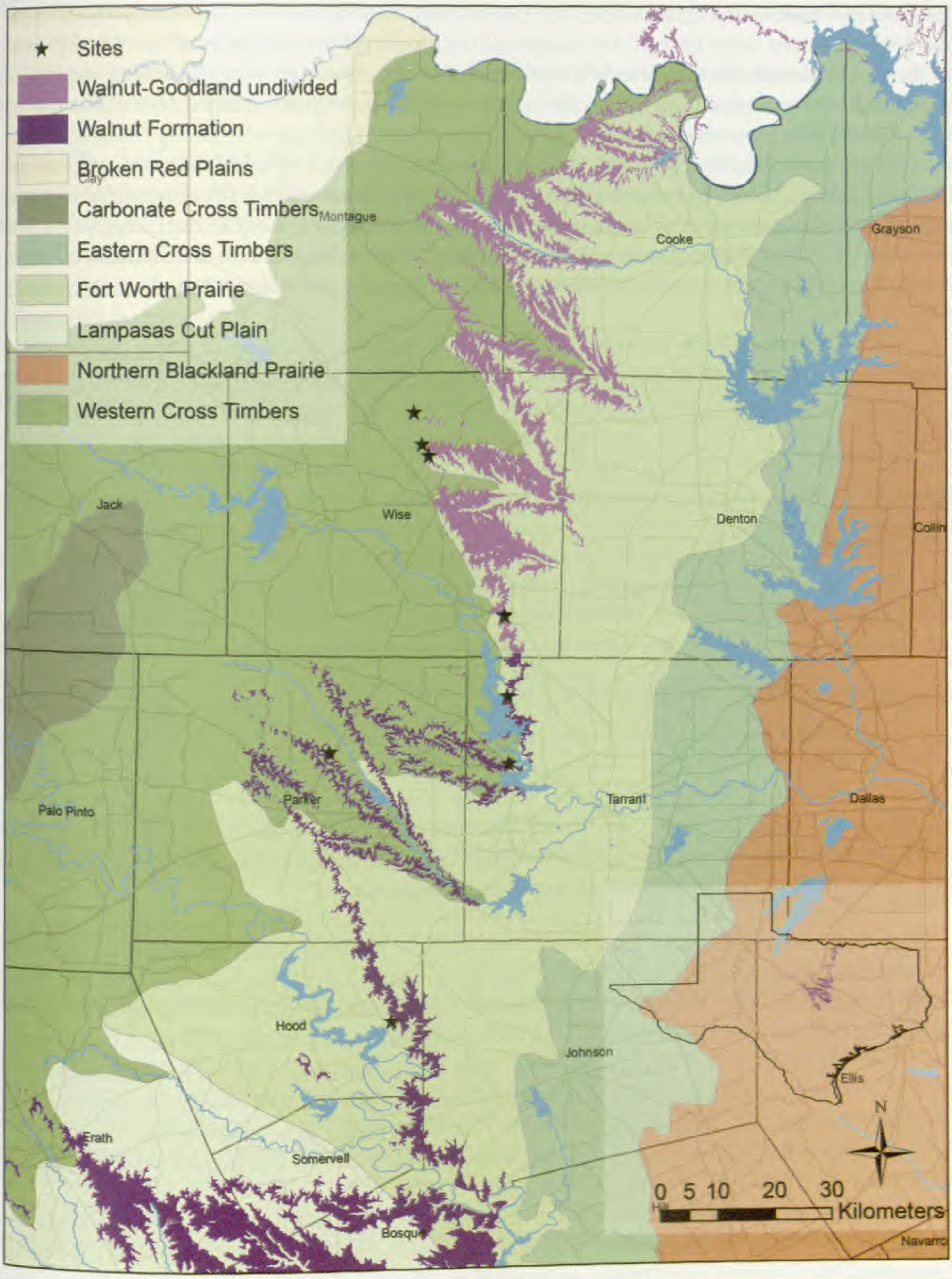

FIG. 1. The Walnut Formation and the undivided Walnut and Goodland formations in relation to the Level IV Ecoregions of Texas as described by Griffith et al. (2004) using the terminology from Hill (1901) and Diggs et al. (1999). In the bottom right is the extent of the Walnut Formation in Texas. Data adapted from Texas Natural Resources Information System and the Environmental Protection Agency.

described two subdivisions of Fort Worth Type Prairies north of the Brazos River, aligned approximately parallel between the two Cross Timbers. The Gainesville Prairie is to the east, and the 'true' Fort Worth Prairie is on the west in Tarrant, Denton, Wise, and Cooke counties. Thus, within the area of this flora, the northern Walnut outcrops are within Hill's Fort Worth Prairie, while the southern are included within the northward attenuation of Hill's Lampasas Cut Plain.

Dyksterhuis defined the Fort Worth Prairie as "the northern portion of the physiographic unit known as the Grand Prairie" (1946), and mapped it to cover all of Hill's province north of the Brazos River Valley, including areas of Parker, Hood, and Johnson counties that Hill considered Lampasas Cut Plain. Diggs et al. (1999) subdivided the Grand Prairie vegetational region into the Fort Worth Prairie north of the Brazos, as Dyksterhuis had, with the Lampasas Cut Plain to the south. In these maps, the area of this flora lies in the western edge of the Fort Worth Prairie.

Names are different in the *Ecoregions of Texas* map (Griffiths et al. 2004), which shows two hierarchical classification levels. At Level III, Texas Blackland Prairies are distinguished from Cross Timbers. Within the Cross Timbers Ecoregion, Level IV ecoregions are Eastern Cross Timbers, Western Cross Timbers, Grand Prairie, and Limestone Cut Plain. The Grand Prairie Ecoregion is between the East and West Cross timbers, extending from the Red River south to the Brazos Valley, corresponding to the Fort Worth Prairie as defined by Dyksterhuis (1946). Using the Environmental Protections Agency Level IV map, the area of this flora is along the western boundary of the Grand Prairie, with outliers in the nearby Western Cross Timbers.

The Fort Worth Prairie is described as a grassland historically devoid of trees except in waterways (Diggs et al. 1999; Dyksterhuis 1946). Dyksterhuis (1946), sampling between 1939 and 1944, found that *Nassella leucotricha* had the greatest coverage. Other common perennial grasses were *Aristida* spp., *Bothriochloa laguroides*, *Bouteloua curtipendula*, *Buchloe dactyloides*, *Schizachyrium scoparium*, and *Sporobolus compositus*. Among these, only *Schizachyrium scoparium* is considered typical of tallgrass prairie, and Dyksterhuis proposed that its relative abundance was negatively correlated with grazing disturbance (1946). Dyksterhuis emphasized that "the abundance of annuals is regarded as a most significant feature" of the Fort Worth Prairie, comprising about 20% of the vegetation (1946). Common annuals included cool season species such as *Bromus japonicus*, *Hordeum pusillum*, and *Plantago* spp., together with such warm season species as *Gutierrezia dracunculoides* and *Sporobolus vaginiflorus*. In the Grand Prairie Ecoregion description, *Sorghastrum nutans* and *Andropogon gerardii* are included as representative grasses (Griffiths et al. 2004), though Dyksterhuis (1946) indicated they were seldom dominant except in "relict" sites protected from grazing.

The upland soils of the Fort Worth Prairie differ from typical prairie soils. They are mapped as calcareous mollisols, inceptisols, and entisols (Ressel 1981). Immature soils overlie the limestone and clayey parent material, showing weakly developed horizons with high concentrations of calcium carbonate, clay, and organic matter (Dyksterhuis 1946). The xeric aspects of the Fort Worth Prairie are due to the structure of shallow calcareous soils, which retain limited moisture. Hill (1887) hypothesized that they have too much lime to support tree growth. The shallow soils and hard limestone make tilling impossible, and thus have encouraged cattle grazing as the primary land use (Diggs et al. 1999; Dyksterhuis 1946; Hill 1901). Today grazing pressure and fire suppression have had the greatest impact on the Fort Worth Prairie, promoting weedy species introduced for forage and species that can withstand grazing, and encouraging invasive woody species that were not present 60 years ago (Diggs et al. 1999; Dyksterhuis 1946).

The Western Cross Timbers border the western edge of the Fort Worth Prairie. Often the boundary occurs where the Walnut Formation abuts deep, non-calcareous, sandy soils derived from Paluxy and Antlers Formations. The Western Cross Timbers are strips of woodlands and savannas, intermixed with occasional prairie openings (Francaviglia 2000; Harris 2008; Kendall 1845; Tharp 1939). The arenaceous and siliceous, mildly acidic alfisols of the Western Cross Timbers create a matrix with adequate water storage, which tree roots can penetrate deeply (Dyksterhuis 1948; Harris 2008; Hill 1887; Sims and Risser 2000). *Quercus stellata* (post oak) and *Quercus marilandica* (blackjack oak) are the dominant trees, interspersed with elms, hackberries, and greenbriars (Dyksterhuis 1948; Harris 2008; Hill 1887; Kendall 1845; Tharp 1939). Washington Irving (1985) described these woodlands as "forests of cast iron" due their hardiness and density. The adaptations of post and blackjack oaks to moderate drought allow them to expand further westward than most other trees of the Eastern deciduous forest (Tharp 1939).

As noted above, the northern boundary of the Lampasas Cut Plain has differed tremendously over the last century (Diggs et al. 1999; Gould 1960; Griffith et al. 2004; Hill 1901). In the Lampasas Cut Plain, Hill described the most representative portion of the Walnut Formation, the Walnut Prairie; where the strata are more extensively exposed (Griffith et al. 2004; Hill 1901; McGowen et al. 1987). In this region, Walnut geology supports prairies on valley floors instead of more xeric uplands as in the Fort Worth Prairie. Kendall (1845) also noted a difference in the landscape as he crossed north of the Brazos River during his expedition. In the Lampasas Cut Plain, the Edwards Limestone outcrops more frequently as hard, resistant caps on the mesas and buttes. Southward, the Lampasas Cut Plain and Edwards Limestone are less dissected, forming the beginning of the Edwards Plateau.

Geology of the Walnut Formation

The Walnut Formation, underlying the western edge of the Fort Worth Prairie and parts of the Lampasas Cut Plain, is exposed in at least 18 counties in Texas, mostly south of the Brazos River (Sellards et al. 1932; United States Geological Survey 2010). Mapped as Walnut Clay, it is part of the Lower Cretaceous Fredericksburg Group, which formed during the Comanchean period 103 million years ago (McGowen et al. 1987, 1991). The Walnut Formation is largely composed of limestone and less consolidated strata variously termed marl, calcareous clay, or shale. It is about 23 m thick in Parker and Tarrant counties and about 8 m thick in Wise County, thinning inland north and west (Sellers et al. 1932; Scott et al. 2003). The Walnut Formation is thicker and more exposed farther south, eventually thinning again at the base of the Edwards Plateau (McGowen et al. 1987, 1991).

By nomenclatural convention, the Walnut Formation overlies the Paluxy Sandstone south of Decatur, Texas; whereas north, the Antlers Formation is beneath. The Glen Rose Formation defines the separation between the Paluxy and Twin Mountains Formations; however, the Glen Rose Formation is absent north of Decatur, forcing the combination of Paluxy and Twin Mountains into the Antlers Sands (McGowan et al. 1987; McGowen et al. 1991). For the remainder of Texas, the Glen Rose Limestone is the underlying formation instead of the Paluxy and Antlers sandstones (Fig. 2). This has been described as an unconformity because "the Paluxy was deposited in a regressive sea, which readvanced over the land, depositing the Walnut Formation" (Sellards et al. 1932).

The Goodland Limestone overlies the Walnut Formation in Parker and Tarrant counties and is undifferentiated from the Walnut on geologic maps in Wise and Montague counties, making outcrops harder to locate. Goodland Limestone can be distinguished from Walnut Limestone by its nodular fabric, paler whitish color, and decreased abundance of *Texigryphaea* fossils. In Hood, Johnson, and Somervell counties, nearer the Brazos River, the Goodland thins, the Walnut expands, and Comanche Peak and Edwards limestones are exposed as the overlying formations. The boundary between Goodland and Walnut Formations is not clearly defined. The lower Marys Creek Member of the Goodland Formation in Tarrant County has been traced southward to match the upper marl interval of the Walnut Formation beneath the Comanche Peak Formation, leading to the proposal that north of the Parker-Hood County line the Marys Creek Marl be considered part of the Goodland Formation; whereas to the south it is within the Walnut (Scott et al. 2003). The Walnut Formation is also known in Oklahoma, where it is associated with Goodland Limestone (Hill 1901), and in West Texas, where it is largely associated with the Edwards and Comanche Peak formations, as on Double Mountain in Stonewall County (Eifler 1993).

Hill (1901) described the Walnut Formation as clay and nonchalky limestones making up the base of the Fredericksburg Division, consisting of "alternations of calcareous laminated clays, weathering yellow on oxidation, semicrystalline limestone flags, and shell agglomerate. … In places they weather into rich black soils and make extensive agricultural belts" (Hill 1901). In the area of this flora, many Walnut Limestone strata are easily recognizable as coquinites or shell agglomerates dominated by fossil *Texigryphaea*, which are relict storm beds. Fresh exposures are blue in color and weather cream to yellow and olive in flaggy layers. Marls

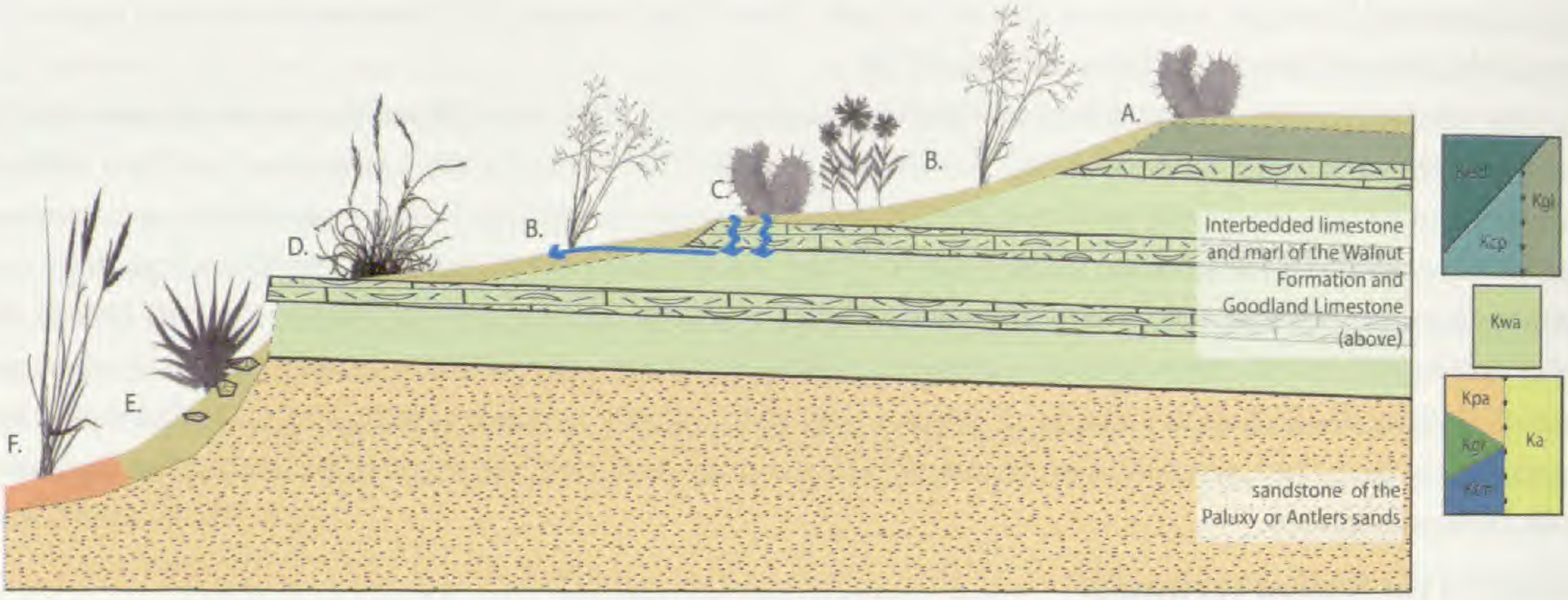

Fig. 2. A typical Walnut Formation landscape overlying Paluxy or Antlers sands and underlying Goodland Limestone showing the general stratigraphy of the Walnut Formation. Interbedded limestones and sands of the Fort Worth Prairie are distributed across North Central Texas. The Edwards (Ked), Comanche Peak (Kcp), or Goodland (Kgl) limestones overlay the Walnut Formation (Kwa). Their basal layer, at A, is a marl layer above the uppermost layer of Walnut Limestone where shallow soils formed over cracked limestone form barrens. Water flows vertically through limestone cracks until it hits an impermeable shale or marl layer, which forces lateral flow, causing water to seep out on the hillslope. Here, at B, soil is saturated through the spring and early summer. Soil dries out completely in late summer, supporting a habitat of hyperseasonal sedges, rushes, and grasses. At C, shallow soil, entisols and mollisols greater than 5 cm deep, forms over limestone creating barrens. This habitat is composed of geophytes, succulents, grasses, and forbs, which have very shallow roots or are able to persist in limestone cracks. At D, limestone is exposed, having no soil to very gravelly entisols less than 5 cm deep, forming a glade habitat. Sheet flow keeps soil from forming and thus vegetation is sparse. At E, the sandstone is not able to support the upper, more resistant layers and it begins eroding forming steep hillslopes. The marl then begins to slump and the lowest limestone shelf begins crumbling forming colluvial slopes of limestone topsoil overlying sandstone and causing an extension and mixing of calcareous and arenicolous species. At F, when the limestone topsoil is no longer present, sand species dominate, tall grasses can persist, and the post and blackjack oak forest begins, creating the Western Cross Timbers on Paluxy (Kpa) or Antlers (Ka) sands. Further south in the Edwards Plateau, the Walnut overlies the Glen Rose Limestone (Kgr). Please note, this is a diagram and is not drawn to scale.

between limestone layers vary in thickness and are easily penetrated by roots. The base of the Walnut consists of calcareous clays intercalated with cemented limestone (Hill 1901). The Goodland, Comanche Peak, and Edwards formations are paler and chalkier than the yellows and browns of the Walnut Formation, helping to distinguish them visually (Hill 1901).

The Walnut Formation developed through marine sedimentation in the Lower Cretaceous when the Gulf of Mexico spread inland, covering Texas. The Lower Cretaceous formations tend to be some of the largest regional formations, extending from mountainous boundaries in Oklahoma to Mexico. Deposited along belts through marine influence, the harder limestones alternate with clay and overlie sands, creating dip and cut plains as well as low escarpments carved by erosion (Hill 1901). To the east, younger geological layers are encountered on top of the Walnut, dipping eastward. These layers are eroded into gentle east-facing slopes, until a resistant limestone layer is exposed. Here a steep, west-facing slope is formed by rapid erosion of a less resistant layer below the harder cap, creating a cuesta topography with gentle plains sloping east and steep west-facing escarpments. The limestone layers make erosion resistant shelves connected by erodible slope-forming marl layers (Diggs et al. 1999; Dyksterhuis 1946; Hill 1901).

The Walnut Formation is unique in the contrasting lithification of its strata, which creates the diversity of modern habitats. There are deep clays, hard limestone glades, and shallow barrens soils derived from marls and fossil shell fragments. Seeps are also abundant on barrens and slopes, and they often interact with the underlying sands. Slope seeps frequently occur where water flows through fractured limestone and meets less permeable clay or less weathered massive limestone layers, creating a perched water table, causing water to flow laterally, and emerge as a seep where the stratum is exposed (Burgess and Busbey 2010, Llado 2011) (Fig. 2). Quaternary alluvial deposits over Paluxy Sandstone make up the bulk of soil parent materials in river valleys adjacent to upland Walnut exposures (Eifler 1993; McGowen et al. 1987; McGowen et al. 1991).

Site Description

The Red, Trinity, and Brazos rivers are the principle waterways, excluding lakes, that cross through the Walnut Formation. The Brazos is the southern boundary for the study site and the Red River the northern boundary. Several tributaries and headwater streams of the Trinity River run through the northern part of the Walnut exposures within the study area. For this research, the targeted area of the Walnut Formation lies between approximately 32.25° and 34°N and -97.25° and -98° W within the study area. The Walnut Formation extends much farther west and south beyond the borders of the study site (Fig. 1).

The area and elevation range of the Walnut Formation is difficult to calculate, as these data are not typical in geologic maps, and have not been found in any geological literature. Based on estimates, the area equates to around 390 sq km (McGowen et al. 1987). The elevation of collected vouchers ranges from a low of about 225 m in Tarrant County to a high of 435 m in Parker County.

Tarrant County receives an average of 86 cm of rainfall per year decreasing to the west and increasing to the east. The first freeze occurs around November 17 each year and the last freeze around March 15 (Alvarez & Plocheck 2011), yielding an average growing season of 249 days (National Oceanic and Atmospheric Administration 2012). The climate is described as humid subtropical with hot summers, having annually wide temperature variations and mild winters (National Oceanic and Atmospheric Administration 2012). The rainfall and temperature patterns during the duration of this study, yielded lower than normal rainfall, 51 to 56 cm, and 2011 was one of the hottest summers on record based on data from the KNFW weather station in southwest Fort Worth (National Climatic Data Center 2012).

METHODS

Vascular plants were collected on the Walnut Formation north of the Brazos River from January 2010 to June 2012, both on the formation and on slopes below Walnut outcrops, where colluvial deposits of marl and coquinite cover Paluxy and Antlers sands. Here the calcareous sediments interact with the sand, extending the range of the prairie limestone flora downslope into the Western Cross Timbers.

Maps from *The Geologic Atlas of Texas* identified approximate boundaries of the Walnut Formation. McGowen et al. (1987) covers the area north of the Brazos River in Parker, Tarrant, Johnson, and Hood counties. McGowen et al. (1991) covers Wise and Montague counties directly north; however, the Goodland and Walnut formations are undivided on this map. Tarrant, Parker, Wise, Johnson, and Hood counties contained the study sites, as no significant outcrops were known from Montague County.

Walnut Formation outcrops were verified using geologic maps and the presence of distinctive massive limestone strata with abundant *Texigryphaea*. First, potential sites were located using geologic maps, then publicly accessible areas were located. Since public parks spanned a broad north-south gradient, fewer private lands were surveyed. GIS maps were created showing the Walnut Formation overlaid with county streets to target stretches of road with high percentages of Walnut Outcrops.

Voucher herbarium specimens were collected using the "meander search" method (Hartman & Nelson 2008), in triplicate - when possible. If only one plant was present, a photographic voucher was taken to help preserve the population. Specimens were identified using *Shinners & Mahler's Illustrated Flora of North Central Texas* (Diggs et al. 1999), which is the basis for nomenclature. *Flora of North America* and recent publications were also used (Estes & Small 2007; Kiger 2004; Nesom 2006; Smith et al. 2003) for identifications of species named or discovered in the area since 1999. Identifications were confirmed with herbarium specimens at the Botanical Research Institute of Texas (BRIT). Experts consulted include Bob O'Kennon, Barney Lipscomb, and Amanda Neill (BRIT). Specimen data include the date, soil type, habitat description, associated plants, species abundance, images of the plant and its habitat, locality, and GPS coordinates. References to protocol include Davis (1961), Diggs et al. (1999), Jennings et al. (2009), and Neill and Wilson (2000). Data and field images were imported into Atrium (BRIT Digital Herbarium 2012), an online biodiversity information system for public access. Specimens were archived in the BRIT Herbarium. Duplicates were shared with TEX/LL and TAES. The Fort Worth Nature Center and Refuge received the duplicates of specimens collected there, instead of TAES.

There were 835 collections from the North Central Texas Walnut Formation made by the authors. The BRIT Herbarium was consulted for other collections not included in the 835; thus all specimens cited are deposited at BRIT. The authors did not personally verify the exposed geologic stratum for all specimens collected by other botanists unless they were from specific sites or collecting events. Legacy collections, from BRIT, were included due to their presence on the Walnut Formation based on GPS coordinates and associated plant species. If Goodland Limestone was mapped within 200 m of the plants GPS location, the stratum the specimen was found upon was questionable and the collection omitted from the checklist.

A full checklist of the flora was created, and the flora was analyzed for rare or endemic taxa, invasive or potentially invasive species, and disjunct taxa. Relevé plots were completed for plant communities common to the Walnut Formation. Sites were subjectively selected based on local knowledge of representative sites and availability. Random site selection was avoided, as the objective was to define homogenous and repetitive plant communities in similar topographic, geological, and pedological contexts. This was done to confirm plant associations within and across geological formations, and to facilitate future comparisons (Jennings et al. 2004). Plots ranged in size and edges were avoided to reduce variability and to ensure the similarity of communities. Data collected for each plot includes GPS location, exposed geologic stratum, soil, hydrologic regime, slope, aspect, topographic position, percent cover and height class for each plant species present, and percent cover of non-vascular species and abiotic factors.

Plant communities were described as in Jennings et al. (2009). Associations are named using dominant and diagnostic taxa for each community. Taxa found within the same stratum are indicated by a hyphen, in different strata by a slash, and parenthetic notations indicate lower constancy or confidence. The order of species names indicates decreasing dominance (Jennings et al. 2009). No formal quantitative analysis on the relevé data was done; these associations are based largely on observation and constancy of dominant and diagnostic species. The authors believe many of the following communities are widespread enough to warrant tentative recognition in the Association Records database (NatureServe 2012b).

RESULTS AND DISCUSSION

Results of the study are included in the following sections: Major vegetational habitats, Comparison with the Walnut Formation South of the Brazos River; Unique Sites; Floristic Comparisons; Range Extensions, Invaders, Endemic Taxa; and Summary of Taxa.

MAJOR VEGETATIONAL HABITATS

While plant communities may not be mappable units as defined by the Ecological Society of America Vegetation Classification Panel (2011), these provisionally named associations are patterns that were consistently encountered throughout the North Central Texas Walnut Formation and could be studied further for consideration as recognized associations.

Plant communities aligned almost perfectly with geological and pedological boundaries. Soil depth and type were best indicated by vegetation structure and cover. As soil depth decreased, there was a strong correlation with light intensity as the canopy cover decreased (Fig. 3). The exception is weathered limestone with pockets of soil accumulation in deep crevices, allowing trees to take root and create a shady canopy as in a limestone scrub woodland.

While the Fort Worth Prairie was a mixed grass prairie in the 1940s, fire suppression and overgrazing converted it to a savannah (Fuhlendorf & Engle 2004; Mayer & Khalyani 2011). Shorter grasses dominate with decreasing soil depth. There are surges of annuals in the spring and fall coinciding with seasonal rains. Within the herb stratum, perennial forbs, annuals, and succulents dominate the spring, while herbaceous perennial bunchgrasses dominate the fall.

Due to the structural similarity of these habitats with limestone cedar glades in Alabama, Kentucky, and Tennessee, we follow the habitat designations described by Baskin and Baskin (1996, 2003) and Quarterman (1950a, 1950b, 1989). Glades are open areas of exposed Walnut Limestone with 0 to 5 cm soil. Here soil forms primarily in limestone cracks yielding patchy vegetation, typically less than 50 percent cover; though some

Fig. 3. Rhome, Texas site south of Highway 114, west of Highway 287: soil depth as it relates to light intensity in a typical Walnut Formation landscape. As soil depth increases over limestone bedrock, root depth increases. Shrubs and trees begin to establish themselves creating woodlands; here light intensity decreases, creating a refuge for sciophytes. The opposite is true on shallow soiled glades and barrens.

plants are capable of surviving in shallow soil over limestone. Barrens have slightly deeper soil, 5 to 25 cm over bedrock, and generally have more than 50 percent vegetative cover during the peak growing season. Seeps form on glades and barrens after cool-season rains when water pools and is unable to percolate through relatively impermeable limestone. Seeps also form on hillslopes when water infiltrates vertically through fractured limestone and reaches a less permeable clayey stratum, where it flows laterally and seeps out where the stratum is exposed on hillslopes. Glades, barrens, and seeps have low vegetation open to full sunlight, though occasionally mottes of *Juniperus* spp., *Quercus* spp., or *Rhus* spp. will form. Limestone scrub woodlands often occur on ridgetops above the contact with Paluxy or Antlers sand where instead of a glade, trees have taken root in cracks creating a refuge for sciophytes (Fig. 2).

Glades traditionally are composed of climax communities (Baskin & Baskin 2003; Jones 2005; Quarterman 1989) with cyclical changes in composition rather than directional changes. During a rainfall event, runoff or overland flow moves soil over nearly impermeable limestone, where it is deposited in cracks and removed from bare limestone, encouraging a glade habitat. Over time, soil accumulates in cracks and crevices and plants take root. Vegetation slows runoff, allowing soil to accumulate, and trees to take hold in the cracks, shifting the community dynamics. Removal of trees or drought can shift the community from mesic or woodland back to a glade (Quarterman 1989).

Glades, barrens, seeps, and limestone scrub woodlands form a rolling to scarped mosaic over Walnut Limestone that is unique to this area of North Central Texas, where most of the limestones are too chalky to form the erosion-resistant scarps or glade habitats. Our terminology differs from limestone cedar glade habitats in the southern Appalachians in that we use the term "Walnut Limestone Glade," though this is somewhat a misnomer because walnut trees do not dominate them as cedars do in the southeast; rather the Walnut Limestone is the geological stratum of the these habitats, the formation name having no relation to the dominant plants.

Glades:

Glades are quite extensive and are characteristic landscape features on the Walnut Formation. Glades are open areas of exposed limestone outcrops and rocky areas with soils around 0 to 5 cm deep. Texigryphaea fossil shell fragments usually dominate surfaces. The most common soils in Hood, Parker, and Tarrant counties are clayey upland paralithic entisols in the Maloterre Series (Colburn 1978; Greenwade et al. 1977; Ressel 1981). In Wise County, the Maloterre Series is not mapped and glades are shown to be associated with the Somervell or Venus Series, both mollisols (Ressel 1989), which, following field investigations, do not appear to be present on glades. The soils associated with glades in Wise County are very gravelly, shallow, undeveloped soils over limestone. They have no mollic epipedon and are likely entisols.

Glades are frequently found on ridge tops at the LBJ National Grasslands. Elsewhere glades are found next to incised stream channels or where large expanses of impermeable limestone are found near the surface below hillslopes. During storm events, impermeable limestone provides little to no infiltration of runoff, creating what is arguably infiltration excess (Hortonian) overland flow, thus preventing or slowing soil development.

Thus, glades are free of trees, except for occasional mottes, and shallow soils are incapable of retaining much water, thus plants are often succulent or extremely shallow rooted. Deep-rooted perennials establish their roots in limestone cracks; some probably extend roots to the marl, which has greater water holding potential. Glades are dominated by gravel or open soil, usually with less than 50 percent herbaceous coverage. The glades are a distinct habitat of specialized, often endemic plants. Few plants are weedy or characteristic of ruderal habitats.

***Aristida purpurea* var. *nealleyi*—*Erioneuron pilosum*—*Dalea* spp.—(*Lesquerella engelmannii*) Limestone Glade Herbaceous Vegetation Association.**—Dry glades tend to be present on ridgetops or upslope of glade seeps where the soil is well drained. Common perennial bunch grasses are *Aristida purpurea*, *Digitaria cognata*, *Erioneuron pilosum*, and *Tridens muticus*. *Limnodea arkansana* and *Vulpia octoflora* are the dominant cool season annual grasses, while *Sporobolus ozarkanus* is the dominant warm season annual grass. Other common components of dry glades include perennial herbaceous dicots such as *Dalea reverchonii*, *D. tenuis*, *Grindelia lanceolata*, *Lesquerella engelmannii*, *Paronychia virginica*, *Sida abutifolia*, scattered succulents including *Coryphantha sulcata*, *Escobaria missouriensis*, *E. vivipara*, *Opuntia phaeacantha*, and *Talinum calcaricum*, various non-vascular plants, and lichens.

Bouteloua curtipendula, *Prunus rivularis*, and *Schizachyrium scoparium* can be found in deep limestone crevices or on glade edges where the hillslope begins. As the glade thins, at the edge of the hillslope, the vegetation thickens. The species listed above are present in greater densities and *Asclepias asperula*, *Artemisia ludoviciana*, *Bouteloua curtipendula*, and *Liatris mucronata* may become dominant.

***Dalea reverchonii*—*Talinum calcaricum*—*Minuartia michauxii* Limestone Glade Herbaceous Vegetation Association.**—In less disturbed sites, this association occurs where soil has been thinned by erosion on the upslope side of a limestone expanse, or where shallow soil has started to accumulate on the downslope side of a glade. This interesting glade association is not locally extensive, but it is widespread among glades and may be more appropriately called a sub-association; however, when present the association is distinctive and recognizable on extremely shallow, clayey soils bordering expanses of bare limestone. *Nostoc commune*, *Sedum nuttallianum*, and *Sporobolus ozarkanus* are very common in these associations.

Barrens:

Glades are often surrounded by barrens or areas of locally thin soils, at least 5–25 cm deep, with small patches of exposed bedrock, rock fragments, and cryptogamic crusts. Barrens may also be on benches where there is more topographic relief; often they are interspersed with seeps. Dominated by bunch grasses, *Schizachyrium* *scoparium, Muhlenbergia reverchonii* (on wetter sites), *Aristida purpurea, Bouteloua pectinata, B. hirsuta*, and *Tridens muticus* are the typical species in this habitat; *Opuntia phaeacantha, Yucca pallida*, various herbaceous perennials, and cool-season and warm-season annuals are also present. Barrens have deeper soils incapable of supporting larger woody species; solitary trees are uncommon, but mottes of *Forestiera pubescens, Juniperus* spp., *Quercus fusiformis, Rhus* spp., and *Ulmus crassifolia* are common and provide a habitat for vines and sciophytes, thus supporting a unique microhabitat.

Opuntia phaeacantha tends to prefer drier upland barrens. *Schizachyrium scoparium* and *Yucca pallida* tend to occur on sloping, well-drained sites with good drainage and deeply weathered limestone or marl at the surface.

***Opuntia phaeacantha—Gaillardia pulchella—Liatris mucronata—(Tridens muticus)* Herbaceous Vegetation Association.**—Found on upland barrens with little to no slope, the association is quite common in shallow soil over limestone. Soils are usually paralithic entisols of the Maloterre Series or shallow, dark mollisols of the Aledo or Bolar Series. *Opuntia phaeacantha* and *Gaillardia pulchella* are common indicators occurring with various bunch grasses. *Liatris mucronata* and *Tridens muticus* are also both common components but vary in dominance. Typical perennial bunch grasses include *Aristida purpurea, Bouteloua rigidiseta, Nassella leucotricha*, and *Panicum oligosanthes. Nassella leucotricha* was not found in great abundance in 2010 and 2011, but following two of the hottest and driest summers on record, *N. leucotricha* was a more dominant member of this barrens community than *Tridens muticus*. Dominant annuals include *Bifora americana, Limnodea arkansana, Monarda citriodora, Plantago* spp., *Tetraneuris linearifolia*, and *Thelesperma filifolium. Bromus japonicus* is a successful invader of this habitat, outcompeting native grasses with exceptional success in wetter years, becoming the dominant species.

***Sporobolus compositus—Yucca pallida—Bouteloua* spp.—*Aristida purpurea* Herbaceous Vegetation Association.**—Found on mid to low slopes typically in marls, where the soil appears to be more clayey than typical Walnut loams, the soil is often mapped as Brackett, a paralithic inceptisol with an ochric epipedon; though in many cases it is probably parent material from the marl layer. Here, *Aristida purpurea* var. *nealleyi, Bouteloua hirsuta, B. pectinata, Sporobolus compositus*, and *Yucca pallida* dominate. This association is also typical on heavily weathered shelves just above the contact between the Walnut Formation and the underlying Paluxy or Antlers sands. *Asclepias asperula, Dalea hallii, Glandularia bipinnatifida, Hedyotis nigricans, Liatris aestivalis, L. mucronata, Marshallia caespitosa*, and *Pediomelum linearifolium* are common plants found in this association. *Schizachyrium scoparium* may be common, but is inconsistent. While still considered barrens, these communities frequently border seepy areas or woodlands dominated by *Quercus buckleyi* or *Fraxinus texensis*.

Muhly Seep (Hillslope and Limestone Glade Seeps):

Seeps are frequently found on hillslopes where water flows through fractured limestone, encounters an impervious shale layer, begins flowing horizontally, and seeps out on hillsides where the slope flattens for a few meters. Slopes are frequently dominated by *Muhlenbergia reverchonii*; Dyksterhuis (1946) called them Muhly Benches. Limestone Glade Seeps are often at the bottom edge of hillslope seeps, where water flowing downslope encounters impervious limestone and accumulates on a flat glade until it percolates through cracks or evaporates in summer heat. While saturated in the spring, these benches become arguably the most arid sites in the summer (Dyksterhuis 1946). The regime of alternative vernal saturation and serotinal desiccation is similar to hyperseasonal savannas described by Sarmiento (1984); thus the term 'hyperseasonal vernal seeps,' seems appropriate. Red oxidized root channels can be found in most seep soils, indicating seasonally hydric conditions.

Seeps are the primary location for riparian vegetation on the Walnut Formation. Many of these seeps feed into headwater streams of the Trinity River. While the species composition is somewhat different when comparing hillslope seeps with limestone glade seeps, the dominant species are generally the same.

***Muhlenbergia reverchonii—Eleocharis* spp.—*Carex microdonta—(Iva angustifolia)* Vernal Seep Herbaceous Vegetation Association.**—In Tarrant, Parker, and Hood counties, Muhly seeps are associated with the Aledo-Brackett-Maloterre Soil Association, and the Venus Series in Wise County. Following their namesake, *Muhlenbergia reverchonii* is usually a component of Muhly Seeps. Sedges such as *Eleocharis occulta*, *E. montevidensis*, and *Carex microdonta* may be co-dominant. *Allium* spp., *Isoëtes butleri*, and *Iva angustifolia* are also common seep components. *Carex microdonta* is typical on hillslope seeps but not on limestone glade seeps. *Tridens albescens* can be found on limestone glade seeps where water pools long enough to grow algal mats that form flaking calcareous crusts when dry; thus *T. albescens* appears to tolerate prolonged flooding better than *Muhlenbergia reverchonii*. The density of *M. reverchonii* is reduced where there is disturbance. Jue (2011) also noticed this on Duck Creek Limestone where *M. reverchonii* was absent from seeps near social trails or roadsides.

Eleocharis montevidensis is typical in seeps with deeper soil or standing water, whereas *E. occulta* inhabits glade seeps or drier edges, but these species often exist together. *Isoëtes butleri* is a common component on seeps that, when present, is dominant, though with its short growing season and reproductive material hidden underground, *I. butleri* is often overlooked as a seep component. *Rhynchospora nivea* may be locally dominant on hillslope seeps in the Paluxy or Antlers sandstones just downslope from contact with the Walnut Formation, in calcareous sandy clay loam.

Limestone Scrub Woodland:

Limestone scrub woodlands are generally found near ridge tops of north-facing slopes, often on Walnut Formation outcrops where soil is locally thin and detritus forms a significant duff layer. Tree roots are often anchored in large limestone cracks.

***Quercus buckleyi—Ulmus crassifolia—Celtis laevigata—Cercis canadensis—Fraxinus texensis* Scrub Woodland Association.**—Common trees include *Quercus buckleyi*, *Ulmus crassifolia*, *Celtis laevigata*, *Cercis canadensis*, and *Fraxinus texensis*. At some sites *Quercus sinuata* var. *breviloba* is present. *Quercus fusiformis* is also frequently present, though rarely dominant. Shrubs include *Ungnadia speciosa*, *Forestiera pubescens*, *Rhus trilobata*, and *Cornus drummondii*. Vines such as *Smilax bona-nox*, *Funastrum crispum*, *Vitis* spp., and *Ibervillea lindheimeri* are typical in these habitats. *Carex planostachys* is commonly the only bit of green plant mixed in with duff on the forest floor, except around forest edges where barrens are dominated by *Opuntia phaeacantha*, *Yucca pallida*, or *Schizachyrium scoparium*. The Ecological Society of America Vegetation Classification Panel (2011) has listed many similar associations in the Edwards Plateau Region of Texas and the Arbuckle Mountains of Oklahoma on mesa tops underlain by limestone, though the vegetation panel has not yet accepted many of these associations.

Headwater Streams and Xeroriparian Woodlands:

Headwater streams of the Trinity River are found throughout the Walnut Formation. Their hydrologic regimes are ephemeral to intermittent, with vernal flows and late-summer drought, which may be interrupted by short, high-flow episodes. These streams seem similar to uppermost Great Plains Prairie streams described by Dodds et al. (2004). The ridgetop starts are usually characterized by a prairie motte with a hillslope seep immediately downslope. The mottes are typically in a slight depression that collects runoff, resulting in a variable species assemblage including *Ambrosia ludoviciana*, *Andropogon gerardii*, *Celtis laevigata*, *Diospyros virginiana*, *Gleditsia triacanthos*, *Prunus rivularis*, and *Quercus fusiformis*. The motte abruptly stops downslope at the top of a headcut incision lined with seeps. Various grasses and *Carex microdonta* dominate the upper edge of the seep. As described above, the middle of a headwater hillslope seep is usually dominated by *Muhlenbergia reverchonii* and *Eleocharis occulta*. Seeps in eroding headwater stream slopes may also have *Panicum virgatum*, *Sorghastrum nutans*, and *Lythrum californicum*. The headwater stream channel at the footslope of seeps is characterized by seasonally hydrophytic species such as *Juncus texanus* and *Eleocharis montevidensis*. The soil is often gravelly with oxidized root channels in the surface layer. Downstream the erosional incision widens and an intermittently defined stream channel meanders along the floor. Small depressions hold water during late winter and spring, developing mats of filamentous algae and charophytes. Vegetation is usually herbaceous, though isolated clumps of shrubs and trees may occur. The side slope and width of the incision vary with bedrock, steeper and narrower in limestone, shallower and wider in marl. Similarly, stream sediments vary from coarse gravel to clay. Harder limestone strata create abrupt pouroffs where the plunging stream erodes softer rock beneath. Plants found here include *Ambrosia artemisiifolia, Aster ericoides, Eleocharis montevidensis, Helenium elegans, Isoëtes butleri, Iva angustifolia, Juncus interior, Juncus texanus,* and *Muhlenbergia reverchonii*. These open riparian habitats have a phenology adapted to hyperseasonal hydrology. Vernal saturation seems to prevent establishment of most cool-season annuals, though they are common on adjacent barrens. Spring dominants are perennial wetland species adapted to survive summer drought as rhizomes or small tubers, such as with *Juncus texanus, Eleocharis occulta,* and *E. montevidensis*. As seep flow declines during the onset of summer, the soil moisture regime shifts from hydric to mesic, and warm-season annuals, such as *Iva angustifolia* and *Ambrosia artemisiifolia,* establish on open ground. Late cool-season annuals may also establish, such as *Helenium elegans, Phalaris caroliniana,* and *Fuirena simplex*. Within the open riparian herbaceous vegetation there may be isolated clumps of *Cephalanthus occidentalis* and other shrubs or stunted trees, indicating access to subsurface summer moisture.

Headwater streams eventually reach downslope sites with deeper sediment or weathered sandstone. This transition is evident by an abrupt change to xeroriparian gallery forest or woodland. Xeroriparian areas on the Walnut Formation are small canyons that get increasingly deeper as the channel erodes Paluxy or Antlers sands. Stream channels usually are filled with alluvium, and surface flow is ephemeral or intermittent. The shallower canyons are characterized by *Celtis laevigata, Fraxinus texensis, Juniperus virginiana,* and *Ulmus crassifolia*. Here, when canyon walls are only a few meters high, the midstory has *Cornus drummondii, Prunus mexicana, Rhus glabra, Rhus trilobata, Sideroxylon lanuginosum,* and *Smilax bona-nox*, and the understory has *Andropogon gerardii, Elymus virginicus, Nasella leucotricha, Schizachyrium scoparium,* and *Sorghastrum nutans*. As the canyon deepens, the walls may be more than 4 m tall, and the gallery canopy is dominated by *Fraxinus texensis, Juniperus virginiana, Quercus buckleyi,* and *Ulmus americana*. The midstory has *Cercis canadensis, Frangula caroliniana, Smilax tamnoides, Toxicodendron radicans, Viburnum rufidulum,* and *Vitis* spp. The understory may include *Carex planostachys* and *Pellaea atropurpurea,* which root in alluvium and colluvium on the walls.

Mixed Grass Hillslope:

Mixed grass prairies are found on lower hillslopes and footslopes where the soil is deeper. Three of the "big four" tall grasses (*Andropogon gerardii, Schizachyrium scoparium,* and *Sorghastrum nutans*) are generally present, and *Panicum virgatum* is sometimes found on wetter sites. Often *Schizachyrium scoparium* is dominant, together with shorter grasses, especially *Bouteloua* spp., diverse forbs, small shrubs, and scattered trees. These footslopes are often Sunev Soils, mollisols that are deeper because the underlying geology is sand instead of limestone (Ressel 1981).

Roadsides and Lawns:

Roadsides and lawns provide a typical weedy flora. Common species include *Ambrosia trifida, Bothriochloa ischaemum* var. *songarica, Bromus catharticus, B. japonicus, Cynodon dactylon, Ipomoea cordatotriloba, Lamium amplexicaule, Medicago spp., Sherardia arvensis, Sisymbrium officinale,* and *Sorghum halepense*. Old home sites support persisting cultivated species such as *Iris germanica, Muscari neglecta, Nandina domestica,* and *Rosmarinus officinalis*.

COMPARISON WITH THE WALNUT FORMATION SOUTH OF THE BRAZOS RIVER

For the most part, similar habitats were observed north and south of the Brazos River. Though it is not within the scope of this paper to present a full comparison, a few trips were made to a Walnut Limestone site near Hico, Texas, and vouchers were collected. The most obvious difference in the flora of the southern Walnut Formation was the addition of many species that are more common in the Edwards Plateau region, for example *Melampodium leucanthum* and *Thelesperma simplicifolium*. Though uncommon, both of these species have been found elsewhere in North Central Texas, but were not collected on the northern Walnut Formation during this study.

Lyday's (1989) descriptions of plant associations of the Edwards, Walnut, and Glen Rose formations in Hays County, on the Edwards Plateau ca. 340 km south of Fort Worth, was used for a simple comparison of the northern and southern portions of the Walnut Formation. Hays County appears to have a very different species composition than the site outside of Hico, which is 266 km north of Hays County. Lyday (1989) found *Yucca rupicola, Rhus virens, Garrya ovata, Juglans major, Berberis trifoliolata,* and *Opuntia engelmannii* on the Walnut Formation in Hays County; these species were not documented on the northern portion of the Walnut Formation during this project, but some species may be present elsewhere locally. Notably, Lyday did not encounter *Quercus fusiformis* or *Ulmus crassifolia*, two dominants on the North Central Texas Walnut Formation, though he found them on adjacent formations, and found *Juniperus ashei* and *Quercus buckleyi* to be the dominant woody species on the Walnut Formation in Hays County. Much of this difference is likely derived from the different topographical context the Walnut Formation inhabits, valleys versus ridgetops, in the Lampasas Cut Plain and Edwards Plateau.

UNIQUE SITES

The major disturbances on the Walnut Formation are suburban development, cattle grazing, and quarrying. Most development is concentrated near Weatherford and Decatur, but urban sprawl continues north and west of Fort Worth. Most soils of the Walnut are too shallow to support crops, but ranching is common. The endemic *Dalea reverchonii* is not found where cattle graze (O'Kennon pers. comm.); thus it is found mostly on quarry sites or roadsides. These sites often have been scraped, creating an anthropogenic seral glade-like habitat, which is perfect for *D. reverchonii*. Quarried sites have a unique flora not typical of glades. These anthropogenic glade habitats have the same shallow soil, less than 5 cm deep, except open bedrock is usually covered with gravelly soil. The disturbance is evident by mounds of soil dividing glade habitats, as at the Utley Property in Weatherford, by a large portion of dug out ground that is about two feet lower than the adjacent landscape, with intermittent pools of water, as at the New Highland Property in Parker County.

Unit 70 of the LBJ National Grasslands supports a woodland on the gentle slope of the cuesta where water flowing off of the cuestas deposits soil giving it some alluvial properties. This depositional site contains *Carya illinoinensis* and *Maclura pomifera*, which were not found in any other habitat on the Walnut Formation.

The only accessible ephemeral stream directly on Walnut Limestone was found 0.66 km west-northwest of the intersection of Highway 287 and Highway 114 in Rhome. The stream runs underneath Highway 114 and provides a unique flora north and south of Highway 114. The site had one of the most diverse glade complexes; unfortunately a McDonald's and Loves gas station now sit on Goodland Limestone just upslope on the south side of the road. This construction altered the hydrology, and soil was dumped on the glade downslope with silt barriers between the soil and the ephemeral stream downslope from the glade, inhibiting the natural erosion processes that keep glades from forming soil. This site supported *D. reverchonii, Gratiola quartermaniae, Isoëtes butleri,* and *Talinum calcaricum*—all rarely collected in North Central Texas. This was the only site with *Briza minor, Callitriche heterophylla, Cardiospermum halicacabum, Justicia americana,* and *Xanthium strumarium*; though these can probably be found at other sites.

The New Highland Site, west-northwest of the intersection of New Highland and Highland Road near Springtown, is a quarry site on Walnut Limestone. Water accumulated here, forming a shallow pool or trough about 18 cm deep (on May 25, 2011) where the Walnut Limestone has been quarried about 3 m deep. The pool supported typical Walnut Seep vegetation, as well as some unique taxa not found at other sites, for example *Eleocharis palustris*. The dominant species found in the pool were *Eleocharis montevidensis, E. occulta, Iva angustifolia,* and *Tridens albescens*.

At a few sites, *Quercus stellata* (post oak) was found in alfisols on the Walnut Formation. Alfisols are mildly acidic sandy clays that are less fertile than mollisols. Their presence over limestone indicates that calcareous topsoil has leached over considerable time resulting in an ochric epipedon and an accumulation of clay nearer bedrock. *Quercus stellata* is generally only found on sandier soils in the East and West Cross Timbers.

FLORISTIC COMPARISONS

Unique floristic connections were found with Apacherian Savannas, formerly called desert grasslands, of Southwestern North America (Burgess 1995), and with Cedar Glades of the Southeast United States (Norton 2010). Though not an ecotone, the Walnut Formation exhibits distinct characteristics of Cedar Glades and

Apacherian Savannas, both structurally and floristically. Both the Apacherian Savannas and Cedar Glades contain edaphic communities that are strongly determined by soil and geology (Quarterman 1950a; Baskin & Baskin 2003; McAuliffe 1994).

A dry glade community found on limestone mesatops at LBJ National Grasslands, and occasionally on the upslope side of glade seeps where soil is well drained, consists of short grasses in shallow soil over limestone. This community resembles parts of the Apacherian Savannas in the Southwestern United States and Mexico, and contains *Coryphantha sulcata, Escobaria vivipara, Opuntia phaeacantha, Panicum hallii, Panicum obtusum, Tridens muticus*, and related species in *Bouteloua* and *Erioneuron*.

Cedar Glades of the Southeastern United States also have a great similarity structurally and floristically to the Walnut Glades. Cedar Glades are on limestone or dolomite from the Ordovician, Silurian, or Mississippian eras (Baskin & Baskin 2003). They are in lowland basins often surrounded and separated by rolling hills (Baskin & Baskin 2003; Norton 2010; Quarterman 1950a). Soils are lacking to very shallow and are deeper in crevices where the rock has cracked vertically (Quarterman 1950b). Annual grasses, perennial herbaceous dicots, mosses, *Nostoc commune*, and various lichens dominate limestone cedar glades (Baskin & Baskin 2003). *Juniperus virginiana* is the dominant shrubby vegetation surrounding the glades (Norton 2010; Quarterman 1950b).

The Walnut Glades and glade-like habitats west of the Mississippi River are not considered true Cedar Glades because they differ floristically (Norton 2010). Both habitats are hyperseasonal, with plants adapted to an extreme wet and extreme dry season (Norton 2010), thus having very different floristic aspects during the year. Dormancy mechanisms allow plants to persist through both saturation and drought (Quarterman 1950a). As with Cedar Glades, Walnut Glades all have a slightly different species composition due to geographical and structural variations (Baskin & Baskin 1996). Many species on Walnut Glades are also found on Cedar Glades, such as *Croton monanthogynus, Panicum acuminatum, Gratiola quartermaniae, Hedyotis nigricans, Heliotropium tenellum, Isoëtes butleri, Juncus filipendulus, Nostoc commune, Nothoscordum bivalve, Oenothera macrocarpa, Talinum calcaricum*, and *Sporobolus vaginiflorus s.l.*. Related species include *Manfreda virginica* in Cedar Glades versus *Yucca pallida* on the Walnut Formation, *Opuntia humifusa* versus *O. phaeacantha, Dalea gattengeri* versus *D. reverchonii* and *D. tenuis, Eleocharis bifida* versus *E. occulta* and *E. montevidensis, Minuartia patula* versus *M. michauxii*, and *Sedum pulchellum* versus *S. nuttallianum* (Jones 2005; Quarterman 1950b; Norton 2010; Baskin & Baskin 2003).

George (1987) did a brief comparison between eastern Cedar Glades and the Weches Formation in East Texas. The Weches is a limestone that is floristically isolated because it is surrounded by sand and arenicolous species. The Weches Formation receives annual precipitation similar to that of limestone cedar glades in the Southeastern United States. George (1987) found shared species between the Weches formation and limestone cedar glades, the most notable being *Leavenworthia texana* and *Sedum pulchellum*. *Leavenworthia texana*, the only species of the genus in Texas, is endemic to deep East Texas; however, its relatives are dominant on Limestone cedar glades, mapped by Baskin and Baskin (2003). *Sedum pulchellum* is more widespread but is not found farther west than East Texas. It appears that the Weches Formation and the Ozark glades could serve as a bridging habitat between eastern limestone cedar glades and Walnut Limestone glades.

RANGE EXTENSIONS, INVADERS, AND ENDEMIC TAXA

A species was denoted as exotic and invasive using the Texas Invasives database (Texas Invasives 2012). The harsh dry conditions of glades and barrens discourage invasives, though they are common on roadsides, in old pastures, and in disturbed seeps and barrens. In barrens and roadsides, *Bromus catharticus, Bromus japonicus, Bromus tectorum*, and *Bothriochloa ischaemum* var. *songarica* are common competitors with the native prairie grasses; among these *Bromus japonicus* was the most problematic on the barrens. *Sorghum halepense* was found at two sites in seeps, at the Utley Prairie, and at intermittent streams near the roadside in Rhome where water was plentiful; however, it was a dominant on roadsides. *Arundo donax* was found at one site (New Highland) in a very disturbed quarry near a deer blind. *Carduus nutans* ssp. *macrocephalus* was found as a roadside weed at only one site in Weatherford and has since been removed by the property owner. *Ligustrum quihoui* was common on barrens at the Fort Worth Nature Center and Refuge in the understory replacing *Forestiera pubescens* and *Rhus trilobata*, but uncommon elsewhere on the Walnut Formation. *Nandina domestica* was found only at the Fort Worth Nature Center and Refuge in a riparian canyon and at an old home site. *Vitex agnus-castus* was found only at the Eagle Mountain Lake Park, with other persisting homestead plants such as *Lantana camara* and *Jasminum floridum*.

Two seep dwellers were found new to North Central Texas during this study. *Gratiola quartermaniae* is endemic to rock outcrops in Tennessee, Alabama, and Central Texas (Estes & Small 2007), but was found commonly in limestone glade seeps in North Central Texas (Taylor & O'Kennon, in prep). *Isoëtes melanopoda* is the only species of the genus listed in North Central Texas (Diggs et al. 1999), but scanning electron microscopy of spores revealed that *I. butleri* is actually prevalent in North Central Texas. *Isoëtes butleri* was known previously only from the Edwards Plateau in Texas and elsewhere in the United States is locally common on limestone (Taylor et al. 2012). *Talinum calcaricum*, now *Phemeranthus calcaricus*, but referred to as *Talinum calcaricum* in this paper for nomenclatural consistency, previously thought to be endemic to limestone cedar glades in Alabama, Kentucky, and Tennessee, was found new to Texas during this study (Swadek 2012).

Texas and Oklahoma regional endemics found on the Walnut Formation are *Asclepias linearis, Carex perdentata, Dalea hallii, D. reverchonii, D. tenuis, Fraxinus texensis, Ibervillea lindheimeri, Juncus texanus, Liatris aestivalis, Lupinus texensis, Oenothera coryi, Pediomelum cyphocalyx, P. hypogaeum* var. *scaposa, Pediomelum latestipulatum, Pediomelum reverchonii, Silphium albiflorum, Tradescantia humilis,* and *Yucca pallida* (Diggs et al. 1999). *Muhlenbergia reverchonii* is not listed as endemic in literature but is only known from limestone seeps in Texas and Oklahoma (Barkworth et al. 2007); it is not clear whether the distribution of *M. reverchonii* might be more widespread. *Eleocharis occulta* (Smith et al. 2003) and *Liatris aestivalis* (Nesom & O'Kennon 2001) were also collected on the Walnut Formation and are endemic to the region. A distinction between strict nativity to Texas was ignored, as the Walnut Formation extends into southern Oklahoma, and political boundaries do not correspond with regional vegetation.

Dalea reverchonii is endemic to North Central Texas with a very limited range, only found in Hood, Parker, and Wise counties on glades and barrens of the Walnut Formation, the exception being the type location in Edwards Limestone on the butte of Comanche Peak in Hood County. It is listed as imperiled by Nature Serve (2012a) and of conservation concern (Diggs et al. 1999).

According to NatureServe (2012a), *D. reverchonii* has been extirpated from the top of Comanche Peak and it grows in "grasslands or openings in post oak woodlands on shallow calcareous clay to sandy clay soils over limestone. Often among sparse vegetation in barren, exposed sites." This is inaccurate. Multiple status reports (Mahler 1984; McLemore & O'Kennon 2003; O'Kennon 2010) indicate that *D. reverchonii* occurs atop Comanche Peak; however, these status reports have not been formally published. Voucher specimens of *D. reverchonii* atop Comanche Peak exist at BRIT (*O'Kennon 23370; 18793* Texas: Hood County), and two type specimens are at the Missouri Botanical Garden (*Reverchon 1273* Texas: Hood County) found on "rocks. Top of the Comanche Peak" in June of 1882; the isotype is at BRIT.

The type population on Comanche Peak, visited in May 2011, is on Edwards Limestone and is the only known occurrence of *Dalea reverchonii* not on Walnut Limestone. This population of *D. reverchonii* is found on the sloping ridgetop edge of the Comanche Peak butte on a glade of Edwards Limestone just above the contact with Comanche Peak Limestone.

Dalea reverchonii is restricted to glade and barren habitats, able to thrive with its taproot wedged deep in limestone cracks. Most commonly, it is found in glade habitats with no soil, or shallow soil, which is covered by gravel from Walnut Limestone, but it is not found in post oak wood openings, contradictory to NatureServe (2012a). It is often associated with *Nostoc commune*, a nitrogen fixing cyanobacterium, and various cryptogamic crusts, together with *Aristida purpurea* var. *nealleyi, Minuartia michauxii, Talinum calcaricum, Plantago helleri*, and *Tetraneuris linearifolia*.

As previously stated, *Dalea reverchonii* appears to thrive in sites that have been quarried, leaving behind suitable anthropogenic glades. Free from cattle grazing, these old quarries are habitat for *D. reverchonii*. Though a rare species in North Central Texas due to its restricted range, existing populations tend to support many individuals. *Dalea reverchonii* can occur under episodic disturbance on Walnut Limestone, even surviving an asphalt application.

Table 1. Distributional summary of the North Central Texas Walnut Formation vegetation.

List by taxonomic category	Families	Genera	Species	Taxa	List by special category	Taxa
Ferns	1	1	1	1	Introduced Taxa to NA	59
Fern Allies	1	1	1	1	Exotic Invasive Taxa	12
Gymnosperms	1	1	3	3	Texas Endemic Taxa	14
Dicots	66	217	329	337	Regional Endemics	6
Monocots	10	66	118	125	Species of Concern	1
Total	79	286	452	467	State Records	1

SUMMARY OF TAXA

The flora consists of 467 infraspecific taxa, 452 species in 286 genera and 79 families. There are 61 introduced species. The richest five plant families are Asteraceae (74 taxa), Poaceae (73), Fabaceae (34), Euphorbiaceae (18), and Cyperaceae (17) (Table 1). Fifteen habitat types were recognized on the Walnut Formation. Few species are ubiquitous across multiple habitats; most species are locally adapted to one particular habitat within the Walnut Formation.

APPLICATIONS AND FURTHER RESEARCH

Floristic Studies

The Walnut Flora, as any other, is never truly static. Additional collections from different habitat types would be valuable additions. The proposed vegetation associations are provisional and should be verified with more quantitative analysis of plot data, in conjunction with soil profile descriptions.

As the southern portion of the Walnut Formation was not thoroughly sampled, a focused study of the area is essential for understanding the Walnut Formation landscape. This would be especially valuable as Hill (1901) described the part of the Walnut Formation found in the Lampasas Cut Plain as the Walnut Prairie, and the most representative portion of the Walnut Formation.

As mentioned, some Walnut Formation vegetation does not appear to align with other Grand Prairie or Fort Worth Prairie limestone formations and better understanding of this ecoregion would emerge from an in-depth comparison of the Comanche Peak, Denton, Duck Creek, Edwards, Fort Worth, Glen Rose, Goodland, Kiamichi, Main Street, and Weno Formations.

Muhly Seeps as Wetlands

Jue (2011) and Llado (2011) studied Muhly Seeps on the Fort Worth Prairie on Duck Creek Limestone. Their objective was to see if the vegetation, soils, and hydrology would classify Muhly Seeps as wetlands using United States Army Corps of Engineers (USACE) 404 permitting criteria. Unfortunately their studies were performed in a drought year, so neither the vegetation nor hydrology aligned closely enough with USACE requirements for wetland status. These requirements state that given a 280-day growing season, soils must be saturated for 12.5% of the growing season meaning 35 days of saturation are required to meet the hydrology criterion (United States Army Corps of Engineers 1987). While Llado and Jue's study site did not yield these results, a few seeps near Rhome, Texas and at the Eidson Property near the Fort Worth Nature Center and Refuge showed hydric soil properties of gleyed color and a hydrogen sulfide odor through June in dryer years. More Muhly Seep sites should be monitored for possible wetland status of these unique habitats.

Cedar Invasion

The increasing presence of *Juniperus* spp. (cedars) in North Central Texas provides an interesting potential for study. Frequently quite invasive in grasslands, cedars were not mentioned at all in historic North Central Texas literature (Hill 1901, Bray 1906, Dyksterhuis 1946). It is well understood in the region that *Juniperus* spp. have extended their ranges in response to fire suppression, allowing *Juniperus* to overtake many landscapes in under 65 years. Eventually habitat expansion of the three species of *Juniperus* in North Central Texas (*J. virginiana*, *J. ashei*, and *J. pinchotii*) may make Walnut Glades more comparable to eastern Cedar Glades.

Comparisons with Eastern Limestone Cedar Glades

Cedar Glades and similar outcrops in Texas could be compared using similar sampling methods as described in Norton (2010) and George (1987). *Nostoc commune*, an important nitrogen fixing cyanobacterium in Cedar Glades, is also quite abundant in Walnut Limestone glades. When comparing these different habitats, the nonvascular flora should also be considered, as it is a major component of habitats (Quarterman 1950b) and cryptogams are important to soil properties (Dunne 1989).

Landscape Design Applications

Williams (2008) and Kinder (2009) used the Fort Worth Prairie, including Walnut Limestone barrens, as a model for green roof design in North Central Texas through biomimicry of natural systems. Shallow limestone barrens, like those of the Fort Worth prairie, are ideal study sites for green roof research because of the plants' ability to survive in soils less than 15 cm deep. Soil depth is important when taking into account the amount of weight a roof can hold. Williams' (2008) and Kinder's (2009) research proposes using native plants and soil—for bacteria, fungi, and the seed bank in the soil—to construct green spaces in urban areas; thus an improved knowledge of the ecology of the Fort Worth Prairie will be a valuable basis for appropriate designs.

Biomimicry has also been proposed for design and implementation of rain gardens or bioswales, along with other storm water management and water-purifying features. In Texas, rain gardens need to survive without year-round water; they must be adapted to seasonal rains and very hot, dry summers. Hyperseasonal seeps and headwater stream riparian vegetation, as described in this investigation, could serve as a native habitat design template.

CONCLUSIONS

The Walnut Formation provides the context for unique habitats and plant communities in North Central Texas. Stratigraphy and landform have large influences on plant communities. Hard limestone strata alternate with softer, clayey sediments, eroding into landscapes forming characteristic glades, barrens, and seeps. The plant communities of these habitats combine elements of prairie and Edwards Plateau vegetation with endemic and disjunct species, indicating a long history of accumulation and adaptation in the unstable climate of the Southern Plains. The vegetation is clearly associated with the Fort Worth Prairie Ecoregion, yet unique within it. The limestone glade association with *Dalea reverchonii*, *Talinum calcaricum*, and *Minuartia michauxii* is the most distinctive. Hyperseasonal vernal seeps and headwater stream habitats are not typical wetlands, nor are they truly prairie grassland. These riparian communities can be found in other parts of the Fort Worth Prairie, yet they seem especially prominent in Walnut Formation landscapes. Connections with the adjacent Western Cross Timbers are evident, with *Quercus stellata* woodlands on ridgetop alfisols, xeroriparian canyons leading into Cross Timbers riparian forest, and footslope calcareous sandy soils where Prairie and Cross Timbers species mix in diverse combinations. Thus the Walnut Formation supports considerable local biodiversity.

Two species new to North Central Texas: *Gratiola quartermaniae* (Taylor & O'Kennon in prep.) and *Isoëtes butleri* (Taylor et al. 2012) were discovered during this project. *Talinum calcaricum* was found new to Texas (Swadek 2012).

The need to further explore the ecology of North Central Texas is becoming more apparent and necessary. As the Metroplex expands, the population grows, and climate change continues, the connection to place and natural history will become more important to quality of life. Using a geological context for a floristic survey offers insights that would be less evident in county-based floras.

ANNOTATED CHECKLIST

Vascular plant families are alphabetically arranged within major groups. Angiosperm families are subdivided into Magnoliopsida (Dicots) and Liliopsida (Monocots). Taxa are listed alphabetically within their respective families by genus, species, and subspecific epithet. Authorities are given for all taxa and common names follow the scientific names. Common names and authorities follow Diggs et al. (1999); if a common name is lacking, one was not indicated in Diggs et al. (1999). For species discovered following 1999, nomenclature follows their representative publications (Estes & Small 2007; Nesom 2006; Smith et al. 2003) Next is the collector abbreviation and number, followed by the abbreviation of the major vegetational habitat in which the taxon was collected, and a special symbol if applicable. Species introduced to North America, regional and Texas endemics, and conservation concerns follow Diggs et al. (1999) and exotic and invasive taxa follow the Texas Invasives Database (2012).

Habitat type:

AQ	aquatic—emergent, floating, submerged
B	barren
DG	dry glade
EH	eroding hillslope
GS	glade seep
HWS	headwater stream
HS	hillslope seep
L	lawn
LSW	limestone scrub woodland
MGH	mixed grass hillslope
P	pond edge
R	roadside
SW	Sand formation—Walnut Formation contact
W	woodland
XR	xeroriparian woodland

Symbols by category following Taxon:

☜	introduced to North America
⊘	exotic and invasive in Texas (Texas Invasives Database 2012)
✦	TX endemic
✧	regional endemic
⚠	conservation concern
!	State record

Collectors:

S	R.K. Swadek
ROK	R.J. O'Kennon
KRN	K.R. Norton
SRK	S.R. Kieschnick
TFF	T.F. Franklin
JQ	Jeff Quayle
ELB	E.L. Bridges
WVM	Will and Valerie McClatchey

LYCOPODIOPHYTA

Isoëtaceae

Isoëtes butleri Engelm., Butler's quillwort S 201 GS; S 871 HS; S 917 GS; S 1238 HS/HWS

POLYPODIOPHYTA

Pteridaceae

Pellaea atropurpurea (L.) Link, cliff-brake S 743 XR; S 1254 XR; KRN 883

PINOPHYTA

Cupressaceae

Juniperus ashei J. Buchholz, mountain cedar S 706 B; S 788 B

Juniperus pinchotii Sudw., red-berry juniper S 723 B

Juniperus virginiana L., eastern red-cedar S 236 B; S 527 HS/SW

MAGNOLIOPHYTA: MAGNOLIOPSIDA

Acanthaceae

Dyschoriste linearis Torr. & A. Gray, narrow-leaf snakeherb S 310 DG; S 584 DG/R; S 1051 DG; S 1107 B

Justicia americana (L.) Vahl, American water-willow S 261 AQ/GS; S 1048 AQ/GS

Ruellia humilis Nutt., prairie petunia S 373 B; S 392 HS; S 398 EH; S 744 XR

Amaranthaceae

Amaranthus blitoides S. Watson, prostrate pigweed S 780 W

Amaranthus retroflexus L., red-root pigweed WVM 261

Amaranthus rudis J.D. Sauer, water-hemp S 756 P

Anacardiaceae

Rhus glabra L., smooth sumac S 281 B; S 402 EH

Rhus lanceolata (A. Gray) Britton, prairie sumac S 704 B

Rhus trilobata Nutt., skunkbush S 227 B; S 926 LSW; WVM 28; WVM 143

Toxicodendron radicans (L.) Kuntze, poison-ivy WVM 134; WVM 180

Toxicodendron radicans (L.) Kuntze ssp. *verrucosum* (Scheele) Gillis, poison-ivy S 630 LSW

Apiaceae

Ammoselinum butleri (Engelm. ex S. Watson) J.M. Coult. & Rose, Butler's sand-parsley S 216 GS

Bifora americana Benth. & Hook. f. ex S.Watson, prairie bishop S 177 B; S 269 GS; S 334 HS; S 1044 B; S 1090 B; S 1106 B; S 1113 LSW; KRN 758 B; KRN 888

Chaerophyllum tainturieri Hook. var. *dasycarpum* Hook. ex S. Watson, hairy-fruit chervil S 180 WS

Chaerophyllum tainturieri Hook. var. *tainturieri*, S 1061 DG

Cymopteris macrorhizus Buckley, big-root wavewing S 823 B

Daucus pusillus Michx., rattle-snake weed S 271 GS; S 1076 B; S 1092 B

Eryngium leavenworthii Torr. & A. Gray, Leavenworth's eryngo S 430 EH

Polytaenia nuttallii DC., prairie parsley S 629 B; S 1041 HS

Spermolepis inermis (Nutt. ex DC.) Mathias & Constance, spreading scaleseed S 896 B; S 1104 B

Torilis arvensis (Huds.) Link, beggar's lice S 270 GS; S 1047 GS; WVM 57 ☜

Apocynaceae

Amsonia ciliata Walter var. *texana* (A. Gray) J.M. Coult., Texas slimpod S 152 B; S 875 B; TFR 219 B

Apocynum cannabinum L., Indian-hemp S 1078 XR

Aquifoliaceae

Ilex decidua Walter, possumhaw S 119 EH; S 797 P; WVM 14; WVM 68; WVM 69

Asclepiadaceae

Asclepias asperula (Decne.) Woodson ssp. *capricornu* (Woodson) Woodson, antelope-horns S 174 B; S 891 DG; S 1102 B; S 1123 B

Asclepias engelmanniana Woodson, Engelmann's milkweed KRN 924

Asclepias linearis Scheele, slim milkweed S 713 MGH/SW ✦

Asclepias stenophylla A. Gray, slim-leaf milkweed S 411 EH
Asclepias verticillata L., whorled milkweed S 415 LSW/SW
Asclepias viridiflora Raf., green-flower milkweed S 413 EH; S 712 EH/SW; S 1248 B
Asclepias viridis Walter, green milkweed S 331 HS; S 617 R; S 1075 B
Funastrum crispum (Benth.) Schltr., wavy leaf milkweed vine S 633 LSW; S 638 B; TFR 218 LSW
Matelea biflora (Raf.) Woodson, two-flower milkvine S 591 B

Asteraceae
Achillea millefolium L., common yarrow S 763 W; S 1240 B
Ambrosia artemisiifolia L., common ragweed S 480 B
Ambrosia confertiflora DC., WVM 276
Ambrosia psilostachya DC., western ragweed S 441 R; S 526 HS/SW
Ambrosia trifida L. var. *texana* Scheele, blood ragweed S 755 P; S 783 R
Arnoglossum plantagineum Raf., prairie-plantain S 1251 XR
Artemisia ludoviciana Nutt. ssp. *mexicana* (Willd. ex Spreng) D. D. Keck, Mexican sagebrush S 445 DG; S 514 MGH/SW; S 764 W; S 772 DG
Aster ericoides L., heath aster S 482 B; S 487 B; S 519 MGH/SW
Aster praealtus Poir., willow-leaf aster S 759 P
Aster pratensis Raf., silky aster ROK 20719 GS
Aster subulatus Michx. var. *ligulatus* Shinners, wireweed S 531 HS
Baccharis neglecta Britton, Roosevelt-weed S 912 HS/SW
Baccharis texana (Torr. & A. Gray) A. Gray, prairie baccharis S 509 DG; S 790 B
Brickellia eupatorioides (L.) Shinners, S 775 W; S 778 W; S 787 R; WVM 270
Carduus nutans L. ssp. *macrocephalus* (Desf.) Nyman, nodding-thistle S 223 B ⊘ ☜
Carduus tenuiflorus Curtis, slender bristle-thistle WVM 12 ☜
Centaurea americana Nutt., basket-flower S 282 B
Cirsium texanum Buckley, Texas thistle S 237 B; S 614 B
Cirsium undulatum (Nutt.) Spreng., wavy-leaf thistle S 1103 B
Chaetopappa asteroides Nutt. ex DC., common least daisy S 827 G; S 858 B
Conyza canadensis (L.) Cronquist var. *glabrata* (A. Gray) Cronquist, S 419 GS
Dracopis amplexicaulis (Vahl) Cass, clasping coneflower S 279 B; S 1040 GS
Dysodiopsis tagetoides Torr. & A. Gray, marigold dogweed S 332 HS; S 404 EH; KRN 877
Echinacea angustifolia DC., blacksamson S 182 EH; S 414 LSW/SW; S 731 EH/SW; S 909 B; S 1071 EH/SW
Echinacea atrorubens Nutt., KRN 776 RRR
Engelmannia peristenia (Raf.) Goodman & C.A. Lawson, Engelmann's daisy S 287 HS; S 348 R; S 893 DG
Erigeron strigosus Muhl. ex Willd var. *strigosus*, prairie fleabane S 181 EH; S 657 HS; S 1245b XR; ROK 12153 G; ROK 12154 G; ROK 12157 B
Eupatorium serotinum Michx., fall boneset S 720 HS/SW
Evax prolifera Nutt. ex DC., rabbit tobacco S 159 B; S 884 DG; S 901 DG
Evax verna Raf. many-stem evax S 848 B
Gaillardia aestivalis Walter var. *aestivalis*, yellow Indian blanket S 319 SW; S 729 EH/SW
Gaillardia aestivalis (Walter) H.Rock var. *flavovirens* (C. Mohr) Cronquist, yellow Indian blanket S 658 HS
Gaillardia pulchella Foug., Indian-blanket S 192 R/DG; S 1046 GS; S 1086 B; S 1099 B
Grindelia adenodonta (Steyerm.) G.L.Nesom, little-head gumweed ROK 22675 R
Grindelia lanceolata Nutt., gulf gumweed S 378 DG; S 709 DG; S 773 DG; KRN 929
Grindelia nuda A. W. Wood, rayless gumweed S 496 DG
Gutierrezia dracunculoides (DC.) S. F. Blake, common broomweed S 431 EH/R; S 454 DG; S 476 B; S 1140 DG
Helenium elegans DC., sneezeweed S 420 GS; S 702 GS; S 1239 HS/HWS; KRN 887
Helianthus annuus L., common sunflower S 424 B
Helianthus maximiliani Schrad., Maximilian sunflower S 467 HS/SW
Heterotheca canescens (DC.) Shinners, gray-gold aster SRK 323 R
Hymenopappus scabiosaeus L'Hér var. *corymbosus* (Torr. & A. Gray) B.L. Turner, old plainsman S 186 EH
Hymenopappus tenuifolius Pursh, old plainsman S 175 B; S 622 EH; S 851 B; WVM 11
Iva angustifolia Nutt. ex DC., marsh-elder S 753 GS; S 792 GS
Lactuca canadensis L., wild lettuce S 395 R
Lactuca ludoviciana (Nutt.) Riddell, western wild lettuce S 639 B
Lactuca serriola L., prickly lettuce WVM 252 III
Liatris aestivalis G.L. Nesom & O'Kennon, summer gayfeather S 365 EH; S 405 EH; S 732 EH/SW RRR
Liatris mucronata DC, narrow-leaf gayfeather S 459 MGH; S 478 B; S 510 EH; S 511 MGH/SW
Lindheimera texana Engelm. & A. Gray, Texas-star S 212 B; S 923 B; S 1100 B
Lygodesmia texana Torr. & A. Gray, Texas skeleton-plant S 314 B; S 1098 B
Marshallia caespitosa Nutt. ex DC. var. caespitosa, Barbara's buttons S 257 EH; KRN 773 DG
Palafoxia callosa (Nutt.) Torr. A. Gray, small palafoxia S 425 B; S 439 DG; S 483 B; SRK 322 R
Parthenium hysterophorus L., false ragweed S 710 W; S 779 W
Pyrrhopappus grandiflorus (Nutt.) Nutt., tuber false dandelion S 197 R/DG
Pyrrhopappus pauciflorus (D. Don) DC., mini-stem false dandelion S 264 GS; S 579 GS; S 1037 GS
Ratibida columnifera (Nutt.) Wooton & Standl., Mexican-hat S 313 B
Rudbeckia grandiflora (D. Don) J.F. Gmel. ex DC. var. *alismifolia* (Torr. & A. Gray) Cronquist, rough coneflower S 391 HS
Rudbeckia hirta L. var. *pulcherrima* Farw., black-eyed Susan S 349 R/DG
Silphium albiflorum A. Gray, white rosinweed S 325 B; S 360 B; KRN 925; KRN 928 ✦
Silphium laciniatum L., compass-plant KRN 926
Silphium radula Nutt., rough-stem rosinweed S 393 HS
Solidago nemoralis Aiton var. *longipetiolata* (Mack. & Bush) E. J. Palmer & Steyerm., S 463 MGH/SW
Solidago nitida Torr. & A. Gray, shiny goldenrod S 794 GS
Solidago radula Nutt., rough goldenrod S 522 HS/SW
Solidago rigida L., stiff goldenrod S 513 MGH/SW; S 784 R
Sonchus oleraceus L., common sow-thistle S 253 GS ☜
Taraxacum officinale L., dandelion WVM 4 L ⊘ ☜
Tetraneuris linearifolia (Hook.) Greene, S 651 B; S 172 HS; S 846 B; S 890 DG; ELB 13633
Tetraneuris scaposa (DC.) Greene, plains yellow daisy S 138 EH; S 145 GS; S 183 EH; S 899 DG; WVM 8; WVM 29; KRN 665
Thelesperma filifolium (Hook.) A. Gray var. *filifolium*, greenthread S 157 B; S 1045 GS; S 1088 B; S 1124 B
Vernonia baldwinii Torr., Baldwin's ironweed S 418 R
Xanthisma texana DC. ssp. *drummondii* (Torr. & A. Gray) Semple, Texas sleepy daisy S 624 DG; S 1137 DG
Xanthium strumarium L. var. *canadense* (Mill.) Torr. & A. Gray, cocklebur S 758 P

Berberidaceae
Nandina domestica Thunb., sacred-bamboo S 742 XR; WVM 47 ⊘ ☜

Boraginaceae
Buglossoides arvensis (L.) I.M. Jonst. S 819 EH/SW ☜

Heliotropium tenellum (Nutt.) Torr., pasture heliotrope S 375 B; S 381 DG; S 474 B

Lithospermum incisum Lehm., narrow-leaf gromwell S 163 EH; S 852 B; S 908 B

Brassicaceae

Capsella bursa-pastoris (L.) Medik., shepherd's-purse S 572 L; WVM 3; WVM 147 ⇦

Draba cuneifolia Nutt. ex Torr. & A. Gray, wedge-leaf draba S 126 B; S 821 B; WVM 25; WVM 24; WVM 32

Lepidium austrinum Small, southern pepperweed S 242 B; S 895 DG

Lepidium virginicum L., Virginia pepper-grass S 855 B

Lesquerella gordonii (A. Gray) S. Watson, popweed S 559 B

Lesquerella engelmannii (A. Gray) S. Watson, Engelmann's bladderpod S 161 EH; S 162 EH; S 198 R/DG; S 587 DG; S 693 DG; S 882 DG

Sisymbrium officinale (L.) Scop., hedge-mustard S 898 R ⇦

Cactaceae

Coryphantha sulcata (Engelm.) Britton & Rose, pineapple cactus S 201 R/DG; S 696 DG

Echinocereus reichenbachii (Terscheck ex Walp.) F. Haage, hedgehog cactus S 636 LSW; KRN 784 DG

Escobaria missouriensis (Sweet) D.R. Hunt var. *robustior* (Engelm.) D.R. Hunt, plains nipple cactus S 207 DG

Escobaria vivipara (Nutt.) Buxb., spiny-star S 434 DG; S 697 DG

Opuntia phaeacantha Engelm. var. *major* Engelm., prickly-pear S 350 DG; S 359 B; S 628 B; S 766 W; S 1085 B

Callitrichaceae

Callitriche heterophylla Pursh., larger waterwort S 293 AQ/GS

Campanulaceae

Triodanis leptocarpa (Nutt.) Nieuwl., slimpod Venus' looking-glass S 194 R/DG

Capparaceae

Polanisia dodecandra (L.) DC, clammyweed S 426 B/R

Caprifoliaceae

Lonicera albiflora Torr. & A. Gray, white honeysuckle S 160 B; S 403 EH

Symphoricarpos orbiculatus Moench, coralberry S 497 EH; S 517 MGH/SW; S 762 W

Viburnum rufidulum Raf., rusty blackhaw S 140 EH; S 294 HS; S 436 LSW; S 740 XR

Caryophyllaceae

Arenaria serpyllifolia L., thyme-leaf sandwort S 202 DG ⇦

Cerastium glomeratum Thuill. S 829 DG ⇦

Minuartia michauxii (Fenzl) Farw. var. *texana* (B.L. Rob.) Mattf., rock sandwort S 195 R/DG; S 626 DG; KRN 664 DG; ROK 12160 DG; JQ 146 DG

Paronychia virginica Spreng., Parks' nailwort S 433 DG; S 484 B

Siliene antirrhina L., sleepy catchfly S 203 DG

Stellaria media (L.) Vill., common chickweed WVM 20 ⊘ ⇦

Convolvulaceae

Convolvulus equitans Benth., Texas bindweed S 204 R/DG

Evolvulus nuttallianus Schult., hairy evolvulus S 168 EH; S 322 SW; S 1105 B

Ipomoea cordatotriloba Dennst. var. *cordatotriloba*, sharp-pod morning-glory S 443 R; S 761 R

Cornaceae

Cornus drummondii C.A. Mey., rough-leaf dogwood S 521 EH; S 913 HS/SW

Crassulaceae

Sedum nuttallianum Raf., yellow stonecrop S 254 GS; S 146 GS

Cucurbitaceae

Cucurbita foetidissima Kunth, buffalo gourd S 1077 B

Ibervillea lindheimeri (A. Gray) Greene, balsam gourd S 226 B; S 389a B

Cuscutaceae

Cuscuta exaltata Engelm., tree dodder ROK 20687 LSW

Cuscuta gronovii Willd. ex Schult., S 464 DG

Cuscuta indecora Choisy var. *indecora*, S 309 DG; S 358 B; S 502 EH; S 1125 B

Cuscuta obtusiflora Kunth var. *glandulosa* Engelm., red-dodder S 384 B

Cuscuta pentagona Engelm. var. *glabrior* (Engelm.) Gandhi, R.D. Thomas, S.L. Hatch, S 300 DG; S 328 B; S 1055 DG

Ebenaceae

Diospyros virginiana L., common persimmon S 294 LSW; S 374 LSW; S 771 MGH/SW

Euphorbiaceae

Acalypha ostryifolia Riddell, hop-hornbeam copperleaf S 421 GS

Chamaesyce fendleri (Torr. & A. Gray) Small, S 376 B; KRN 772 DG: ROK 12194 DG

Chamaesyce missurica (Raf.) Shinners, prairie spurge S 446 DG; S 498 EH; S 718 DG

Chamaesyce nutans (Lag.) Small, eyebane S 785 R; ROK 22674 R

Cnidoscolus texanus (Müll. Arg.) Small, Texas bull-nettle S 1114 B; WVM 225

Croton monanthogynus Michx., doveweed S 337 B; S 382 DG; S 455 DG; S 770 W; WVM 263

Croton texensis (Kl.) Muell., Texas croton ROK 22673 R

Ditaxis humilis (Engelm. & A. Gray) Pax var. *humilis*, low wild mercury KRN 750 R; KRN 1044

Euphorbia bicolor Engelm. & A. Gray, snow-on-the-prairie S 435 B

Euphorbia davidii Subils, S 776 W

Euphorbia dentata Michx., toothed spurge S 389 B; S 655 B

Euphorbia longicruris Scheele, wedge leaf euphorbia S 327 B

Euphorbia marginata Pursh., snow-on-the-mountain S 440 R; WVM 257

Euphorbia spathulata Lam., warty euphorbia S 199 R/DG; S 232 B; S 859 B; S 869 HS; ROK 12145 G

Phyllanthus polygonoides Nutt. ex Spreng, knotweed leaf-flower S 234 B; S 501 EH; S 574 L; S 885 DG; WVM 35; WVM 186

Stillingia texana I.M. Johnst., Texas stillingia S 311 DG; S 363 B; S 1058 DG; S 1079 B

Tragia brevispica Engelm. & A. Gray, short-spike noseburn S 648 B; WVM 255

Tragia ramosa Torr., catnip noseburn S 356 B; S 618 B; S 635 LSW; S 1057 DG

Fabaceae

Acacia angustissima (Mill.) Kuntze var. *hirta* (Nutt.) B.L. Rob., fern acacia S 619 EH; S 699 DG; S 774 EH

Astragalus lotiflorus Hook, lotus milk-vetch S 139 EH; S 817 EH/SW

Cercis canadensis L. var. *canadensis*, eastern red bud S 556 LSW

Cercis canadensis L., red bud S 132 EH

Chamaecrista fasciculata (Michx.) Greene, partridge-pea S 367 EH/SW; S 371 B

Dalea aurea Nutt. ex Pursh, golden dalea S 307 DG; S 372 B; S 698 DG; KRN 882

Dalea enneandra Nutt., big-top dalea S 369 B; KRN 880

Dalea frutescens A. Gray, black dalea S 747 DG

Dalea hallii A. Gray, Hall's dalea S 460 MGH; S 724 B; KRN 879 ★

Dalea multiflora (Nutt.) Shinners, white-praire clover S 362 B

Dalea purpurea Vent., violet prairie-clover ROK 19614

Dalea reverchonii (S. Watson) Shinners, Comanche Peak prairie clover S 255 DG; S 1049 DG; S 1136 DG; KRN 790 DG; KRN 875; ROK 12149 DG; SRK 314 R/DG; SRK 321 R/DG ⚠

Dalea tenuis (J.M. Coult.) Shinners, S 312 DG; S 429 E; S 366 EH/SW; KRN 878

Desmanthus illinoensis (Michx.) MacMill. ex B.L. Rob. & Fernald, Illinois bundle-flower S 284 HS; S 364 B

Gleditsia triacanthos L., common honey-locust S 754 DG

Indigofera miniata Ortega var. *miniata*, coast indigo S 320 SW; S 733 EH/SW

Lupinus texensis Hook, Texas bluebonnet S 179 B; S 927 B; WVM 41; WVM 167

Medicago arabica (L.) Huds., spotted bur-clover S 233A R ☞

Medicago minima (L.) L., bur-clover S 563 R; S 571 L; S 233B R ☞

Medicago sativa L., alfalfa S 623 R ☞

Mimosa roemeriana Scheele, Roemer's sensitive briar S 258 EH; S 1060 DG; S 1249 B; S 1250 B

Pediomelum cuspidatum (Pursh) Rydb., tall-bread scurf-pea S 176 B; S 586 EH; S 906 B; KRN 885

Pediomelum cyphocalyx (A. Gray) Rydb., turnip-root scurf-pea S 347C B; ROK 12202 G; ROK 12159 G; KRN 886; KRN 762 EH; KRN 783 EH

Pediomelum hypogaeum Nutt. ex Torr. & A. Gray var. *scaposum*, edible scurf-pea S 326 B; S 853 B; ROK 12158 G

Pediomelum latestipulatum (Shinners) Mahler var. *latestipulatum*, Texas plains indian-breadroot S 213 B

Pediomelum latestipulatum (Shinners) Mahler, Texas plains indian-breadroot KRN 659 DG; ROK 20000 GS

Pediomelum linearifolium (Torr. & A. Gray) J.W. Grimes, S 351 EH; S 361 B

Pediomelum reverchonii (S. Watson) Rydb., rock scurf-pea S 354 B; S 705 B

Prosopis glandulosa Torr., honey mesquite S 570 B

Senna lindheimeriana (Scheele) H.S. Irwin & Barneby, Lindheimer's senna S 1235 B

Senna roemeriana Scheele, two-leaf senna S 302 R/DG, S 400 DG; S 749 DG; S 1052 DG; S 1121 B; TFR 229 DG

Tephrosia virginiana (L.) Pers., goat's rue S 417 LSW/SW

Vicia ludoviciana Nutt. ssp. *ludoviciana*, deer pea vetch S 856 B

Vicia villosa Roth ssp. *villosa*, hairy vetch S 554 EH/R ☞

Fagaceae

Quercus buckleyi Nixon & Dorr, Texas red oak S 129 LSW; S 130 LSW

Quercus fusiformis Small, plateau live oak S 533 B; S 555 LSW; S 557 LSW; WVM 16

Quercus sinuata Walter var. *brevifolia* (Torr.) C.H. Mull, bastard oak S 575 L; S 751 LSW

Quercus stellata Wangenh., post oak S 492 B

Gentianaceae

Centaurium texense (Griseb.) Fernald, Texas centaury S 627 B; S 1139 GS; KRN 923; TFR 228 B

Eustoma russellianum (Hook.) G. Don, Texas bluebells S 686 B

Sabatia campestris Nutt., prairie rose gentian S 283 B; S 1131 B

Geraniaceae

Erodium cicutarium (L.) L'Hér ex Aiton, filaree S 120 GS; WVM 2 ☞

Erodium texanum A. Gray, storks-bill S 567 EH/R; S 900 DG; S 918 B

Geranium carolinianum L., crane's bill S 239 B; S 581 R

Geranium dissectum L. S 877 GS ☞

Geranium texanum (Trel.) A. Heller, Texas geranium WVM 6

Juglandaceae

Carya illinoinensis (Wangenh.) K. Koch, pecan S 768 W; S 777 W

Krameriaceae

Krameria lanceolata Torr., trailing ratany S 589 B; S 1066 DG; S 1084 B; S 1108 B; TFR 224 B; WVM 205

Lamiaceae

Hedeoma acinoides Scheele, slender hedoma S 170 B; S 1097 B

Hedeoma drummondii Benth., Drummond's hedeoma S 1058 DG

Hedeoma hispida Pursh, rough hedeoma S 229 B

Hedeoma reverchonii A. Gray, Reverchon's false pennyroyal ROK 12152 G; ROK 20517 G

Lamium amplexicaule L., henbit S 577 L; WVM 9 ☞

Monarda citriodora Cerv. ex Lag., lemon beebalm S 280 B; S 1072 B

Rosmarinus officinalis L. S 822 L ☞

Salvia azurea Michx. ex Lam var. *grandiflora* Benth., blue sage S 765 W; S 456 B; WVM 248

Salvia farinacea Benth, mealy-cup sage S 466 B

Salvia texana (Scheele) Torr., Texas sage S 158 B; S 845 B; S 883 DG

Scutellaria drummondii Benth., Drummond's skullcap S 200 R/DG; S 887 DG; WVM 159

Scutellaria drummondii Benth. var. *edwardsiana* B.L. Turner, Drummond's skullcap S 861 B; S 929 B

Scutellaria resinosa Torr., resin-dot skullcap S 167 EH; S 590 B

Scutellaria wrightii A. Gray, Wright's skullcap S 873 B; WVM 137; WVM 154; ELB 13641

Warnockia scutellarioides (Engelm. & A. Gray) M.W.Turner, prairie brazoria KRN 749 GS

Linaceae

Linum pratense (J.B. Norton) Small, meadow flax S 153 B; S 902 DG; KRN 754 GS

Linum rigidum Pursh, flax S 164 EH

Linum rupestre (A. Gray) A. Gray, rock flax ROK 12204 G

Linum sulcatum Riddell, grooved flax S 396 B; KRN 881

Loasaceae

Mentzelia oligosperma Nutt. ex Sims, stickleaf S 385 B; TFR 227 DG

Loganaceae

Mitreola petiolata (J.F. Gmel.) Torr. & A. Gray, lax hornpod S 721 HS; S 515 MGS/SW

Lythraceae

Lythrum californicum Torr. & A. Gray, California loosestrife S 275 B; S 423 B; S 1247 HS/HWS

Malvaceae

Abutilon fruticosum Guill. & Perr., indian-mallow S 346 B; S 728 LSW; TFR 226 LSW

Callirhoe pedata (Nutt. ex Hook.) A. Gray, finger poppy-mallow S 166 EH; S 876 B; S 892 DG; WVM 160

Malva neglecta Wallr., common mallow S 576 SLW; WVM 141 ☞

Sida abutifolia Mill., spreading sida S 308 DG; S 694 DG

Sida spinosa L., prickly sida WVM 266

Menispermaceae

Cocculus carolinus (L.) DC., Carolina snailseed S 745 LSW; WVM 253

Moraceae

Maclura pomifera (Raf.) C.K. Schneid, bois d'arc S 711 W; S 769 W

Morus microphylla Buckley, Mexican mulberry S 752 DG; KRN 661

Nyctaginaceae

Mirabilis albida (Walter) Heimerl, white four-o'clock S 760 R; S 767 W

Mirabilis linearis Pursh., linear-leaf four-o'clock S 329 B

Oleaceae

Forestiera pubescens Nutt, elbow-bush S 121 G

Forestiera pubescens Nutt. var. *pubescens*, elbow-bush S 247 B

Fraxinus texensis (A. Gray) Sarg., Texas white ash S 127 LSW; S 1084b LSW RRR

Jasminum floridum Bunge, S 689 B ☞

Ligustrum quihoui Carriere, Quihoui's privet S 494 B; S 727 LSW ⊘ ☞

Onagraceae

Calylophus berlandieri Spach ssp. *pinifolius* (Engelm. ex A. Gray) Towner, Berlandier's evening-primrose S 191 R/DG; S 1056 DG; WVM 128

Calylophus serrulatus (Nutt.) P.H. Raven, yellow evening-primrose S 695 DG

Gaura drummondii (Spach) Torr. & A. Gray, sweet gaura WVM 132

Gaura lindheimeri Engelm. ex A. Gray, white gaura WVM 129

Gaura suffulta Engelm. ex A. Gray, roadside gaura S 148 B; S 616 B/R; S 920 B; S 1234 B

Oenothera coryi W.L.Wagner, WVM 31

Oenothera macrocarpa Nutt. ssp. *macrocarpa*, fluttermill primrose S 185 EH; S 585 DG/R

Oenothera speciosa Torr. & A. Gray, Spach's evening-primrose S 289 GS; S 562 R; WVM 66; WVM 130; WVM 133

Oenothera triloba Nutt., stemless evening-primrose S 578 L; S 653 B; S 888 DG

Stenosiphon linifolius (Nutt. ex E. James) Heynh., false gaura S 353 EH/SW; S 369 B; S 450 DG; ROK 12150 G

Oxalidaceae

Oxalis stricta L., gray-green woodsorrel S 621 EH; S 632 LSW; WVM 63

Passifloraceae

Passiflora lutea L., yellow passion-flower S 1253 XR

Plantaginaceae

Plantago aristata Michx., bracted plantain S 298 GS; ROK 12146 DG

Plantago helleri Small, cedar plantain S 147 GS; S 919 B; S 1091 B; KRN 660 DG; KRN 662 DG; WVM 120

Plantago patagonica Jacq., bristle-bract plantain S 583 DG/R; S 1054 DG; S 1127 B

Plantago rhodosperma Decne., red-seed plantain S 246 B; S 659 B; S 854 B; S 889 DG; S 1039 GS; WVM 146

Plantago virginica L. pale-seed plantain S 860 B

Plantago wrightiana Decne., Wright's plantain S 241 B; S 297 GS; S 634 LSW; S 1093 B; TFR 223 B

Polemoniaceae

Ipomopsis rubra (L.) Wherry, standing-cypress S 357 B

Polygalaceae

Polygala alba Nutt., white milkwort S 187 EH; S 481 B; KRN 779

Polygonaceae

Eriogonum longifolium Nutt., long-leaf wild buckwheat S 453 DG; S 512 MGH/SW; S 722b B

Rumex crispus L., curly dock S 252 GS; WVM 127 ⇐

Portulacaceae

Claytonia virginica L., Virginia spring beauty S 125 B

Portulaca pilosa L., chisme S 536 DG

Talinum calcarium S. Ware., limestone fame flower S 387 DG; S 625 DG; S 746 DG; S 1050 DG !

Primulaceae

Dodecatheon meadia L., common shooting-star S 593 LSW

Ranunculaceae

Anemone berlandieri Pritz, ten-petal anemone S 123 B; S 820 B; WVM 26

Delphinium carolinianum Walt. ssp. *virescens* (Nutt.) R.E.Brooks, prairie larkspur S 1134 LSW; S 1243 XR; KRN 788 R/B

Rhamnaceae

Ceanothus herbaceus Raf., S 1068 EH/SW; ROK 23003 R

Frangula caroliniana (Walter) A. Gray, Carolina buckthorn S 410 B/SW; S 739 XR

Rosaceae

Crataegus viridis L., greenhaw S 565 DG

Photinia serratifolia (Desf.) Kalkman, photinia S 741 XR ⊘ ⇐

Prunus mexicana S. Watson, Mexican plum S 131 ES

Prunus rivularis Scheele, thicket plum S 316 B; WVM 316

Rosa setigera Michx. var. *tomentosa* Torr. & A. Gray, prairie rose S 321 SW; S 1248 HS/HWS

Sanguisorba annua (Nutt. ex Hook.) Torr. & A. Gray, prairie rose S 150 B; S 904 DG; ROK 12147 DG; ROK 12156 DG

Rubiaceae

Cephalanthus occidentalis L. buttonbush S 1245 GS/HWS

Galium aparine L., catchweed bedstraw WVM 10; WVM 50

Galium pilosum Aiton, hairy bedstraw S 687 LSW

Galium virgatum Nutt., southwest bedstraw S 136 EH; S 230 B; S 256b DG; S 847 B

Hedyotis nigricans (Lam.) Fosberg, prairie bluets S 475 B; S 1053 DG; S 1080 B; S 1110 B; TFR 230 B; WVM 273

Houstonia pusilla Schoepf, tiny bluet S 124 B

Sherardia arvensis L., field madder S 564 R; S 826 L; WVM 37; WVM 51 ⇐

Rutaceae

Zanthoxylum hirsutum Buckley, prickley-ash S 217 B; S 401 EH; S 1135 LSW

Salicaceae

Populus deltoides Bartram ex Marshall, cottonwood S 801 R

Santalaceae

Comandra umbellata (L.) Nutt. ssp. *pallida* (A. DC.) Piehl, bastard toadflax KRN 761A

Sapindaceae

Cardiospermum halicacabum L., common balloonvine S 422 GS; S 757 P

Sapindus saponaria L. var. *drummondii* Hook & Arn, western soapberry S 296 LSW

Ungnadia speciosa Endl., Mexican buckeye S 134 LSW; S 388 DG; S 750 DG; WVM 43

Sapotaceae

Sideroxylon lanuginosum Michx. ssp. *oblongifolium* (Nutt.) T.D. Penn., chittamwood S 508 DG; WVM 43

Scrophulariaceae

Agalinis densiflora (Benth.) S. F. Blake, fine-leaf gerardia S 432 EH

Agalinis heterophylla (Nutt.) Small ex Britton, prairie agalinis S 465 B; S 469 B

Buchnera americana L., American bluehearts S 318 SW, ROK 20718 HS

Castilleja indivisa Engelm., Texas paintbrush S 156 B; WVM 234

Castilleja purpurea (Nutt.) G. Don var. *purpurea*, purple paintbrush S 155 B

Gratiola quartermaniae D. Estes, limestone hedge hyssop S 267 AQ/GS; S 566 AQ/GS; S 880 AQ/GS; ROK 20515B GS

Nuttallanthus texanus (Scheele) D.A. Sutton, Texas toad-flax S 864 B

Penstemon cobaea Nutt., wild foxglove S 184 EH; S 259 EH

Veronica peregrina L. ssp. *peregrina*, necklaceweed S 560 GS; S 561 GS

Veronica peregrina L. ssp. *xalapensis* (Kunth) Pennell, Xalapa speedwell S 211 B

Solanaceae

Physalis heterophylla Nees, clammy ground cherry S 782 W/R

Solanum dimidiatum Raf., western horse-nettle S 286 R; WVM269

Solanum elaeagnifolium Cav., silver-leaf nightshade S 303 R/DG; ROK 22681 R

Solanum ptychanthum Dunal, American nightshade S 781 W/R

Solanum rostratum Dunal, buffalo-bur S 442 R; S 722 W

Ulmaceae

Celtis laevigata Willd. var. *reticulata* Torr., net-leaf hackberry S 228 B; S 507 DG
Ulmus americana L., American elm S 796 P; WVM 23
Ulmus crassifolia Nutt., cedar elm S 800 LSW

Urticaceae

Parietaria pensylvanica Muhl. ex Willd var. *pensylvanica*, hammerwort S 649 LSW

Valerianaceae

Valerianella amarella (Lindh. ex Engelm.) Krok, hairy cornsalad S 143 GS; S 568 EH/R; S 849 B; S 874 B
Valerianella radiata (L.) Dufr. f. *parviflora* (Dyal) Egg. Ware, beaked cornsalad S 149 B; S 865 HS
Valerianella woodsiana (Torr. & A. Gray) Walp., Wood's cornsalad S 553 B

Verbenaceae

Glandularia bipinnatifida (Nutt.) Nutt., prairie verbena S 135 EH; S 620 EH; S 924 B
Glandularia pumila (Rydb.) Umber, pink verbena S 122 G; S 828 G
Lantana camara L., west Indian lantana S 691 B ⊘ ⇐
Lippia nodiflora (L.) Michx., frogfruit S 374 B
Verbena halei Small, slender vervain S 703 GS; S 233b B; WVM 115
Vitex agnus-castus L. var. *agnus-castus*, common chastetree S 690 B ⊘ ⇐

Violaceae

Hybanthus verticillatus (Ortega) Baill, nodding-green violet S 205 DG; KRN 789 DG

Viscaceae

Phoradendron tomentosum (DC.) Engelm. ex A. Gray, mistletoe S 534 B; WVM 1

Vitaceae

Cissus incisa Des Moul, cowitch S 390 B
Parthenocissus quinquefolia (L.) Planch, Virginia-creeper S 925 LSW
Vitis cinerea Engelm var. *cinera*, sweet grape S 295 LSW
Vitis mustangensis Buckley, mustang grape S 301 LSW/R; S 857 B, WVM 233
Vitis riparia Michx., river grape S 1252 XR
Vitis vulpina L., fox grape S 1256 XR

MAGNOLIOPHYTA: LILIOPSIDA

Agavaceae

Yucca arkansana McKelvey, Arkansas yucca S 260 EH
Yucca pallida McKelvey, pale yucca S 345 B; KRN 884 ★

Commelinaceae

Commelina erecta L. var. *erecta*, dayflower S 437 LSW
Commelina erecta L. var. *angustifolia* (Michx.) Fernald, narrow-leaf dayflower S 347b R
Tradescantia humilis Rose, Texas spiderwort S 647 B ★
Tradescantia occidentalis (Britton) Smyth, prairie spiderwort S 190 WS
Tradescantia tharpii E.S. Anderson & Woodson, Tharp's spiderwort S 872 B

Cyperaceae

Carex cherokeensis Schwein., Cherokee caric sedge S 688 XR; S 1112 LSW; KRN 713 LSW
Carex microdonta Torr. & Hook., small-tooth caric sedge S 133 HS; S 142 GS; S 180 HS; S 335 HS; S 867 HS; S 1083 B; KRN 780 P
Carex muehlenbergii Schkuhr ex Willd. var. *enervis* Boott, S 178 B
Carex perdentata S.D. Jones, conspicuously-toothed caric sedge S 1236 B ✽
Carex planostachys Kunze, cedar caric sedge S 169 EH; S 323 SW; S 631 LSW; S 652 B; S 818 EH/SW; S 1064 DG; S 1082 B; S 1109 B; S 1245 XR; KRN 777
Carex retroflexa Muhl. ex Willd., reflexed-fruit caric sedge S 1237 B
Cyperus acuminatus Torr. & Hook. ex Torr., taper-leaf flat sedge S 528 DG
Cyperus lupulinus (Spreng.) Marcks, slender flat sedge S 664 B
Cyperus setigerus Torr. & Hook., S 291 GS; WVM 268
Eleocharis montevidensis Kunth, S 337 HS; S 641 GS; S 611a GS; S 866 HS; S 878 GS; S 1035 GS
Eleocharis occulta S. G. Smith, limestone spikerush S 141 GS; S 173 HS; S 268 GS; S 341 HS; S 642 GS; S 870 HS; S 921 GS; S 1067 DG; KRN 658 HS; KRN 781 P RRR
Eleocharis palustris (L.) Roem. & Schult., large-spike spike-rush S 645 GS
Fimbristylis puberula Michx. var. *puberula*, S 317 HS/SW; S 333 HS; S 406 HS/SW; S 407 HS/SW; S 1081 B; KRN 778; KRN 782 P
Fuirena simplex Vahl var. *aristulata* (Torr.) Kral, S 265 GS; S 340 HS; S 409 HS/SW; S 701 GS; S 1242 HS/HWS
Rhynchospora nivea Boeck., snowy white-top sedge S 336 HS/SW
Scleria ciliata Michx., fringed nut-rush S 416 LSW/SW
Scleria verticillata Muhl. ex Willd, low-nut rush S 523 HS/SW

Iridaceae

Iris germanica L., garden iris S 824 L ⇐
Nemastylis geminiflora Nutt., prairie celestial S 137 EH; S 558 EH; S 569 B
Sisyrinchium langloisii Greene, pale blue-eyed grass S 165 EH; S 171 B; S 911 HS/SW; S 922 GS

Juncaceae

Juncus brachyphyllus Wiegand, small-head rush S 580 GS
Juncus bufonis L., toad rush S 215 GS; S 288 GS
Juncus capitatus Weigel, capped rush S 266 GS; S 613 GS
Juncus dudleyi Wiegand, Dudley's rush S 1042 HS
Juncus filipendulus Buckley, ring-seed rush S 1241 S/HWS; KRN 922; KRN 930; ROK 20002
Juncus interior Wiegand, inland rush S 580 GS; S 612 GS; S 643 GS; S 901 HS/SW; S 1133 B
Juncus marginatus Rostk., grass-leaf rush ROK 13319 GS
Juncus nodatus Coville, jointed rush ROK 20068 GS
Juncus texanus (Engelm.) Coville, Texas rush S 264b GS; S 343 HS; S 408 HS/SW; S 611 GS; S 700 GS; S 1043 HS; S 1246 HS/HWS ★
Juncus torreyi Coville, Torrey's rush S 299 GS; S 344 HS

Liliaceae

Allium canadense L. var. *hyacinthoides* (Bush) Ownbey & Aase, wild onion S 144 GS
Allium canadense L. var. *fraseri* Ownbey, wild onion S 183 EH; S 248 GS; S 1038 GS; KRN 753 GS
Allium drummondii Regel, prairie onion S 154 B; S 225 GS; S 850 B; S 864 HS; WVM 34
Camassia scilloides (Raf.) Cory, wild hyacinth S 222 B
Cooperia drummondii Herb., rain-lily S 380 DG
Cooperia pedunculata Herb., prairie rain-lily WVM 254
Erythronium mesochoreum Knerr, KRN 1387; KRN 1397
Muscari neglectum Guss. ex Ten., starch grape-hyacinth S 826 L ⇐
Nothoscordum bivalve (L.) Britton, crow poison S 488 B; S 537 GS; S 749 GS; S 868 HS
Zigadenus nuttallii (A. Gray) S. Watson, death-camass S 221 B; S 897 B

Orchidaceae

Spiranthes cernua (L.) L.C. Rich., nodding ladies'-tresses KRN 663 B
Spiranthes magnicamporum Sheviak, great plains ladies'-tresses S 486 B; S 529 HS; S 530 HS

Poaceae

Aegilops cylindrica Host, jointed goat grass S 1089 B; TFR 217 B ⇐

Agrostis perennans (Walter) Tuck., autumn bent grass S 214 GS

Andropogon gerardii Vitman ssp. *gerardii*, big bluestem S 457 MGH; ROK 22679 DG

Andropogon glomeratus (Walter) Britton, Sterns, & Poggenb., bushy bluestem S 525 HS/SW

Aristida lanosa Muhl. ex Elliott, woolly-sheath threeawn S 735 EH/SW

Aristida oligantha Michx., prairie threeawn S 795 EH/SW

Aristida purpurea Nutt. var. *longiseta* (Steud.) Vasey, red threeawn S 315 B; S 1087 B

Aristida purpurea Nutt. var. *nealleyi*, blue threeawn S 218 B; S 355 B; S 886 DG; S 903 DG; S 1070 EH/SW; S 1111 B; S 1116 B; S 1122 B

Aristida purpurea Nutt., var. *purpurea*, blue threeawn S 1119 B

Arundo donax L., giant reed S 798 B ⊘ 🗺

Avena fatua L., wild oats S 193 R/DG 🗺

Bothriochloa barbinodis (Lag.) Herter var. *barbinodis*, cane bluestem S 428 EH; S 489 B; S 503 EH; S 1118 B

Bothriochloa ischaemum L. var. *songarica* (Rupr. Ex Fisch. & C.A.Mey) Celerier & Harlan, King Ranch bluestem S 342 HS; S 449 DG; S 452 DG; S 499 EH; S 907 B; S 1063 DG; WVM 282 ⊘ 🗺

Bothriochloa laguroides (DC.) Herter. ssp. *torreyana* (Steud.) Allred & Gould, silver bluestem S 352 EH/SW; S 370 B; S 719 DG

Bouteloua curtipendula (Michx.) Torr. var. *curtipendula*, side-oats grama S 451 DG

Bouteloua hirsuta Lag., hairy grama S 737 EH/SW; WVM 265

Bouteloua pectinata Feath., tall grama S 427 EH; S 458 MGH; S 473 B; S 725 B

Bouteloua rigidiseta (Steud.) Hitchc., Texas grama S 535 B; TFR 221 B

Briza minor L., little quaking grass S 292 GS 🗺

Bromus catharticus Vahl, rescue grass S 224 GS; WVM 65 🗺

Bromus japonicus Muhl. ex Willd, Japanese brome S 245 B; S 928 B; S 1036 GS; WVM 33 🗺

Bromus tectorum L. var. *tectorum*, cheat grass brome S 238 B ⊘ 🗺

Buchloe dactyloides (Nutt.) Engelm., buffalo grass S 592 B; S 905 B; S 1130 B; WVM 149

Cenchrus spinifex Cav., common sandbur S 730 EH/SW

Chloris verticillata Nutt., tumble windmill grass S 582 R; WVM262

Coelorachis cylindrica (Michx.) Nash, Carolina joint-tail S 660 B

Desmazeria rigida (L.) Tutin, S 573 L 🗺

Digitaria cognata (Schult.) Pilg. ssp. *pubiflora* (Vasey) Wipff, western witch grass S 447 DG; S 506 EH; S 640 B

Eleusine indica (L.) Gaertn., goose grass WVM 264 🗺

Elymus canadensis L., Canada wild rye S 274 B; S 276 B; S 881 GS

Elymus virginicus L. Virginia wild rye S 1244 XR

Eragrostis curtipedicellata Buckley, gummy love grass S 493 B; S 637 B; S 789 B

Eragrostis intermedia Hitchc., plains love grass S 662 B

Eragrostis pilosa (L.) P.Beauv., India love grass S 663 B 🗺

Eragrostis secundiflora J. Presl. ssp. *oxylepis* (Torr.) S.D. Koch, red love grass S 734 EH/SW

Eragrostis sessilispica Buckley, tumble love grass KRN 889

Eriochloa sericea (Scheele) Munro ex Vasey, Texas cup grass S 654 B; S 1074 B

Erioneuron pilosum (Buckley) Nash, hairy tridens S 379 DG; S 588 DG; S 235 DG; S 1126 B

Hordeum pusillum Nutt., little barley S 151 B; S 208 DG; S 251 GS

Limnodea arkansana (Nutt.) L.H. Dewey, Ozark grass S 656 B; S 1065 DG; S 1101 B; S 1115 B; S 1132 B

Lolium perenne L. ssp. *perenne*, perennial rye grass S 196 R/DG; S 243 B; S 383 DG 🗺

Lolium perenne L., ssp. *multiflorum* (Lam.) Husn., Italian rye grass S 262 GS 🗺

Muhlenbergia reverchonii Vasey & Scribn., seep muhly S 438 GS; S 505 EH; S 726 B ⚑

Nassella leucotricha (Trin. & Rupr.) Barkworth, Texas winter grass S 278 B; S 1069 EH/SW; S 1120 B; TFR 220 B

Panicum aciculare Desv. var. *angustifolium* Elliott, needle-leaf rosette grass S 339 HS

Panicum acuminatum Sw. var. *lindheimeri* (Nash) Lelong, Lindheimer's rosette grass S 263 GS; S 338 HS; S 520 MGH/SW

Panicum acuminatum (Sw.) Gould & C.A.Clark, tapered rosette grass ROK 12205 GS

Panicum capillare L., witchgrass S 786 R; S 799 B

Panicum diffusum Sw., spreading panicum S 1129 B

Panicum hallii Vasey var. *hallii*, Hall's panic grass S 650 B

Panicum obtusum Kunth, vine mesquite S 277 B

Panicum oligosanthes Schult. var. *scribnerianum* (Nash) Gould, Scribner's rosette grass S 244 B; S 491 B

Panicum virgatum L., switchgrass S 468 HS/SW; 470 B; S 500 EH; S 524 HS/SW; S 615 R; S 692 DG

Phalaris caroliniana Walter, wild canary grass S 272 GS; S 644 GS

Poa annua L., annual bluegrass S 250 GS 🗺

Polypogon monspeliensis L., rabbit's-foot S 290 GS 🗺

Schedonnardus paniculatus Nutt., tumble grass S 324 B

Schizachyrium scoparium (Michx.) Nash, little bluestem S 461 MGH; S 477 B

Setaria parviflora (Poir) Kerguelen, knot-root bristle grass S 444 R

Setaria pumila (Poir.) Roem. & Schult., yellow bristle grass S 412 EH 🗺

Setaria reverchonii (Vasey) Pilg., Reverchon's bristle grass S 1117 B; ROK 12155 DG

Sorghastrum nutans (L.) Nash, yellow Indian grass S 462 MGH; S 485 B

Sorghum halepense (L.) Pers., Johnson grass TFR 222 B ⊘ 🗺

Sporobolus compositus (Poir.) Merr. var. *drummondii* (Trin.) Kartesz & Gandhi, meadow dropseed S 471 B; S 504 EH; S 736 EH/SW; 791 B

Sporobolus ozarkanus Fernald, Ozark dropseed S 793 DG

Tridens albescens (Vasey) Wooton & Standl., white tridens S 249 GS; S 646 GS; S 914 GS; S 1128 B

Tridens flavus (L.) Hitchc., purpletop S 399 EH; S 738 XR

Tridens muticus (Torr.) Nash var. *elongatus* (Buckley) Shinners, rough tridens S 448 DG; S 479 B

Tridens muticus (Torr.) Nash var. *muticus*, slim tridens S 495 DG

Tripsacum dactyloides L., eastern gamma grass S 330 B

Trisetum interruptum Buckley, prairie trisetum S 209 GS; S 231 B; S 250b DG; S 1138 GS

Triticum aestivum L., bread wheat ROK 12140 R 🗺

Vulpia octoflora (Walter) Rydb. var. *octoflora*, common sixweeks grass S 894 DG; S 1062 DG

Smilacaceae

Smilax bona-nox L., saw greenbrier S 397 EH; S 518 MGH/SW; WVM 138

Smilax tamnoides L., devil greenbrier S 1256 XR/SW

Typhaceae

Typha domingensis Pers., narrow-leaf cat-tail S 285 HS

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EXPANDED DISTRIBUTION OF *ISOËTES BUTLERI* (ISOËTACEAE) IN TEXAS

Kimberly Norton Taylor, Robert J. O'Kennon, Tiana Franklin Rehman

Botanical Research Institute of Texas
1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.,
knorton@brit.org, okennon@brit.org, trehman@brit.org

ABSTRACT

More than 125 *Isoëtes butleri* populations are reported from 11 additional counties in north central Texas. These collections bridge the 450 km disjunction between Oklahoma and central Texas records. SEM examination of megaspore ornamentation and size confirm the determination. Descriptions of sites, population sizes, associated plants, soils, and species characteristics are included and discussed.

RESUMEN

Se registran más de 125 poblaciones de *Isoëtes butleri* de 11 condados adicionales en norte central de Texas. Estas colecciones unen la disyunción de 450km previamente observada que separaba las poblaciones de Oklahoma y Texas. Las identificaciones se confirmaron usando un microscopio electrónico de barrido para observar la ornamentación y tamaño de las megasporas. Se incluyen descripciones de localidades, tamaños de poblaciones, las plantas asociadas, los suelos y las características de la especie.

Isoëtes butleri Engelm. is known to occur in Tennessee, Kentucky, Alabama, Arkansas, Missouri, Kansas, Oklahoma (Baskin & Baskin 1978), Georgia (Boom & Evans 1979), Illinois (Mohlenbrock 1955), and Texas (Lott et al. 1982). The species is most abundant in the cedar glades of the Tennessee Central Basin and the Ozark region of Missouri and Arkansas where it typically grows in seasonally saturated soil over exposed limestone bedrock (Taylor & Schwegman 1992).

Baskin and Baskin (1978) note that *I. butleri* is only known from "calcareous glades" in the southeastern United States. While various authors indicate that it is also found on sandstone (Taylor et al. 1975; Lott et al. 1982), it has been suggested that "the sandstone substrate may be cemented together by a calcareous matrix which, in effect, creates the normal pH conditions" (Lott et al. 1982). The relatively recent documentation of *I. butleri* in the Edwards Plateau of Texas represents a disjunction of about 450 km (Lott et al. 1982). Hansen (2010) discovered populations in Bell and Coryell counties approximately 100 km to the northeast of Llano Co. in the Lampasas Cut Plain.

Holmes et al. (2005) discovered populations of *I. butleri* in glauconite glade pools of the Weches Formation in San Augustine and Sabine counties in eastern Texas. These locations represent a disjunction of 250 km to the south of locations in Miller Co., Arkansas and over 300 km to the east of locations in Bell Co. The Weches formation comprises a narrow strip approximately 650 km long from northeast to south-central Texas.

In June 2003, O'Kennon and Caren McLemore collected a specimen that they identified as *I. melanopoda* (*18645*, BRIT) from a Walnut Limestone seep in the Lyndon B. Johnson National Grasslands in Wise Co., Texas. Upon examination of this specimen and additional collections from the same location (*Norton & O'Kennon 1394*, BRIT; *Rehman, O'Kennon, Norton, Barfield 371*, BRIT), the authors determined that it is actually *I. butleri* (Taylor et al. 1993). This population represents the first known location for *I. butleri* in north central Texas, over 240 km north of Hansen's 2010 collections in the Lampasas Cut Plain.

In May 2010, O'Kennon, Franklin, and Barfield collected *Isoëtes butleri* (*22362*, BRIT) from a Walnut Limestone seep at the Fort Worth Nature Center and Refuge in Tarrant Co., Texas. Scanning electron micrographs (Fig. 1) showed megaspores averaging approximately 500 μm in diameter and megaspore ornamentation consistent with that described by Taylor et al. (1975). The limestone substrate at both the Wise and Tarrant Co. sites is consistent with previous indications that the species is calciphilous (Baskin & Baskin 1978; Taylor & Taylor 1981; Lott et al. 1982; Taylor & Schwegman 1992).

In the spring of 2012, the authors conducted an extensive search in north central Texas around Fort

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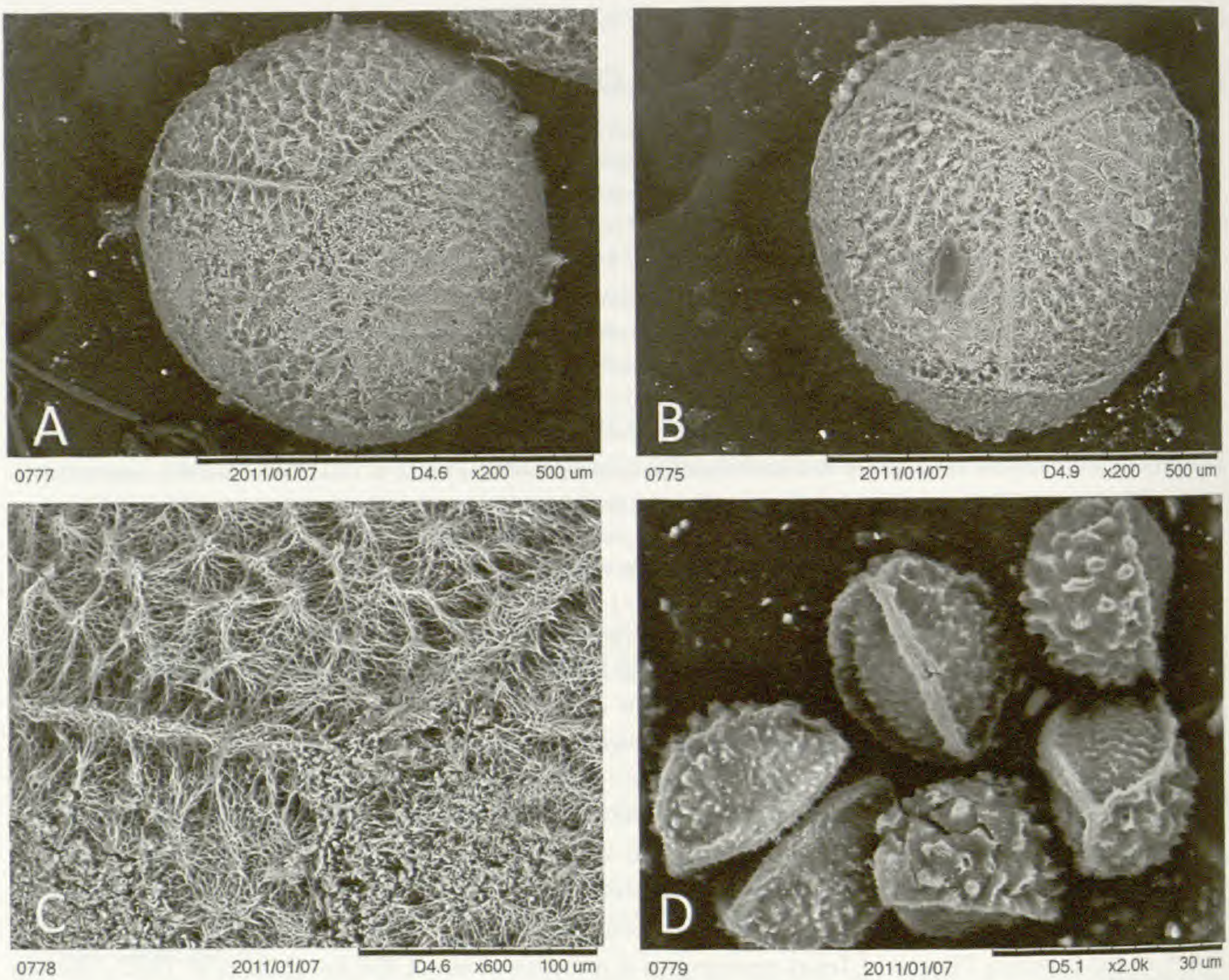

Fig. 1. SEM micrographs of *Isoëtes butleri* megaspores and microspores, *O'Kennon, Franklin, Barfield 22362* (BRIT). A–B. Megaspores; C. Megaspore ornamentation; D. Microspores.

Worth. Areas where limestone outcrops formed "glades" reminiscent of those found in the Central Basin of Tennessee were searched for *I. butleri*. Satellite imagery and geologic maps were used to identify other possible locations for exploration. Over 125 new locales were confirmed for *I. butleri*. These collections represent 11 new county records, including Bosque, Cooke, Denton, Erath, Hood, Johnson, Montague, Parker, Somervell, Tarrant, and Wise counties (Fig. 2). At least one voucher specimen from each county was collected and deposited in the BRIT herbarium. High resolution images of each specimen are available online at http://atrium.brit.org/.

All sites are underlain by Cretaceous limestone with the majority being Walnut Limestone, Grayson Marl, Goodland/Comanche Peak Limestone, and Duck Creek Limestone. The majority of the sites (109 of 125) were found on seasonally saturated seeps underlain by Walnut Limestone. This hard, fossil rich limestone has a tendency to outcrop, producing glades. These glades often form at lower topographic positions as the eroding soil uncovers the hard limestone bedrock below. Seepage from upslope often forms pools over the impenetrable bedrock. *Isoëtes butleri* was found in shallow soil ranging from less than 2 cm at the bottom of the slope to approximately 15 cm up slope.

Isoëtes butleri is most abundant in areas with little competing vegetation, and can often form a dense monoculture. Most sites were estimated to have between 100 and 1000 plants. Transects at the Acton Nature Center in Hood Co., and at the Rough Creek Lodge on the Somervell – Erath Co. line each resulted in an estimate of well over 100,000 individuals. Sites ranged in size from a few square meters to 2.5 ha. Associated spe-

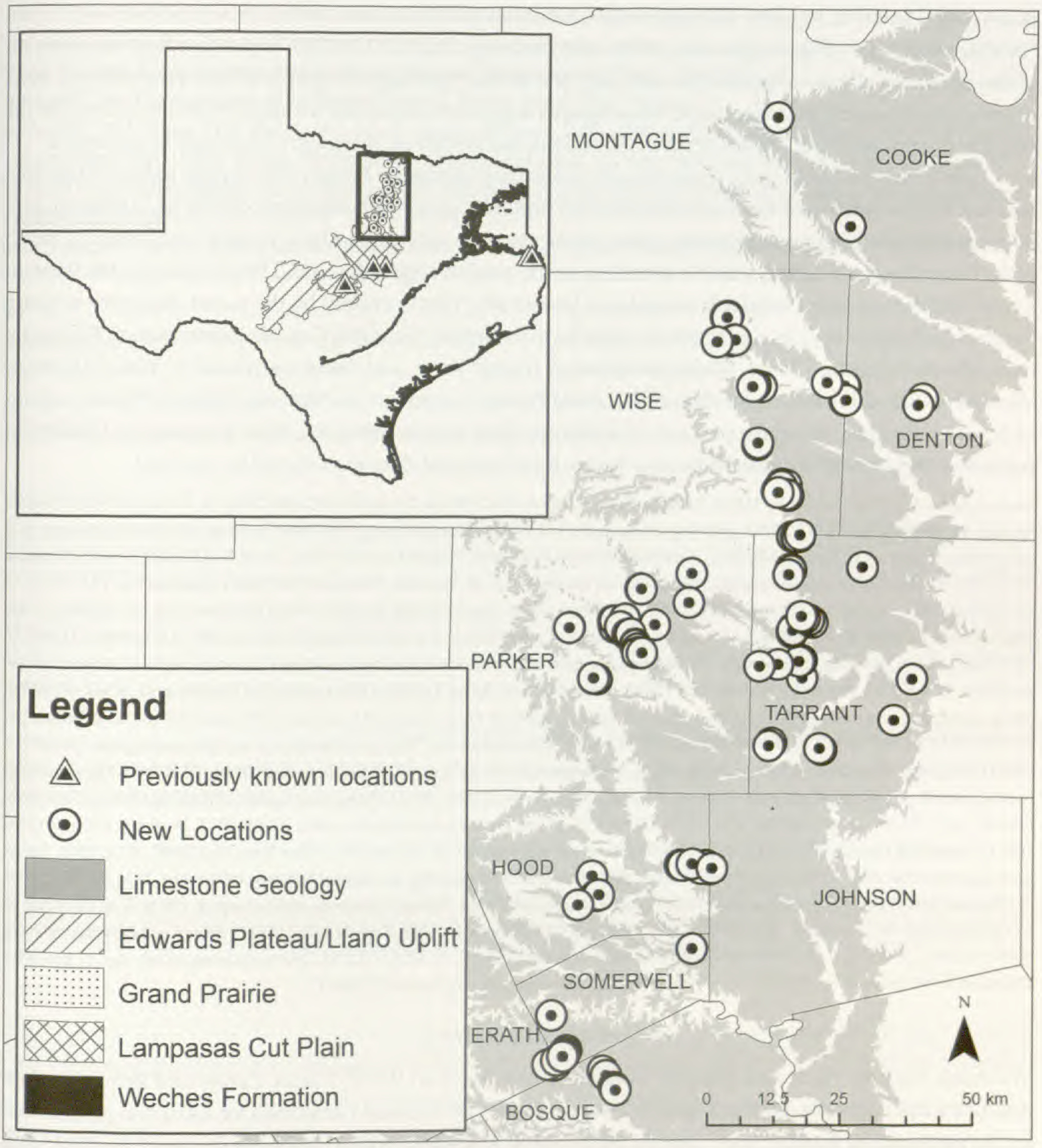

FIG. 2. Locations of currently known *Isoëtes butleri* sites in Texas.

cies include *Eleocharis occulta* S.G. Sm., *Juncus filipendulus* Buckl., *Hypoxis hirsuta* (L.) Coville, *Spiranthes magnicamporum* Sheviak, *Gratiola quartermaniae* D. Estes, *Nothoscordum bivalve* (L.) Britton, *Allium canadense* var. *fraseri* Ownbey, and *Muhlenbergia reverchonii* Vasey & Scribn.

Plants become evident in early March and above ground sporophylls begin to yellow by mid-May and disappear almost completely by mid-June, which is consistent with previous observations (Baskin & Baskin 1978; Taylor & Schwegman 1992). All plants collected were dioecious, with gynoecious and androecious individuals growing adjacent to one another. Gynoecious plants are easily distinguished by the presence of megaspores which develop in mid-April. The evidence of dioecy in these north central Texas individuals is consistent with much of the published literature (Engelmann 1878; Taylor & Schwegman 1992; Turner et al 2005).

Boom (1982) however, suggests that genetically based dioecy does not exist for the species and cites a specimen "in which both types of sporangia were on the same plant (e.g., *Kral 52572*, VDB)." Upon thorough examination of this specimen, all plants appeared to have only one form of sporangia. Megaspores were present in the roots of some plants bearing microsporangia, but megasporangia were absent and the spores were likely found in the soil. It is our opinion that *I. butleri* is indeed dioecious, but further examination of this issue is warranted.

Isoëtes butleri is much more widespread in Texas than previously known. The cryptic nature of this species has likely contributed to its misidentification and the paucity of herbarium collections. At first glance, above ground parts appear to resemble culms of the associate species *Eleocharis occulta*. Until recently, much of the limestone glade habitat which is abundant on the western edge of the Grand Prairie and into the Western Cross Timbers remained relatively unexplored botanically. This is evident by the recent discovery or range expansion of several species characteristic of glades in the region, including *Gratiola quartermaniae*, *Phemeranthus calycinus* (Engelm.) Kiger, *Minuartia michauxii* (Fenzl) Farw., and *Dalea reverchonii* (S. Wats.) Shinners. We believe that additional exploration of the Grand Prairie, Lampasas Cut Plain, and Edwards Plateau regions of Texas would likely reveal the presence of additional glade taxa in addition to more locations for *I. butleri*. In particular, regions with exposed limestone bedrock and seasonal saturation should be searched.

Representative Voucher Specimens. **U.S.A. TEXAS. Bosque Co.:** Co Rd 2650 ca. 0.7 mi SE of Co Rd 2660, ca. 3.5 air mi NW of Walnut Springs, 32.087772, -97.795782, 297 m, growing in seasonally wet Walnut Limestone seep with water pooling on exposed limestone bedrock at base of slope, abundant, 28 Mar 2012, *Norton & O'Kennon 1481* (BRIT). **Cooke Co.:** FM 373 ca. 0.5 mi N of FM 922, 4 mi E of Rosston, 33.51212, -97.38164, 269 m, approximately 50 plants in wet roadside seep, 21 Apr 2012, *O'Kennon 24978* (BRIT). **Denton Co.:** FM 156 ca. 1.5 mi S of Hwy 380 ca 4.5 mi W of Denton, 33.222563, -97.258846, 210 m, approximately 50 plants in wet limestone seep on roadside, 21 Apr 2012, *O'Kennon 24983* (BRIT). **Erath Co.:** Rough Creek Lodge, Co Rd 2013 ca. 4.2 mi SE of hwy 67, 10.4 mi SW of Glen Rose, 32.097517, -97.879603, 311 m, growing in seasonally wet Walnut Limestone seep with water pooling on exposed limestone bedrock at base of slope, abundant, 27 Apr 2012, *Norton & O'Kennon 1671* (BRIT). **Hood Co.:** Peak Rd ca. 2 mi SE of Paluxy Hwy, S of Granbury, 32.38345, -97.80091, 318 m, growing in thin soil over Walnut Limestone on N side of Comanche Peak, 27 Apr 2012, *Norton & O'Kennon 1664* (BRIT). **Johnson Co.:** Co Rd 1233A ca. 0.3 mi NE of FM 4/Cleburne Hwy between Decordova and Cleburne, abundant in wet limestone glade, 32.429217, -97.611739, 236 m, 7 Apr 2012, *O'Kennon 24834* (BRIT). **Montague Co.:** FM 2382 ca. 0.7 mi E of St. Jo, 33.695964, -97.506674, 352 m, growing in swale on side of road, approximately 20 plants, 21 Apr 2012, *O'Kennon 24982* (BRIT). **Parker Co.:** Corner of Highland Rd and New Highland Rd, ca. 3 mi SW of Springtown, 32.926796, -97.647542, 310 m, growing in limestone swale, 10 Apr 2012, *Norton & O'Kennon 1537* (BRIT). **Somervell Co.:** Rough Creek Lodge, Co Rd 2013 ca. 4.2 mi SE of hwy 67, 10.4 mi SW of Glen Rose, 32.122892, -97.857961, 326 m, growing in wet clay over Walnut Limestone bedrock, glade seep with water pooling on exposed bedrock, infrequent, 28 Mar 2012, *Norton & O'Kennon 1470* (BRIT). **Tarrant Co.:** Fort Worth Nature Center and Refuge, Walnut Limestone Muhly Seep ca. 150 m W of entry gate on Confederate Park Rd, 32.829340, -97.477730, 207 m, 26 May 2010, *O'Kennon, Franklin, Barfield 22362* (BRIT). **Wise Co.:** LBJ National Grasslands, Unit 49, ca. 0.5 mi E of Fs 910 and Co Rd 2360 down unmarked road, 33.3201, -97.5781, 290 m, growing in wet clay, 27 Jun 2003, *O'Kennon & McLemore 18645* (BRIT); 16 June 2011, *Rehman, O'Kennon, Norton, Barfield 371*(BRIT).

ACKNOWLEDGMENTS

We thank Suzanne Tuttle and Michelle Villafranca from the Fort Worth Nature Center and Refuge for their assistance and collection permits; Austin Sewell from the LBJ National Grasslands for collection permits and for his assistance in locating sites; Camelia Maier and PhD student Pallavi Upadhyay for use of the SEM lab at Texas Woman's University; Caren Marcom (McLemore), Keri Barfield, and Becca Swadek for their work in the field; and all of the land owners who allowed us to collect on their property. We thank Walter C. Holmes, Jerry Baskin, and one anonymous reviewer for helpful reviews.

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BOOK NOTICE

Donald Pigott. 2012. **Lime-Trees and Basswoods. A Biological Monograph of the Genus *Tilia*.** (ISBN-13: 978-0-521-84054-5, hbk.). Cambridge University Press, The Edinburgh Building, Cambridge CB2 8RU, United Kingdom. (**Orders:** www.cambridge.org). $130.00, 405 pp., 314 b/w illustrations, 8½" × 11".

From the Publisher: "Lime trees (*Tilia* spp.) are widely distributed and locally important members of northern temperate broad-leaved forests. In marked contrast to the largely uniform morphology of the genus its taxonomic treatment has become increasingly confused and controversial, with over one hundred species and numerous subspecies described. Using extensive data from field studies of natural populations around the world, this book clarifies the situation, proposing a revised taxonomy of 23 species and 14 subspecies. Detailed descriptions are provided for all recognized taxa and are accompanied by illustrations. Data from herbaria and cultivated trees are used to extend the analyses where appropriate and type specimens are included to stabilize nomenclature. Lime tree ecology is also considered, with an exploration of experimental and analytical data on regeneration, growth and reproduction in relation to climate and soils. Additional material includes a glossary of botanical terms and appendices of herbarium codes and relevant physical concepts."

Each taxonomic entry is treated systematically with a variety of descriptive information: Synonymy (if any), Nomenclature, Type Information, Description and Figure, Chromosome Number, Variation and Hybrids, Hybridization, Geographical Distribution, Ecology and Plant Communities. Keys are also provided.

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6. Chromosome numbers, molecular biology and hybridization
7. Geographic and ecological data
8. European and west Asian taxa
9. East Asian taxa 1: sections Endochrysea, Henryana and Anastraea
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A FLORISTIC INVENTORY OF VASCULAR PLANTS OF THE MEDICINE BOW NATIONAL FOREST AND VICINITY, SOUTHEASTERN WYOMING, U.S.A.

Laura E. Lukas
1272 Bishop Hill Rd.
Charlottesville, Virginia 22902, U.S.A.
lauraelizabethlukas@gmail.com

B.E. Nelson
Rocky Mountain Herbarium
Department of Botany, Dept 3165
University of Wyoming
1000 E. University Ave.
Laramie, Wyoming 82071, U.S.A.
bnelsonn@uwyo.edu

Ronald L. Hartman
Rocky Mountain Herbarium
Department of Botany, Dept 3165
University of Wyoming
1000 E. University Ave.
Laramie, Wyoming 82071, U.S.A.
rhartman@uwyo.edu

ABSTRACT

This inventory expands the floristic coverage of the Medicine Bow Mountains (Medicine Bow National Forest proper) located in southeastern Wyoming. The Forest, covering 2,150 sq km (830 sq mi) and ranging in elevation from 2,400–3,650 m (7,900–12,013 ft), was surveyed for all species of vascular plants. Most of the lands inventoried are in the Medicine Bow-Routt National Forest but small parcels are under the jurisdiction of the Bureau of Land Management or the State of Wyoming. These parcels are within three miles of the Forest boundary. Over three summers, 9,837 numbered specimens were collected at 168 sites. Two unnamed putative hybrids were documented. A summary of taxa follows (numbers in parentheses are taxa documented by other workers): 88 families, 376 genera, 835 (201) species, 910 (212) unique taxa for a combined total of 1,122 unique or terminal taxa. *Alchemilla filicaulis* ssp. *filicaulis* and *Carex arcta* are species new to Wyoming. Also documented were 51 (18) exotics as well as seven noxious weeds. Twenty-two species of conservation concern were also found at 51 locations.

RESUMEN

Este inventario expande la cobertura florística de las Medicine Bow Mountains (Medicine Bow National Forest propiamente dicho) localizadas en el sureste de Wyoming. El bosque, que cubre 2,150 km^2 (830 sq mi) con un rango de elevación de 2,400–3,650 m (7,900–12,013 ft), fue estudiado para colectar todas las especies de plantas vasculares. La mayor parte de los terrenos inventariados están en el Medicine Bow-Routt National Forest pero algunas pequeñas parcelas están bajo la jurisdicción del Bureau of Land Management o del estado de Wyoming. Estas parcelas están a menos de tres millas del límite del bosque. Durante tres veranos, se colectaron 9,837 especímenes numerados en168 lugares. Se documentaron dos híbridos putativos sin nombrar. El resumen de taxa es como sigue (los números en paréntesis son taxa documentados por otros autores): 88 familias, 376 géneros, 835 (201) especies, 910 (212) taxa únicos de un total combinado de 1,122 taxa únicos o terminales. *Alchemilla filicaulis* ssp. *filicaulis* y *Carex arcta* son especies nuevas para Wyoming. También se documentaron 51 (18) exóticas así como siete malas hierbas nocivas. También se encontraron 22 especies con necesidad de conservación en 51 localizaciones.

INTRODUCTION

The Medicine Bow Mountains (Medicine Bow National Forest proper, herein referred to as the Medicine Bows) have had a long history of botanical research. Most relevant is the floristic work beginning with Aven Nelson and his students in the 1890s. Likewise there have been a long series of ecological studies by faculty and students of the University of Wyoming (J.F. Reed, W.K. Smith, D.H. Knight), the U.S. Forest Service (R. Musselman), and visiting scientists (W.D. Billings, R.F. Daubenmire, L.C. Bliss, H.A. Mooney). For more than 50 years, the University of Wyoming's S.H. Knight Science Camp hosted hundreds of students enrolled in summer courses in biological and geological sciences. The camp was closed in the early 1980s. Most of the activities mentioned above occurred along the "Wyoming Highway 130 corridor" from near Centennial to the area on Libby Flats and the summit of Medicine Bow Peak (Fig. 1). B.E. Nelson did a Master's degree on the Medicine Bow Mountains and summarized collection data from throughout the range (Nelson 1974), later publishing results in a book (Nelson 1978, 1984). The first book edition had intense use by students at the Science Camp.

This botanical inventory is part of the larger effort by the Rocky Mountain Herbarium (RM) to map in relatively fine detail the geographic distributions of species based on vouchered specimens and to produce a

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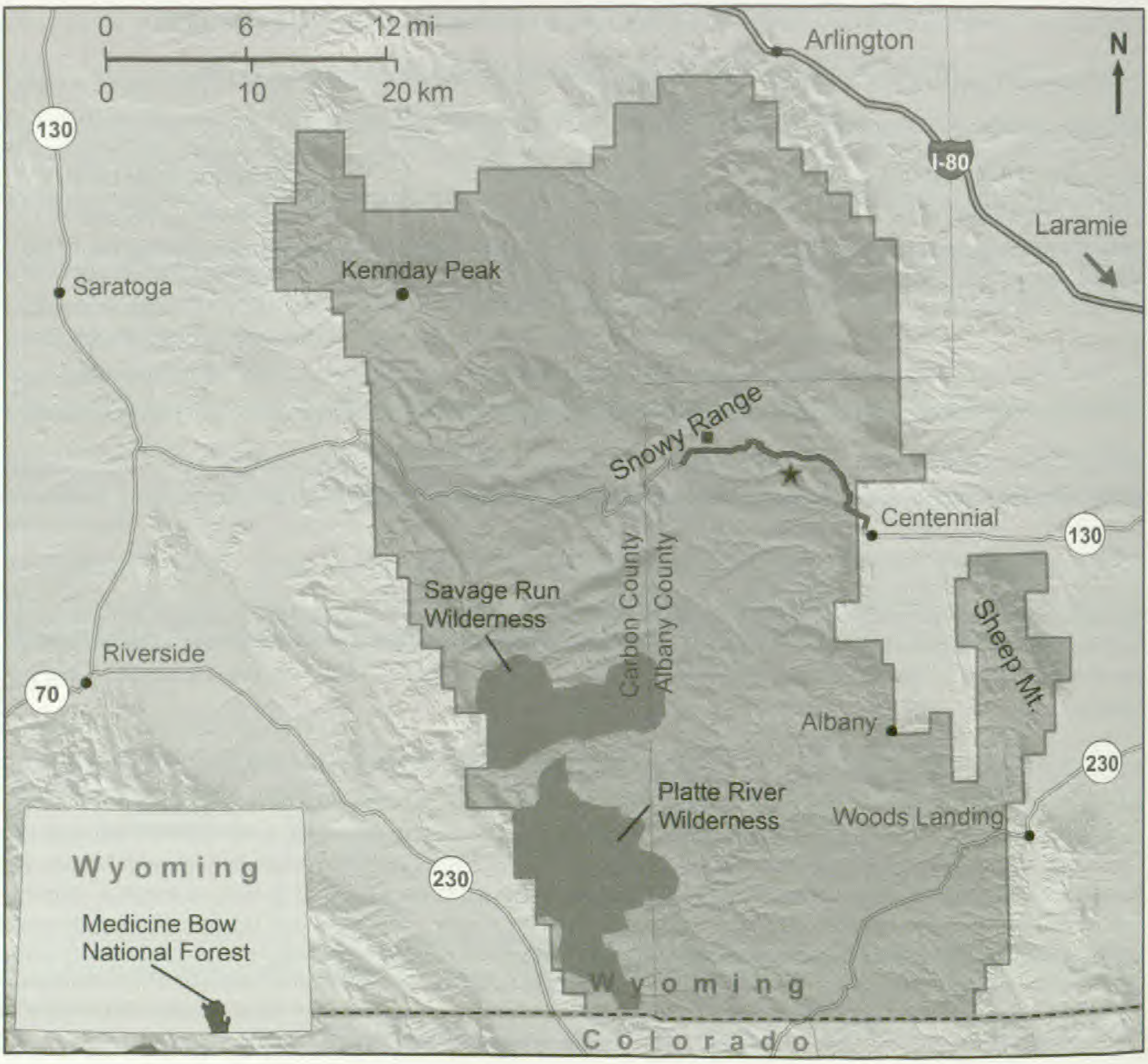

Fig. 1. Map of the Medicine Bow National Forest in southeastern Wyoming. The darkened line delineates the "Wyoming Highway 130 corridor" that had received primary attention (Centennial to Libby Flats). This is also true of Medicine Bow Peak, indicated by a solid square. The location of the UW Science Camp is represented by a star.

flora of the greater Rocky Mountain region (Hartman 1992; Hartman & Nelson 2011). To that end, 74 (52 by MS students) major floristic inventories have been conducted during the past 33 years in Arizona, Colorado, Idaho, Kansas, Montana, Nebraska, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming. Over 650,000 new collections have been obtained by the graduate students, staff, and research associates of the RM. These specimens form the core of the RM Plant Specimen Database (730,000 specimen records, 35,000 specimen images, and 4,000 field images (Hartman et al. 2009)).

Study area.—The area encompasses 2,150 sq km (830 sq mi) mostly in the Medicine Bow National Forest in southeastern Wyoming (Fig. 1). It represents the northern half of the mountain range that extends north from Cameron Pass in Colorado. At its widest point, the range is 51 km (32 mi) across. The Colorado portion, not included in the study, consists of Roosevelt and Routt National Forests and state lands.

The Medicine Bows cover 218,535 ha (540,000 acres), 210,036 ha (519,000 acres) of which are managed by the Forest Service. It lies within the coordinates: N41.000° to N41.584° and W105.9763° to W106.6307°. Protected areas are the Savage Run Wilderness in the west central part that covers 6,040 ha (14,927 acres), the

Platte River Wilderness in the southwestern corner, 9,206 ha (22,749 acres), and the roadless area around Rock Creek Trail in the northeastern portion, 7,098 ha (17,540 acres) (Marston & Clarendon 1988).

The range is divided between Albany and Carbon counties (Fig. 1). The eastern boundary of the Forest lies about 30 miles west of Laramie whereas the western edge is about 10 miles east of Saratoga. Included in the area are two districts (Brush Creek and Laramie) of the Forest and some small parcels of adjacent Bureau of Land Management and state lands (Fig. 2, symbols beyond Forest boundary).

Wyoming Highway 130 runs east-west through the north central portion of the mountains while Wyoming Highway 230 travels southeast of Sheep Mountain into Colorado, reentering Wyoming just west of the range, and then northwest through Saratoga. Interstate 80 continues through Laramie and then northwest through Rawlins. Thus, it adjoins the range along the northeastern flank.

Topography.—The Wyoming Medicine Bows are surrounded by the Laramie Plains to the east, the Hanna Basin to the north, and the Saratoga Basin to the west. These peripheral areas range in elevation from 1,829–2,438 m (6,000–8,000 ft); 2,400 to 3,650 m (7,900–12,013 ft) for Forest proper. The Snowy Range ("Snowies") runs northeast to southwest through the north central part of the Forest from 3,230–3,660 m (10,600–12,013 ft). They tower above the surrounding landscape, reaching 3,650 m (12,013 ft) on Medicine Bow Peak. Isolated at the forest's northwestern corner is Kennaday Peak (3,295 m; 10,810 ft). Much of rest of the Medicine Bows is a plateau, at an elevation of about 2,743 m (9,000 ft), with river canyons and other drainages dissecting the range. The primary rivers are the Laramie on the east, the Medicine Bow on the north, and the North Platte on the west. Numerous glacial potholes dot the surface of the mountains' northern half and glacial erratics lay strewn on the periphery. Isolated Sheep Mountain protrudes from the southeastern flank of the Medicine Bows.

Climate.—Wyoming has a semiarid climate. Periods of drought (precipitation less than 75 percent of normal for three months or longer) lasting ten years or more are common (Curtis & Grimes 2004). The basins surrounding the Medicine Bows receive 25–36 cm (10–14 in) of precipitation annually (Wyoming State Climate Office 2010). Precipitation increases with elevation, so the foothills receive 53–78 cm (21–32 in) of precipitation annually, while the highest elevations, around 3,353 m (11,000 ft) and above, receive up to 1.27 m (50 in) (Marston & Clarendon 1988).

The timing of wet and dry seasons also shifts with elevation. In the basins, most precipitation falls from late April to mid-July, while November to February is relatively dry (Wyoming State Climate Office 2010; Curtis & Grimes 2004). The high mountains receive most of their precipitation between October and May in the form of snow, with a peak from December to February, while the dry season is late summer to early fall (GLEES 2009).

Thunderstorms are common in the summer, particularly in July, and are most intense at lower elevations (Marston & Clarendon 1988). Hail is frequent at their onset but lasts only a few minutes. Between 1970 and 2000, 50 to 60 percent of wildfires were sparked by lightning strikes and spread by the strong winds that accompany these storms (Curtis & Grimes 2004).

Wyoming is the ninth coldest of the 50 states with an annual average temperature of 8.1° C (45.6° F) (Curtis & Grimes 2004). The highest mean temperatures in the basins surrounding the Medicine Bows are in early July and range from 16.1 to 18.9° C (61 to 66° F), while the maximum temperature during the summer is 32.2° C (90° F) and the minimum is 7.8° C (46° F). Growing seasons are short, averaging 90 frost free days from June to September (Marston & Clarendon 1988). Temperatures also fluctuate rapidly during the growing season. The coldest month in the lowlands is January with a mean temperature of -6.7 to -5.6° C (20 to 22° F), a maximum normal of -0.55 to 0.55° C (31 to 33° F), and a minimum normal of -10.6 to -13.3° C (8 to 13° F) (Wyoming State Climate Office 2010).

The annual average temperature at montane elevations in the Medicine Bows ranges from -1.1 to 4.4° C (30 to 40° F). The growing season is very short with an average of 61–80 frost free days in the foothills, 41–60 in the mountains, and just a few days in the alpine zone. At 11,000 ft (3,353 m), the temperature can be as low as -45.6° C (-50° F) in winter, but the mean hovers around freezing (Marston & Clarendon 1988; Heidel & Jones 2006).

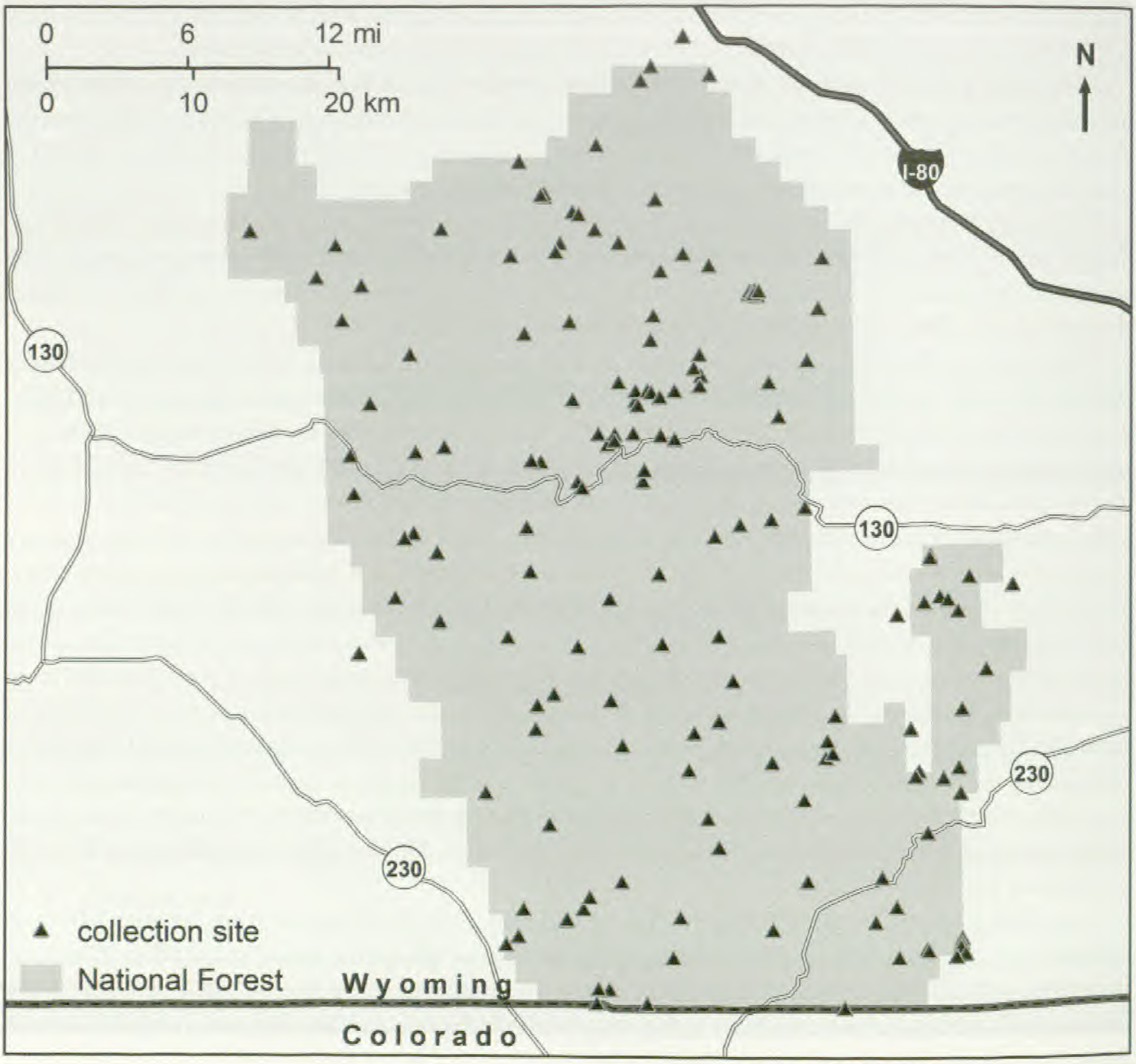

Fig. 2. Specimens were collected at 168 sites during 2007, 2008, and 2009, mostly within the confines of the Medicine Bow National Forest.

Wyoming is the windiest of the 50 states, and the Medicine Bows are in a particularly blustery spot. This is because there are no land masses to stop the prevailing west winds from attaining great speeds by the time they reach the area (Marston & Clarendon 1988). The wind tends to be strongest in the afternoons. In the winter, winds range from 48–64 km per hour (30–40 mi per hour) with gusts of 80–97 km per hour (50–60 mi per hour) and even 161 km per hour (100 mi per hour) (Marston & Clarendon 1988).

Especially strong winds may accompany summer storms. Microbursts are powerful downward surges of wind that can level areas of the forest. Tornadoes rarely occur in and around the Medicine Bows with only 37 reports from 1950 to 2003 (Curtis & Grimes 2004).

Geology and Geomorphology.—The Medicine Bow Mountains have a core consisting of Precambrian rocks that were pushed up during the Laramide Orogeny, 80 to 50 million years ago. During this time, the Earth's crust was pushed from west to east, shifting Precambrian basement rocks against younger sedimentary strata (Miller et al. 1992). These Cretaceous strata are now exposed on the eastern flank (Munn and Arneson 1998). The foothills and basins surrounding the range are remnants of Oligocene, Miocene, and Pliocene deposits from inland seas (Hausel 1993; Stearn et al. 1979).

A five mile wide shear zone, the Cheyenne belt, cuts from northeast to southwest through the center of the range, crossing Wyoming 130 near the eastern border of the Medicine Bows (Knight 1990; Hausel 1993). This shear zone was created 1.7 to 1.8 billion years ago when the Earth's crust was displaced thousands of feet, elevating the southern plate and lowering the northern plate (Knight 1990; Sims et al. 2001).

The rocks south of the Cheyenne Belt are younger schist and gneiss (1.8 to 1.7 billion years old), Sherman Granite (1.4 billion years old), and mafic complexes (1.8 billion years old). Those north of this belt are Archean granite and gneiss (older than 2.5 billion years) overlain by quartzite and schist (2.5 to 1.7 billion years old; Hausel 1993; Marston & Clarendon 1988; Sims et al. 2001). The Snowy Range is a six-mile-long chunk of Medicine Peak Quartzite (2.4 to 2 billion years old), an extremely durable metamorphosed sandstone deposited by a Precambrian ocean or river (Hausel 1993; Houston 1968). This 6,000 foot thick formation rises over the surrounding landscape as it is more resistant to weathering (Knight 1990; Houston 1968). The Nash Fork formation, exposed across the central part of the range, is made of black slate, phyllites, stromatolites, metadolomite, and gabbro (Knight 1990; Hausel 1993; Houston et al. 1968).

During the Pleistocene, the northern half of the range was glaciated at least three times, during the Pre Bull Lake, Bull Lake, and Pinedale episodes (Pierce et al. 1976; Stearn et al. 1979). These glaciers scoured the range, carving out small valleys as well as Lake Marie, Lookout Lake, and leaving many ponds in the northwestern part of the range. The glaciers emptied into Centennial Valley depositing cobbles and boulders. Many areas have a discontinuous mantle of glacial deposits (Houston 1968).

METHODS

The procedures largely follow practices employed by graduate students and staff at the Rocky Mountain Herbarium for inventories in the region (Hartman 1992; Hartman & Nelson 2011). The primary objective was to collect the diversity of vascular plants throughout the growing season. L.E. Lukas, B.E. Nelson, and R.L. Hartman collected during the field seasons of 2007 (2 June to 15 September), 2008 (9 June to 6 September), and 2009 (7 June to 26 August).

Collection sites were selected for the most part using a stratified methodology. Furthermore the goal was to achieve relative even distribution of sites across the landscape. We also focused on unusual habitats such as carbonate soil, fens, and rocky outcrops. Sites where different community types intersected were frequented thus leading to the sampling of a greater diversity in plant species. Although a site generally was not revisited, adjacent ones were collected during different months to cover the range of phenology. Places where rare plants had previously been documented were often visited. This led to the development of a search image for these species and the associated habitat.

Plants were collected when in flower or fruit. In cases where they could be readily identified, vegetative samples were taken (e.g., *Salix* and *Populus*). Relevant data on location (including GPS reading) and habitat were recorded. At the end of the collecting route, the plastic bags of specimens were placed on ice in a cooler to prevent wilting. The following day the specimens were pressed and dried for a minimum of 48 hours.

Subsequently, the specimens were bundled and transported to the RM where they were frozen for periods of three days. This procedure killed any insects that may have survived the drying process. During the subsequent academic year, the specimens were identified using Dorn's 2001 edition of *Vascular Plants of Wyoming*, the *Flora of North America* (1993+), and other relevant literature. Regardless, the nomenclature in the checklist follows that in the Rocky Mountain Herbarium Database (Hartman et al. 2009). All taxa were checked against specimens verified by specialists. The species determination and other relevant data were entered into the RM Plant Specimen Database (Hartman et al. 2009). Labels were then generated. The original set of specimens is deposited at RM. A representative set of specimens was presented to the Medicine Bow–Routt National Forest. The remaining sets of duplicates have been distributed to other herbaria.

RESULTS AND DISCUSSIONS

Vegetation Types

The vegetation of the Medicine Bow Mountains has been described by many researchers. Its zonation has been defined based on plant communities at climax, that is, after succession has reached a stable state (Alexander et al. 1986; Cook 1996; Daubenmire 1943; Jones & Ogle 2000). Other investigators describe vegetation zones based on the current state (Peet 1981; Walford et al. 2001). This latter approach is followed in the subsequent discussion. First the plant communities are divided into broad physiognomic and zonal categories. Within each, the communities are discussed. As described below the discussions consist of a combination of literature citations and personal observations.

Forests and woodlands

According to Dillon et al. (2005) forests cover 79 percent of the Medicine Bows, of which lodgepole pine comprises 50 percent and subalpine fir/spruce 21 percent. The forests begin in the foothills as aspen and mixed conifer woodlands and end in alpine krummholz.

Subalpine fir/spruce forest.—These forests are the most frequent subalpine type throughout the Rocky Mountains. In the Medicine Bows they occur from 2,740–3,350 m (9,000–11,000 ft) and are the highest forest type, becoming ribbon communities or krummholz near and at timberline. *Abies bifolia* and *Picea engelmannii* are codominant, but the latter species is generally larger and older. Also there are a higher percentage of young individuals of *A. bifolia* in the understory, possibly due to vegetative reproduction and higher drought tolerance in seedlings compared with *P. engelmannii* (Alexander et al. 1986; Knapp & Smith 1982).

Understory vegetation generally is sparse, except at the highest elevations where the forest becomes dispersed. In forests with a dense canopy the understory is dominated by *Carex geyeri* and *Vaccinium scoparium*. Individuals of *Pinus contorta* are often present as are clones of *Populus tremuloides*. Other common associates in more open areas are *Arnica cordifolia*, *Erigeron glacialis*, *Erythronium grandiflorum*, *Fragaria virginiana*, *Hieracium triste*, *Juniperus communis*, *Ligusticum porteri*, *Noccaea fendleri*, *Orthilia secunda*, *Osmorhiza depauperata*, *Pedicularis bracteosa*, *P. racemosa*, *Poa reflexa*, *P. wheeleri*, *Ribes lacustre*, *Rosa sayi*, and *Trisetum spicatum*.

Disturbance is somewhat less common in these forests than in lodgepole communities that occur at lower elevations. Stand-replacing fires may occur in the subalpine forest every 25 to 700 years. Blowdowns that can level large swathes of forest occasionally occur and may lead to bark beetle infestations (Peet 1981).

Lodgepole pine forest.—These forests cover much of the montane throughout the Rocky Mountains, where they are restricted to dry uplands (Jones & Ogle 2000). In the Medicine Bows, *Pinus contorta* is found at elevations from 2,440–3,050 m (8,000–10,000 ft). The canopy is usually closed and the understory sparse, dominated by *Carex geyeri*, *C. rossii*, *Juniperus communis* or *Vaccinium scoparium*. *Arceuthobium americanum* is a common parasite on branches of *P. contorta*. Other associates in more open areas are *Antennaria rosea*, *Arnica cordifolia*, *Berberis repens*, *Campanula rotundifolia*, *Orthilia secunda*, *Poa wheeleri*, *Rosa sayi*, *Shepherdia canadensis*, *Solidago simplex*, and *Trisetum spicatum*.

Lodgepole pine forests occur on many soil types, but especially ones that are acidic, well-drained, and granitic. They are able to occupy more arid conditions than subalpine fir and Engelmann spruce because they have a higher water-use efficiency (Knapp & Smith 1981).

Lodgepole pine trees often live less than 250 years (Dillon et al. 2005). Fire is more frequent in this community compared to the subalpine fir/spruce forest. Serotinous reproduction of *P. contorta* is more common below 2,773 m (9,100 ft). After fires, seed dispersal in proximity to one or more individuals may produce “doghair” stands (Porter 1962).

Pinus contorta forests in the southern Rocky Mountains are currently experiencing a major bark beetle outbreak. In 2007, most of the trees were green, despite pitch tubes through their bark. By 2009, vast swathes of the forest, especially on the western side of the range, were composed of only dead trees with orange needles.

Aspen forest.—These woodlands represent the only forest type in the Medicine Bows that consists largely of deciduous trees. Aspen can survive in part because of their photosynthetic bark which fixes carbon even at near-freezing temperatures (Pearson & Lawrence 1958; Strain & Johnston 1963). *Populus tremuloides* forests grow at elevations from 1,980–2,890 m (6,500–9,500 ft). Small patches occur in the foothills along cold air drainages, at the interface between Precambrian granite and sedimentary rocks, along margins of coniferous forests, scattered throughout the mountains on north aspects, and lining stream margins.

The aspen understory is often diverse and lush. The composition remains similar regardless of elevation. It includes *Elymus glaucus*, *E. trachycaulus*, *Juniperus communis*, and *Rosa sayi*. Other associates are *Amelanchier alnifolia*, *Arnica cordifolia*, *Berberis repens*, *Carex geyeri*, *Galium boreale*, *Heracleum maximum*, *Ligusticum porteri*, *Lupinus argenteus* varieties, *Osmorhiza depauperata*, *Poa pratensis*, *P. reflexa*, *Prunus virginiana*, *Symphoricarpos* species, *Thalictrum fendleri*, *Vicia americana* var. *americana*, and *Viola nuttallii*.

Many aspen forests are fire dependent. Their clonal nature, due to extensive horizontal root systems, allows the trees to regenerate following a fire. With time, these forests may be replaced by conifers or become grassy areas (Alexander et al. 1986).

Douglas fir/limber pine woodland.—These woodlands occur on warm, dry sites with shallow, rocky soils derived from sedimentary strata. Thus they may be found along the western, southeastern, and northeastern margins of the range, generally below 2,590 m (8, 500 ft). At low elevations these woodlands are restricted to north aspects.

Pseudotsuga menziesii/Pinus flexilis woodlands have a mostly closed canopy. This proved to be the most difficult forest to walk through as the understory is very dense and dominated by *Juniperus communis*. Aspen and lodgepole pine are also common, and there may be scattered individuals of *Pinus ponderosa*. Other common associates are *Antennaria rosea*, *Arnica cordifolia*, *Artemisia tridentata* var. *vaseyana*, *Berberis repens*, *Carex geyeri*, *Elymus spicatus*, *Eremogone congesta*, *Koeleria macrantha*, *Leucopoa kingii*, *Poa interior*, *Prunus virginiana*, *Purshia tridentata*, *Ribes cereum*, *Sedum lanceolatum*, and *Symphoricarpos* species.

Ponderosa pine woodland.—These woodlands are rare in the Medicine Bows. They exist primarily on the southern and western slopes of Sheep Mountain and on the southwestern flank in the Bennet Creek area. They occur at elevations from 2,480–2,590 m (8,150–8,500 ft) in deep, well-drained, gravelly, granite-derived soils (Wirsing 1973). At their upper margins, these woodlands grade into Douglas fir/limber pine forests.

Pinus ponderosa woodlands have a grassy or shrubby understory and an open canopy. The shrubs *Artemisia tridentata* var. *vaseyana*, *Juniperus communis*, and *Purshia tridentata* are common, as are the subshrubs or herbs *Anemone patens*, *Antennaria microphila*, *A. rosea*, *Arctostaphylos uva-ursi*, *Berberis repens*, *Carex geyeri*, *C. rossii*, *Drymocallis fissa*, *Eremogone fendleri*, *Lupinus argenteus* varieties, and *Penstemon virens*.

Shrublands

Shrublands cover 10 percent of the landscape (Dillon et al. 2005). They occur in basins and plains on the periphery of the range as well as throughout the mountains where edaphic factors are not favorable for the establishment of forests.

Sagebrush steppe.—This community type is widespread in southeastern Wyoming. The shrubs may be sparse to dense with a canopy to three feet in height. Herbaceous taxa are usually interspersed and ground cover may include a crust of mosses, lichens, and algae. In the Medicine Bows, *Artemisia nova* and *A. tridentata* subspecies *vaseyana* dominate, the latter being at higher, cooler, more mesic sites (Barker & McKell 1983).

The understory is dominated by grasses such as *Achnatherum nelsonii*, *Elymus cinereus*, *E. spicatus*, *Festuca idahoensis*, *Koeleria macrantha*, and *Hesperostipa comata*. Common herbs include *Balsamorhiza sagittata*, *Lupinus* species, *Oxytropis lagopus*, *O. lambertii*, and *Poa wheeleri*. Common shrubs are *Chrysothamnus viscidiflorus*, *Ericameria nauseosa* varieties, *Purshia tridentata*, *Ribes cereum*, *Rosa sayi*, and *Symphoricarpos* species. *Juniperus scopulorum* may occur as scattered individuals, especially in rocky places.

Grasslands and Forblands

Dry alpine meadow.—In the Medicine Bows, alpine vegetation starts around 3,350 m (11,000 ft) in elevation, but this may vary with aspect. The alpine climate is harsh with cold temperatures, windy conditions, and a short growing season. Although precipitation occurs almost daily, it is usually light and evaporation and also evapotranspiration by plants is high (Billings 1988). In response to such harsh conditions, alpine vegetation consists primarily of low perennial herbs and shrubs with proportionally high below ground biomass.

Common plants in dry alpine meadows of the Snowy Range are *Antennaria corymbosa, Aquilegia coerulea, Artemisia scopulorum, Cerastium arvense, Draba aurea, D. crassifolia, Elymus scribneri, Erigeron pinnatisectus, Eritrichum nanum, Festuca saximontana, Geum rossii, Hymenoxys grandiflora, Lewisia pygmaea, Luzula spicata, Mertensia viridis, Minuartia obtusiloba, M. rubella, Oxyria digyna, Packera fendleri, Paronychia pulvinata, Penstemon whippleanus, Phlox pulvinata, Poa glauca, Polemonium viscosum, Ribes lacustre, Selaginella densa, Silene acaulis, Solidago multiradiata, Tonestus pygmaeus, Trifolium dasyphyllum, T. parryi,* and *Trisetum spicatum.* Included here are fell-fields and scree slopes with a similar representation of species.

Moist to wet alpine meadow.—Such meadows occur around glacial ponds, along snowmelt streams, downhill from persistent snow banks, and in depressions. These areas are often on leeward slopes. The soil is either wet or moist throughout most of the growing season. Cryoturbation, which causes patterned ground, and solufication in moist soils damage plant roots and expose bare ground for colonization (Knight 1994).

Moist to wet alpine meadows may be dominated by woody plants, graminoids, or forbs. Common associates are *Agoseris glauca* var. *dasycephala, Arnica mollis, Bistorta vivipara, Carex macloviana, C. nova* var. *nova, C. phaeocephala, C. scopulorum, Chamerion angustifolium, Erigeron glacialis, E. grandiflorus, E. melanocephalus, Gaultheria humifusa, Juncus drummondii, Kalmia microphylla, Packera dimorphophylla, Pedicularis groenlandica, Phleum alpinum, Saxifraga rhomboidea, Sedum rhodanthum, Stellaria longipes, Trifolium parryi, Trollius albiflorus,* and *Veronica wormskjoldii.* In the wettest areas, *Deschampsia cespitosa* is prominent. Shrubs include *Salix brachycarpa, S. glauca,* and *S. planifolia.*

Wet montane meadow.—These meadows are found on margins of low-gradient streams and ponds. The soil is wet to moist throughout the growing season and the organic horizon is well developed (Jones & Ogle 2000). In the subalpine zone, *Bistorta bistortoides, Deschampsia cespitosa, Phleum alpinum,* and *Ranunculus alismifolius* are predominant. Other common wet meadow dwellers are *Caltha leptosepala, Epilobium* species, *Geum macrophyllum, Juncus arcticus, Pedicularis groenlandica, Trollius albiflorus,* and *Zigadenus elegans.*

Dry montane meadow.—There are many dry parks and smaller meadows on the margins of coniferous forests. It is not always known how they are able to persist for long periods of time. Explanations for the exclusion of trees include dry, fine-textured soils, high competition from the roots of herbs and graminoids, microclimates that are too cold, or soil that is too shallow such as along ridge tops blown free of snow (Jackson 1957; Knight 1994).

Festuca idahoensis and *Poa secunda* varieties, and *P. cusickii* are often dominant at higher elevations. Other common species are *Carex foenea, Elymus smithii, E. trachycaulus, Eremogone fendleri, Erigeron compositus, Frasera speciosa, Koeleria macrantha, Leucopoa kingii, Lewisia pygmaea, Oxytropis campestris, Packera cana, Phlox pulvinata,* and *Potentilla diversifolia.*

Northern mixedgrass prairie.—This is the common vegetation type in the Laramie Plains. In some places it extends into the foothills where one would normally expect to find sagebrush steppe. This is usually due to the presence of high winds or shallow soil. Here the soil may be fine and derived from sedimentary strata (Sims et al. 2001). Dominants include grasses *Bouteloua gracilis, Hesperostipa comata, Koeleria macrantha, Elymus cinereus, E. smithii, Festuca idahoensis, Leucopoa kingii, Poa fendleriana* ssp. *longiligula,* and *P. secunda* ssp. *secunda.* Cushion plants such as *Eremogone congesta* and *Paronychia sessiliflora* are dominant in the windiest spots. Common forbs include: *Allium textile, Antennaria microcephala, Artemisia frigida, Astragalus flexuosus, A. spatulata, Castilleja angustifolia, Cryptantha virgata, Drymocallis fissa, Erigeron eatonii, Eriogonum flavum, Erysimum capitatum* var. *purshii, Heterotheca villosa, Linum lewisii, Oxytropus lambertii, Packera cana, Penstemon virens, Phlox hoodii, Senecio integerrimus* var. *exaltatus,* and *Sphaeralcea coccinea.*

Wetlands

Riparian conifer forest.—Numerous creeks and rivers flow through the various forest types providing habitat for this distinct community. Regardless, *Picea engelmannii* is often the dominant overstory species. Patches of *Picea pungens, Populus angustifolia* along creeks in the non-forested lowland and *P. tremuloides* may also be found here. Riparian conifer forests cover the elevational range from 2,400 to over 3,050 m (7,900 to over 10,000 ft).

Common species encountered along forested riparian areas are *Alnus incana*, *Androsace* species, *Caltha leptosepala*, *Calamagrostis canadensis*, *Carex* species, *Cornus sericea*, *Deschampsia cespitosa*, *Equisetum arvense*, *Glyceria* species, *Luzula parviflora*, *Mertensia ciliata*, *Mimulus guttatus*, *Mitella pentandra*, *Platanthera* species, *Primula pauciflora*, *Saxifraga odontoloma*, *Senecio triangularis*, and *Streptopus amplexifolius*.

Riparian shrubland.—This community occurs from the foothills to the alpine. The canopy ranges from two to five feet in height. Herbaceous species grow interspersed with the shrubs. The soil is moist, acidic, and generally mineral (Jones & Ogle 2000).

Most riparian shrublands are dominated by a variety of *Salix* species. *Salix boothii* is common in valley bottoms and is bordered by either sagebrush steppe, aspen woodlands, or conifer forest. *Salix geyeriana* and *S. planifolia* occurs in mid to high elevations along streams, seeps, and depressions. Other common species growing in riparian shrublands are *Alnus incana*, *Betula glandulosa*, *Caltha leptosepala*, *Carex aquatilis*, *C. utriculata*, *Deschampsia cespitosa*, *Geum macrophyllum*, *Juncus arcticus*, *Mertensia ciliata*, *Pedicularis groenlandica*, *Swertia perennis*, and *Symphyotrichum foliaceum* varieties.

Fen.—Peatlands are wetlands with cool, anaerobic soils that allow the accumulation of a thick horizon of partially decayed organic matter. This organic layer is called peat, which varies in depth (Heidel & Jones 2006). Fens are minerotrophic peatlands, that is, ones fed by groundwater or surface water. Fens are important because they are home to restricted species that represented over 10 percent of the species of conservation concern in Wyoming (Heidel & Laursen 2003). Ten such species occur in fens in the Medicine Bows, nine of which are generally boreal in distribution (Heidel & Jones 2006). Of these ten species, *Carex leptalea*, *C. limosa*, *C. paupercula*, and *Salix candida* are the most frequent and at times are dominant.

Fens are common in parts of the montane zone of the Medicine Bows. They are mostly associated with low-gradient streams (Heidel & Jones 2006). Fens are dominated by graminoids, shrubs, and various moss species (Heidel & Jones 2006). Common taxa are *Betula glandulosa*, *Carex aquatilis*, *C. canescens*, *C. capillaris*, *C. jonesii*, *C. paupercula*, *C. utriculata*, *Conioselinum scopulorum*, *Eleocharis quinqueflora*, *Epilobium* species, *Gentianopsis detonsa*, *Oxypolis fendleri*, *Pedicularis groenlandica*, *Salix planifolia*, *Sedum rhodanthum*, and *Viola macloskeyi*.

Pond.—Most of the ponds and small lakes are located toward the northern end of the range in Carbon County. These were formed by glaciers during the Pleistocene. Other ponds occur in moist to wet meadows throughout the Medicine Bows.

The ponds are generally surrounded by an outer band of *C. aquatilis* and an inner band of *Carex utriculata*. Other common aquatic and semi-aquatic taxa are *Callitriche hermaphroditica*, *C. palustris*, *Carex limosa*, *C. paupercula*, *Eleocharis palustris*, *E. quinqueflora*, *Glyceria* species, *Hippuris vulgaris*, *Lemna trisulca*, *Myriophyllum verticillatum*, *Nuphar polysepala*, *Potamogeton epihydrus*, *P. pusillus*, *P. richardsonii*, *Ranunculus flammula*, and *Sparganium angustifolium*.

Disturbed

Clear-cut/burn.—Areas of lodgepole pine forests that have been clear-cut are common, as are various montane habitats that are open due to wildfires. Either of these disturbance types are colonized by a similar assemblage of plants. Especially common are *Achillea millefolium* and *Antennaria rosea*. Other components include *Agrostis scabra*, *Boechera stricta*, *Bromus inermis*, *Campanula rotundifolia*, *Carduus nutans*, *Ceanothus velutinus*, *Collomia linearis*, *Dactylis glomerata*, *Elymus elymoides* var. *brevifolius*, *Festuca saximontana*, *Gayophytum diffusum*, *Lupinus argenteus* varieties, *Matricaria discoidea*, *Packera fendleri*, *Poa arida*, *P. interior*, *Potentilla gracilis* var. *pulcherrima*, *Rosa sayi*, *Spergularia rubra*, and *Trisetum spicatum*.

Roadside.—Margins of roads and similarly disturbed areas provide habitat for many weedy species. Included are exotics such as *Agropyron cristatum* var. *desertorum*, *Bromus inermis*, *Capsella bursa-pastoris*, *Dactylis glomerata*, *Melilotus officinalis*, *Phleum pratense*, *Spergularia rubra*, *Taraxacum erythrospermum*, *T. officinale*, *Tragopogon dubius*, *Trifolium hybridum*, *T. repens*, *T. pratense* and natives such as *Achillea millefolium*, *Anaphalis margaritacea*, *Antennaria parvifolia*, *Boechera stricta*, *Campanula rotundifolia*, *Castilleja linariifolia*, *Chamerion* *angustifolium* varieties, *Elymus elymoides* var. *brevifolius*, *E. trachycaulus* var. *trachycaulus*, *Eremogone congesta*, *Erigeron subtrinervis*, *Gayophytum diffusum*, *Matricaria discoidea*, *Oxytropis lambertii*, and *Solidago simplex.*

Species Newly Documented In Wyoming

Carex arcta is a circumboreal species. It was found at three locations in the Long Lake–Stillwater Park area in the northwestern portion of the Medicine Bows (*Hartman 70269, 70331, 70338*). This area is dotted with glacial pot-hole ponds and streams, the habitat in which all specimens were growing. The nearest populations occur in Idaho and Montana. The identity of all specimens was verified by Andrew Hipp of the Morton Arboretum.

Alchemilla filicaulis ssp. *filicaulis* was documented for the first time in Wyoming. This species is native to Europe and possibly Greenland and eastern Canada. It may have been introduced to North America by early European colonizers who used it as an herbal remedy. It is likely that the Wyoming populations were originally planted, as they were found in the Keystone area, within half a mile of buildings. Forest Service ecologist Kathy Roche first discovered the plants. Laura Lukas and Elena Kosovich (*Lukas 2677, Kosovich s.n.*) subsequently collected specimens from separate populations, and the specimens' identity was verified by John McNeill of the Royal Botanic Garden, Edinburgh.

Taxa of Conservation Concern

Twenty-two taxa of special concern were found at 51 sites during this survey. According to the Wyoming Natural Diversity Database (Heidel 2007), these are taxa with either an S1 (critically imperiled) or an S2 (imperiled) status in Wyoming. An update (Heidel 2012) subsequent to the completion of the project indicates that five taxa have been removed from this list (indicated in this enumeration by an open diamond; ◊). Many of these taxa are globally secure but rare in portions of their range. *Astragalus leptaleus, Carex nelsonii, Chionophila jamesii, Cymopterus alpinus, Erigeron elatior, Packera pseudaurea* var. *flavula, Paronychia pulvinata, Penstemon cyathophorus,* and *Tonestus pygmaeus* appear restricted to the Rocky Mountain region. Comments on species of special concern found in this study follow. Included are an additional 27 taxa documented by other workers. All are indicated by a closed diamond (♦) in the annotated checklist. Distribution data were derived in part from Kartesz, The Biota of North America Program (2011).

Agrostis mertensii Trin. is circumboreal and in the high mountains to the south in western North America; also known from eastern North America. It was growing in an alpine fellfield. Voucher: *Lukas 8371.*

Astragalus leptaleus A. Gray is restricted to Colorado, Idaho, Montana, and Wyoming. It was found along Laramie River near of Woods Landing. Voucher: *Nelson 74948*

Besseya alpina (A. Gray) Rydb. is restricted to Colorado, New Mexico, Utah, and Wyoming. This species was growing in an alpine boulder field. Voucher: *Hartman 86342.*

◊ **Carex leptalea** Wahlenb. is scattered throughout North America, Mexico, and the West Indies. It was collected in a fen on Sheep Mountain. Voucher: *Hartman 86120a.*

◊ **Carex limosa** L. occurs throughout northern North America and Eurasia. It was growing among ponds. Voucher: *Lukas 7560.*

Carex nelsonii Mack. is restricted to the mountains of Colorado, Montana, Utah, and Wyoming. This plant occurred near an alpine pond. Voucher: *Lukas 7464b.*

Carex occidentalis L.H. Bailey occurs from the northern Great Plains to the Southwest and Texas. It was found in sagebrush steppe and on the edge of an aspen forest and moist meadow. Vouchers: *Lukas 3625, 4854.*

Chionophila jamesii Benth. is endemic to the mountains of Colorado, New Mexico, and Wyoming. It occurred occasionally in dry and moist alpine meadows. Vouchers: *Hartman 86311, Lukas 1852, 1906, 6245, 7732, 10639.*

Cymopterus alpinus A. Gray is confined to the southern Rocky Mountains. It was growing on rock outcrops in openings in conifer forests. Vouchers: *Hartman 85293, Lukas 5856.*

Erigeron elatior (A. Gray) Greene is restricted to Colorado, New Mexico, Utah, and Wyoming. It was growing in moist montane meadows and shrublands near open conifer forests. Vouchers: *Lukas 2217, 7243, 7274.*

Erigeron pinnatisectus (A. Gray) A. Nelson is restricted to Colorado, New Mexico, and Wyoming. It was common in dry alpine boulder slopes and meadows. Vouchers: *Hartman 86330, Lukas 1896, 1940, 7718, 7805, 8327, 10626.*

Ipomopsis tenuituba (Rydb.) V.E. Grant ssp. **tenuituba** occurs from Colorado and Wyoming west to California. It was growing in dry montane parks and foothill sagebrush steppe. Vouchers: *Lukas 7135, 10306, 10725.*

◊**Juncus filiformis** L. is a circumboreal species restricted to Arizona, Colorado, Utah, and Wyoming. It was growing on a sunny montane creek bank. Voucher: *Lukas 3805.*

Packera pseudaurea (Rydb.) W.A. Weber & Á. Löve var. **flavula** (Greene) D. K. Trock & T. M. Barkley is restricted to Colorado, Idaho, New Mexico, and Wyoming. It was found in a meadoow along the Laramie River near of Woods Landing. Voucher: *Nelson 74934*

Paronychia pulvinata A. Gray is restricted to Colorado, New Mexico, Utah, and Wyoming at high elevations. It was growing in rocky alpine areas. Vouchers: *Hartman 86348, Lukas 1959.*

Penstemon cyathophorus Rydb. is restricted to Colorado and Wyoming. It was found in rocky foothill sagebrush steppe. Voucher: *Lukas 5513.*

Pyrrocoma crocea (A. Gray) Greene var. **crocea** is restricted to Colorado, New Mexico, Utah, and Wyoming. It was growing in dry lodgepole pine forest edges and dry parks. Vouchers: *Lukas 6900, 7122, 7836.*

Salix candida Flüeggé ex Willd. occurs throughout northern North America south through the Rockies to Colorado. It is restricted to calcareous soils and was collected in a fen on Sheep Mountain. Voucher: *Hartman 86121.*

Senecio bigelovii A. Gray var. **hallii** A. Gray is restricted to the mountains of Arizona, Colorado, New Mexico, and southern Wyoming. It was found in a variety of moist, montane habitats such as aspen groves and meadows. Vouchers: *Lukas 1816, 2369, 2721, 2849, 3793, 4496.*

◊**Sparganium natans** L. is a circumboreal species that dips south in the West. It was found in a montane stream and pond. Vouchers: *Hartman 86213, Lukas 7943.*

Tonestus pygmaeus (Torr. & A. Gray) A. Nelson is restricted to the mountains of Colorado, Montana, New Mexico, and Wyoming. It was growing in dry, rocky alpine situations. Vouchers: *Hartman 86347, Lukas 8331, 10628.*

◊**Viburnum edule** (Michx.) Raf. ranges across northern North America and south to Colorado and California. These plants were collected from a montane shady creek-side and a rocky slope in a lodgepole pine forest. Vouchers: *Lukas 2346, 3942.*

Exotic and Invasive Species

Exotic and often invasive species may dramatically impact species diversity and composition. Approximately 6.1 percent of the taxa found during this inventory were of exotic origin (Kartesz, The Biota of North America Program 2011) and 59 percent of these are classified as invasives. Seven of the 25 noxious weeds listed by the Wyoming Weed and Pest Council (2011) were documented. They were *Cardaria draba*, *Carduus nutans*, *Cirsium arvense*, *Cynoglossum officinale*, *Elymus repens*, *Leucanthemum vulgare*, and *Linaria vulgaris*. In the annotated checklist they are indicated by a dot (•). Of the seven noxious weed species found, only *Cardaria draba* and *Cynoglossum officinale* were growing exclusively in heavily disturbed sites. The other taxa, in addition to being found along roadsides and in clear-cuts or burns, were found in meadows with little or no evidence of recent human activity.

Summary of Taxa

A total of 910 unique or terminal taxa were collected, represented by 9,837 specimens taken from 168 sites (Figure 2). Below is a summary of the plants encountered during the study. Values in parentheses are taxa collected by others workers and housed at RM. These appear in the checklist with associated collector and collection number, county, elevation, and habitat if available.

List by taxonomic category	
Families	88
Genera	376
Species	835(201)
Hybrids	2(1)
Infraspecies	73(10)
Unique taxa	910(212)
Unique taxa combined	1122

List by special category	
Exotic taxa	51(18)
Percent exotic taxa	6.1
WY Noxious weeds	7(3)
Species of conservation concern	22(27)
State records	2

Unique taxa recorded by Nelson 1974 781

List of unique taxa by major plant group	
Fern Allies	6(3)
Ferns	5(9)
Gymnosperms	10
Angiosperms	889(190)

During his 1974 study, B.E. Nelson recorded 781 unique taxa, 93 percent of which were also found during this inventory.

CONCLUSIONS

This inventory expanded the floristic coverage of the Medicine Bow Mountains in Wyoming with 9,837 new collections representing 910 unique taxa and two unnamed hybrids. In addition, 212 taxa were added from other collections at RM. We found that the flora of the Medicine Bow Mountains has relatively few exotics and invasive species. It also contained a respectable number of species of conservation concern. Two new species for Wyoming were documented: *Alchemilla filicaulis* ssp. *filicaulis* and *Carex arcta*. The former is native to Europe and possibly parts of Greenland, and eastern Canada. Its occurrence in the Medicine Bows most likely is due to deliberate plantings.These populations are currently small but should be monitored in case they become invasive. *Carex arcta* is distributed across northern North America, and has been recorded as far south as Idaho, Montana, and the mountains of California.

ANNOTATED CHECKLIST

The checklist is organized alphabetically by family and species. Nomenclature follows the RM Plant Specimen Database (Hartman et al. 2009). Below is a key to the abbreviations for vegetation types and status of individual taxa. The format of each listing is as follows: *Taxon* Authority (**number of vouchers collected**) county; elevation; vegetation type. Taxa collected by workers unrelated to this inventory are denoted by the collector's name and number, county, elevation, and vegetation type (initials omitted for *R.L. Hartman* and *B.E. Nelson*).

County abbreviations:

A	Albany
C	Carbon

Habitat type:

asf	Aspen forest
ccb	Clear-cut/burn
dam	Dry alpine meadow
dlw	Douglas fir/limber pine woodland
dmm	Dry montane meadow
fen	Fen
lpf	Lodgepole pine forest
mwa	Moist to wet alpine meadow
nmp	Northern mixedgrass prairie
pnd	Pond/aquatic
ppw	Ponderosa pine woodland
rcf	Riparian conifer forest
rds	Roadside
rsl	Riparian shrubland
sbs	Sagebrush steppe
sfs	Subalpine fir/spruce forest
wmm	Wet montane meadow

Symbols preceding taxon:

*	Species exotic to Wyoming
•	Noxious weed in Wyoming
♦	Species of conservation concern
!	New record for Wyoming
×	Putative hybrid

FERN ALLIES

Equisetaceae

Equisetum arvense L. **(53)** A, C; 7460–10020′; asf, fen, rcf, rsl, sfs, wmm

Equisetum ×*ferrissii* Clute; *Nelson 1113*; A; 9100′; lpf

Equisetum hyemale L. var. *affine* (Engelm.) A. A. Eaton **(17)** A, C; 7460–9210′; asf, rcf, rsl, sbs, sfs, wmm

Equisetum laevigatum A. Braun **(7)** A, C; 7640–8760′; asf, rcf, sbs, wmm

Equisetum variegatum Schleich. ex F. Weber & D. Mohr **(1)** C; 8710′; rcf

Isoëtaceae

Isoëtes bolanderi Engelm. var. *bolanderi* **(4)** C; 9030–10710′; pnd

Lycopodiaceae

Lycopodium annotinum L.; *R.D. Dorn 4168*; C; 8300′; rcf

Selaginellaceae

Selaginella densa Rydb. **(29)** A, C; 7460–11750′; dam, dlw, dmm, mwa, nmp, ppw, rsl, sbs, sfs, wmm

♦ *Selaginella mutica* D.C. Eaton ex Underw. var. *mutica*; *R.E. Brooks 3770*; C; 8500′; sfs

FERNS

Aspleniaceae

Asplenium septentrionale (L.) Hoffm.; *Nelson 13476*; C; 8500′; rock outcrop

♦ *Asplenium trichomanes-ramosum* L.; *Nelson 994*; C; 10300′; rock outcrops

Dennstaedtiaceae

Pteridium aquilinum (L.) Kuhn var. *latiusculum* (Desv.) Underw. ex A. Heller; *W.B. Jones 162*; A; 8500′; rock outcrop

Dryopteridaceae

♦ *Athyrium alpestre* (Hoppe) Clairv. var. *americanum* Butters; *M. Ownbey 1124*; A; 11000–11300′; rock outcrop

Cystopteris fragilis (L.) Bernh. **(15)** A, C; 7620–11750′; dam, dlw, dmm, lpf, rcf, sbs, sfs, wmm

Dryopteris filix-mas (L.) Schott; *A. Nelson 10566*; A; 10000′; rock outcrop

Woodsia oregana D.C. Eaton var. *cathcartiana* (B. L. Rob.) C.V. Morton **(9)** A, C; 7440–9330′; asf, dlw, dmm, nmp, sbs

Woodsia oregana D.C. Eaton var. *oregana* **(1)** C; 8070–8570′; sbs

Woodsia scopulina D.C. Eaton ssp. *scopulina* **(1)** A; 8000–8100′; dlw

Ophioglossaceae

Botrychium lunaria (L.) Sw.; *R.D. Dorn 1447*; A; 10800–10900′; dmm

Polypodiaceae

Polypodium saximontanum Windham; *Nelson 13475*; C; 8300′; rock outcrop

Pteridaceae

Cryptogramma acrostichoides R. Br. **(2)** C; 10550–10970′; dmm

Pellaea breweri D.C. Eaton; *Nelson 1003*; A; 10300′; rock outcrop

Pellaea glabella Mett. ex Kuhn var. *occidentalis* (E. E. Nelson) Butters; *R.D. Dorn 1974*; C; 10000′; rock outcrop

GYMNOSPERMS

Cupressaceae

Juniperus communis L. var. *depressa* Pursh **(69)** A, C; 7460–11750′; asf, ccb, dam, dlw, dmm, fen, lpf, mwa, pnd, ppw, rcf, rds, rsl, sbs, sfs, wmm

Juniperus scopulorum Sarg. **(11)** A, C; 7440–8590′; asf, dlw, lpf, sbs

Pinaceae

Abies bifolia A. Murray bis **(46)** A, C; 7460–11750′; asf, dam, dmm, fen, lpf, mwa, rcf, sbs, sfs, wmm

Picea engelmannii Parry ex Engelm. var. *engelmannii* **(60)** A, C; 7890–11750′; asf, dam, dmm, fen, lpf, mwa, pnd, rcf, rds, rsl, sfs, wmm

Picea glauca (Moench) Voss **(1)** A; 10250–10540′; mwa

Picea pungens Engelm. **(4)** A, C; 8020–9910′; rcf, sfs

Pinus contorta Douglas ex Loudon var. *latifolia* Engelm. **(60)** A, C; 8020–10600′; asf, ccb, dam, dlw, dmm, fen, lpf, pnd, ppw, rcf, rsl, sbs, sfs, wmm

Pinus flexilis E. James **(24)** A, C; 7440–10280′; asf, ccb, dlw, dmm, lpf, nmp, sbs, sfs

Pinus ponderosa C. Lawson & P. Lawson var. *scopulorum* Engelm. **(10)** A, C; 7460–9330′; dlw, ppw, rds, sbs, wmm

Pseudotsuga menziesii (Mirb.) Franco var. *glauca* (Beissn.) Franco **(19)** A, C; 7440–9330′; asf, dlw, dmm, lpf, sbs

ANGIOSPERMS

Adoxaceae

♦ *Adoxa moschatellina* L.; *G. Osterhout s.n.*; A; 7700′

Sambucus racemosa L. var. *melanocarpa* (A. Gray) McMinn **(3)** A, C; 7620–10710′; dlw, wmm

Sambucus racemosa L. var. *microbotrys* (Rydb.) Kearney & Peebles **(14)** A, C; 7510–10710′; fen, rcf, sbs, sfs, wmm

♦ *Viburnum edule* (Michx.) Raf. **(2)** A, C; 8270–8920′; lpf, rcf

Alismataceae

Alisma triviale Pursh **(1)** C; 8920′; pnd

Sagittaria cuneata E. Sheld. **(3)** C; 8210–9120′; pnd, wmm

Alliaceae

Allium acuminatum Hook.; *B. Torgny BC-75*; C; 8100–8200′; dmm

Allium brevistylum S. Watson **(41)** A, C; 7460–10280′; asf, fen, dlw, dmm, lpf, rcf, rsl, sbs, sfs, wmm

Allium cernuum Roth **(9)** A, C; 7640–9220′; dmm, sbs

Allium geyeri S. Watson var. *geyeri* **(1)** A; 7630′; rsl

Allium geyeri S. Watson var. *tenerum* M.E. Jones **(2)** C; 8030–8910′; dmm, wmm

Allium schoenoprasum L. **(1)** C; 8210′; rsl

Allium textile A. Nelson & J.F. Macbr. **(5)** A; 7740–8140′; nmp, ppw, sbs

Amaranthaceae

* *Amaranthus albus* L.; *B. Hammel 528*; A; 8100′; rds

Amaranthus blitoides S. Watson; *J.F. Reed 3098*; A; 8000′; rds

Amaranthus powellii S. Watson **(1)** A; 7440′; sbs

Amaranthus retroflexus L.; *Nelson 1050*; A; 7500′; rds

Atriplex gardneri (Moq.) D. Dietr. var. *utahensis* (M.E. Jones) Dorn **(1)** A; 8020′; rds

* *Atriplex rosea* L.; *B. Hammel 726*; A; 7500′; rds

Atriplex truncata (Torr. ex S. Watson) A. Gray **(1)** A; 7380–7400′; nmp

Chenopodium atrovirens Rydb. **(7)** A, C; 7460–9580′; ccb, dmm, sbs

Chenopodium berlandieri Moq. var. *zschackei* (Murr) Murr ex Asch. **(1)** C; 8140–8750′; dmm

Chenopodium capitatum (L.) Ambrosi var. *capitatum* **(1)** A; 7640–8220′; ccb

Chenopodium capitatum (L.) Ambrosi var. *parvicapitatum* S. L. Welsh **(1)** A; 8530′; rcf

Chenopodium desiccatum A. Nelson **(1)** A; 7380–7400′; nmp

Chenopodium fremontii S. Watson; *Nelson 961*; A; 8100′; rsl

Chenopodium leptophyllum (Moq.) Nutt. ex S. Watson **(1)** A; 7640–8220′; sbs

Chenopodium pratericola Rydb. **(1)** C; 7620′; sbs

Corispermum welshii Mosyakin; *Nelson 18345*; C; 8300′; rds

Krascheninnikovia lanata (Pursh) A. Meeuse & A. Smit **(1)** A; 7740–7880′; ppw

Monolepis nuttalliana (Schult.) Greene **(5)** A, C; 7640–9580′; ccb, dmm, nmp, rcf, sbs

* *Salsola tragus* L. **(1)** A; 7380–7400′; nmp

Anacardiaceae

Rhus trilobata Nutt. var. *trilobata* **(1)** A; 7380–7400′; nmp

Apiaceae

Angelica ampla A. Nelson **(3)** A, C; 7510–8210′; rsl, sbs

Angelica grayi (J.M. Coult. & Rose) J.M. Coult. & Rose **(4)** A, C; 9510–11090′; mwa, rcf, wmm

Angelica pinnata S. Watson **(14)** A, C; 7640–9580′; asf, ccb, fen, rcf, rsl, wmm

* *Carum carvi* L.; *Nelson 13373*; A; 8900′; rds

Conioselinum scopulorum (A. Gray) J.M. Coult. & Rose **(20)** A, C; 7640–9930′; asf, ccb, fen, rcf, rsl, wmm

Cymopterus acaulis (Pursh) Raf.; *W. Fertig 16480*; A; 8000′; sbs

♦ *Cymopterus alpinus* A. Gray **(2)** A; 8400–10280′; ppw, sfs

Cymopterus lemmonii (J.M. Coult. & Rose) Dorn **(1)** C; 8140–8750′; dlw

Cymopterus longipes S. Watson **(1)** C; 7880′; sbs

Cymopterus terebinthinus (Hook.) Torr. & A. Gray var. *albiflorus* (Torr. & A. Gray) M.E. Jones; *Hartman 24314*; A; 9000–9500′; ppw

Harbouria trachypleura (A. Gray) J.M. Coult. & Rose **(19)** A, C; 7640–9450′; dlw, ccb, dmm, nmp, ppw, sbs

Heracleum maximum Bartr. **(15)** A, C; 7460–9450′; asf, ccb, rcf, sfs, rsl, wmm

Ligusticum porteri J.M. Coult. & Rose var. *porteri* **(58)** A, C; 7460–11090′; asf, dmm, fen, lpf, mwa, pnd, rcf, rsl, sfs, wmm

Lomatium dissectum (Nutt.) Mathias & Constance var. *multifidum* (Nutt.) Mathias & Constance **(3)** C; 7880–8300′; rds, sbs

Lomatium orientale J.M. Coult. & Rose **(4)** A, C; 7460–9250′; ppw, sbs

Lomatium triternatum (Pursh) J.M. Coult. & Rose var. *platycarpum* (Torr.) B. Boivin **(2)** A, C; 8290–8530′; sbs, sfs

Musineon tenuifolium Nutt. ex Torr. & A. Gray **(1)** A; 9180′; lpf

Orogenia linearifolia S. Watson; *Hartman 2976*; C; 8400–8700′; wmm

Osmorhiza chilensis Hook. & Arn. **(12)** C; 7890–9710′; asf, rcf, sfs

Osmorhiza depauperata Phil. **(52)** A, C; 7460–10970′; asf, dlw, dmm, fen, lpf, rcf, rsl, sfs, wmm

Oxypolis fendleri (A. Gray) A. Heller **(26)** A, C; 8370–9930′; dmm, fen, rcf, rsl, sfs, wmm

Perideridia montana (Blank.) Dorn **(7)** A, C; 8070–8890′; asf, dmm, rsl, sbs

Sium suave Walter **(2)** C; 8210–8920′; pnd, rcf

Zizia aptera (A. Gray) Fernald **(1)** A; 8070′; rcf

Apocynaceae

Apocynum androsaemifolium L. **(1)** C; 8020–8030′; sbs

Apocynum cannabinum L. **(1)** C; 7510′; sbs

Asclepias hallii A. Gray; *C.L. Porter 7498*; A; 7600′; rds

Asclepias speciosa Torr. **(1)** A; 8070′; rds

Araceae

Lemna trisulca L. **(2)** C; 9630′; pnd

Asparagaceae

Leucocrinum montanum Nutt. ex A. Gray **(1)** A; 8510–8530′; sbs

Maianthemum stellatum (L.) Link **(18)** A, C; 7440–9450′; asf, lpf, rcf, rds, rsl, sbs, sfs, wmm

Yucca glauca Nutt.; *A. Nelson 1460*; A; 7700′

Asteraceae

Achillea millefolium L. **(87)** A, C; 7460–11750′; asf, ccb, dam, dmm, fen, lpf, mwa, pnd, rcf, rds, rsl, sbs, sfs, wmm

Agoseris aurantiaca (Hook.) Greene var. *aurantiaca* **(36)** A, C; 7460–11000′; asf, ccb, dmm, fen, lpf, pnd, rcf, rsl, sbs, sfs, wmm

Agoseris aurantiaca (Hook.) Greene var. *purpurea* (A. Gray) Cronquist **(8)** C; 8020–10020′; ccb, rcf, rsl, sfs, wmm

Agoseris glauca (Pursh) Raf. var. *dasycephala* (Torr. & A. Gray) Jeps. **(32)** A, C; 7880–11090′; asf, dam, dmm, mwa, rcf, rsl, sbs, sfs, wmm

Agoseris glauca (Pursh) Raf. var. *glauca* **(21)** A, C; 7640–9910′; asf, ccb, dmm, fen, rcf, rsl, wmm

Agoseris parviflora (Nutt.) D. Dietr. **(18)** A, C; 7700–9990′; dlw, dmm, nmp, ppw, rcf, rsl, sbs, wmm

Almutaster pauciflorus (Nutt.) Á. Löve & D. Löve **(1)** A; 8930–9030′; wmm

♦ *Amauriopsis dissecta* (A. Gray) Rydb.; *R.D. Dorn 5302*; A; 8600′; dmm

Anaphalis margaritacea (L.) Benth. & Hook. **(25)** A, C; 8070–9990′; asf, dmm, fen, pnd, lpf, rcf, rds, sfs, wmm

Antennaria anaphaloides Rydb. **(11)** A, C; 7620–10280′; asf, dlw, dmm, fen, sbs, sfs

Antennaria corymbosa E. E. Nelson **(27)** A, C; 8220–10240′; dam, dmm, fen, pnd, rcf, rsl, sfs, wmm

Antennaria howellii Greene ssp. *howellii* **(1)** C; 9220′

Antennaria howellii Greene ssp. *petaloidea* (Fernald) R.J. Bayer **(2)** A, C; 7630–8970′; ccb, rsl

Antennaria luzuloides Torr. & A. Gray **(1)** A; 9250–9580′; fen

Antennaria media Greene **(15)** A, C; 7700–11750′; dam, dmm, lpf, mwa, rds, sbs, sfs, wmm

Antennaria microphylla Rydb. **(22)** A, C; 7700–10830′; asf, ccb, dam, dmm, fen, lpf, nmp, rcf, rsl, sbs, wmm

Antennaria parvifolia Nutt. **(32)** A, C; 7460–10710′; asf, dmm, lpf, ppw, rsl, pnd, rcf, rds, sbs, sfs, wmm

Antennaria pulcherrima (Hook.) Greene **(1)** A; 9130–9150′; rsl

Antennaria rosea Greene ssp. *arida* (E. Nelson) R.J. Bayer **(72)** A, C; 7460–11090′; asf, ccb, dam, dlw, dmm, fen, lpf, mwa, nmp, rcf, rsl, sbs, sfs, wmm

Antennaria umbrinella Rydb. **(42)** A, C; 7460–11090′; ccb, dam, dlw, dmm, lpf, ppw, rsl, sbs, wmm

* *Anthemis tinctoria* L.; *R.D. Dorn 3179*; A; 8900′; rds

Arnica chamissonis Less. **(14)** A, C; 7630–9480′; dmm, lpf, rcf, rsl, wmm

Arnica cordifolia Hook. **(61)** A, C; 7460–11090′; asf, cbb, dam, dlw, dmm, fen, lpf, rcf, rsl, sbs, sfs, wmm

Arnica fulgens Pursh **(1)** C; 7880′; sbs

Arnica latifolia Bong. **(14)** A, C; 8140–10970′; asf, dmm, mwa, rcf, sfs, wmm

Arnica mollis Hook. **(48)** A, C; 8030–11090′; dam, dmm, fen, lpf, mwa, pnd, rcf, rsl, sfs, wmm

Arnica parryi A. Gray **(23)** A, C; 7890–10970′; asf, ccb, dam, dmm, lpf, rcf, rsl, sfs, wmm

Arnica rydbergii Greene **(5)** A, C; 8210–10970′; dam, dmm, rcf, rsl, sfs

Artemisia biennis Willd. var. *biennis*; *C.L. Porter 10120*; A; 8400′; rds/sbs

Artemisia campestris L. var. *pacifica* (Nutt.) M. Peck; *Nelson 18346*; C; 8450′; sandy flat

Artemisia cana Pursh var. *cana* **(1)** A; 8020′; rds

Artemisia cana Pursh var. *viscidula* Osterh. **(2)** A, C; 8560–9030′; sbs, wmm

Artemisia dracunculus L. **(1)** A; 8020′; rds

Artemisia frigida Willd. **(9)** A, C; 7380–9370′; nmp, sbs

Artemisia ludoviciana Nutt. var. *ludoviciana* **(4)** A, C; 8020–8970′; asf, rcf, rds, sbs

Artemisia nova A. Nelson **(2)** A; 8,000–8240′; sbs

Artemisia scopulorum A. Gray **(12)** A, C; 10240–11750′; dam, dmm, mwa, wmm

Artemisia tridentata Nutt. var. *vaseyana* (Rydb.) B. Boivin **(5)** A, C; 8020–8560′; rds, sbs

Artemisia tripartita Rydb. var. *rupicola* (Beetle) Dorn; *Nelson 13273*; A; 8800′; dmm

Balsamorhiza sagittata (Pursh) Nutt. **(12)** A, C; 7700–9450′; dlw, dmm, nmp, rds, sbs

Brickellia grandiflora (Hook.) Nutt.; *A. Nelson 8766*; A; 8100′; rsl, rocky areas

* ● *Carduus nutans* L. **(6)** A, C; 7510–8970′; ccb, dmm, sbs

Centaurea stoebe L. ssp. *micranthos* (S.G. Gmelin ex Gugler) Hayek **(1)** C; 8560′; sbs

Chaenactis douglasii (Hook.) Hook. & Arn. var. *douglasii* **(6)** A, C; 7510–8520′; rsl, sbs

Chrysothamnus vaseyi (A. Gray) Greene **(2)** A; 7440–8070′; sbs

Chrysothamnus viscidiflorus (Hook.) Nutt. var. *lanceolatus* (Nutt.) Greene **(6)** A, C; 7640–9050′; dmm, rds, sbs

Chrysothamnus viscidiflorus (Hook.) Nutt. var. *viscidiflorus* **(1)** C; 8288′; sagebrush hills

* • *Cirsium arvense* (L.) Scop. **(3)** A, C; 7640–9430′; ccb, rcf

Cirsium canescens Nutt. **(1)** A; 8000–8100′; dlw

Cirsium clavatum (M.E. Jones) Petr. var. *americanum* (A. Gray) D.J. Keil **(34)** A, C; 7460–9910′; asf, dmm, fen, lpf, rcf, rds, sbs, sfs, wmm

Cirsium flodmanii (Rydb.) Arthur **(1)** A; 7640–8220′; sbs

Cirsium pulcherrimum (Rydb.) K. Schum. var. *pulcherrimum* **(3)** A, C; 7900–9500′; dmm, rsl, sbs

Cirsium scariosum Nutt. var. *americanum* (A. Gray) D.J. Keil **(1)** C; 8020–8030′; rcf

Cirsium scariosum Nutt. var. *coloradense* (Rydb.) D.J. Keil **(12)** A, C; 7380–9580′; dmm, nmp, rsl, sfs, wmm

Cirsium scariosum Nutt. var. *scariosum* **(1)** A; 7640–8220′; sbs

Crepis acuminata Nutt. **(18)** A, C; 7460–9450′; asf, dmm, nmp, rds, sbs

Crepis atribarba A. Heller **(8)** A, C; 7620–9220′; ccb, dlw, dmm, lpf, sbs

Crepis modocensis Greene var. *modocensis* **(6)** A, C; 7460–8680′; nmp, sbs

Crepis occidentalis Nutt. var. *occidentalis; C.S. Gilbert s.n.*; A; 9100′

Crepis runcinata (E. James) Torr. & A. Gray var. *runcinata* **(1)** C; 8770′; wmm

Cyclachaena xanthifolia (Nutt.) Fresen.; *O. Asplund 72–48*; C; 8900′; rds

Dieteria canescens (Pursh) Nutt. var. *canescens* **(7)** A, C; 7380–8750′; ccb, nmp, sbs

Dieteria canescens (Pursh) Nutt. var. *glabra* (A. Gray) D. R. Morgan & R. L. Hartm. **(2)** C; 8140–8750′; sbs

Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & G.I. Baird var. *graveolens* (Nutt.) Reveal & Schuyler; *Nelson 1164*; C; 7500′; thick sagebrush

Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & G.I. Baird var. *nauseosa* **(5)** A, C; 7380–8520′; nmp, sbs

Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & G.I. Baird var. *oreophila* (A. Nelson) G.L. Nesom & G.I. Baird **(2)** A, C; 7440–8560′; sbs

Ericameria parryi (A. Gray) G.L. Nesom & G.I. Baird var. *howardii* (Parry ex A. Gray) G.L. Nesom & G.I. Baird **(2)** A; 8020–9070′; rds, sbs

Ericameria parryi (A. Gray) G.L. Nesom & G.I. Baird var. *parryi* **(4)** A, C; 7640–8980′; lpf, sbs

Erigeron acris L. var. *kamtschaticus* (DC.) Herder **(1)** C; 10970′; dmm

Erigeron caespitosus Nutt. **(16)** A, C; 7620–10280′; asf, ccb, dlw, dmm, lpf, rcf, sbs, sfs

Erigeron canus A. Gray **(2)** A; 8100–8200′; nmp, sbs

Erigeron compositus Pursh **(19)** A, C; 7700–10710′; dlw, dmm, nmp, ppw, sbs, sfs, wmm

Erigeron corymbosus Nutt. **(2)** C; 7460′; sbs

Erigeron eatonii A. Gray var. *eatonii* **(25)** A, C; 7460–9840′; asf, ccb, dlw, dmm, nmp, rsl, sbs, sfs, wmm

♦ *Erigeron elatior* (A. Gray) Greene **(3)** C; 8370–8640′; rcf, wmm

Erigeron engelmannii A. Nelson var. *engelmannii* **(2)** C; 7730′; sbs

Erigeron eximius Greene **(3)** A, C; 8070–9220′; asf, rcf

Erigeron flagellaris A. Gray **(1)** C; 8370′; wmm

Erigeron formosissimus Greene var. *formosissimus* **(4)** A, C; 8030–8920′; dmm, rcf, rsl, wmm

Erigeron formosissimus Greene var. *viscidus* (Rydb.) Cronquist **(8)** A, C; 7460–9580′; dmm, lpf, sbs, sfs, wmm

Erigeron glabellus Nutt. var. *glabellus* **(3)** A, C; 7460–7630′; rsl, sbs

Erigeron glacialis (Nutt.) A. Nelson var. *glacialis* **(61)** A, C; 7890–11750′; fen, lpf, mwa, pnd, rcf, rsl, sfs, wmm

Erigeron grandiflorus Hook. **(13)** A, C; 10590–11750′; dam, dmm, mwa, wmm

Erigeron lonchophyllus Hook. **(1)** A; 8930–9030′; wmm

Erigeron melanocephalus (A. Nelson) A. Nelson **(15)** A, C; 9590–11750′; dam, dmm, mwa, pnd, sfs, wmm

Erigeron nematophyllus Rydb. **(10)** A, C; 7700–9220′; dlw, sbs

Erigeron nivalis Nutt. **(2)** A; 8740–8890′; lpf, rcf

Erigeron ochroleucus Nutt. **(1)** A; 8080–8140′; sbs

♦ *Erigeron pinnatisectus* (A. Gray) A. Nelson **(7)** A, C; 10730–11750′; dam

Erigeron pulcherrimus A. Heller **(1)** C; 7730′; sbs

Erigeron pumilus Nutt. var. *pumilus* **(3)** A, C; 7880–9250′; ppw, sbs

Erigeron speciosus (Lindl.) DC. **(2)** C; 7890–8560′; rcf, sbs

Erigeron subtrinervis Rydb. ex Porter & Britton **(18)** A, C; 7440–8820′; asf, dlw, dmm, lpf, ppw, rcf, rds

Erigeron uintahensis Cronquist **(2)** C; 7510–8750′; rsl, sbs

Erigeron ursinus D.C. Eaton **(13)** A, C; 8710–10830′; dam, dmm, mwa, sbs, sfs, wmm

Erigeron vetensis Rydb. **(2)** A; 8090–9330′; dlw, nmp, ppw

Eucephalus engelmannii (D.C. Eaton) Greene **(7)** C; 8560–9710′; asf, rcf, wmm

Gaillardia aristata Pursh **(4)** C; 7890–8750′; dmm, rds, sbs

Gnaphalium exilifolium A. Nelson **(1)** C; 8210′; rcf

Gnaphalium palustre Nutt.; *Hartman 4927*; A; 8300′; rds

Gnaphalium uliginosum L.; *G. Ownbey 614*; A; 8700′; rsl

Grindelia hirsutula Hook. & Arn. **(1)** C; 8560′; sbs

Grindelia squarrosa (Pursh) Dunal **(1)** A; 7640–8220′; ccb

Grindelia subalpina Greene **(2)** A, C; 7440–9300′; ccb, sbs

Gutierrezia sarothrae (Pursh) Britton & Rusby **(4)** A; 7380–8070′; nmp, rds, sbs

Helianthella quinquenervis (Hook.) A. Gray **(10)** A, C; 8080–9760′; asf, dmm, lpf, rcf, wmm

Helianthella uniflora (Nutt.) Torr. & A. Gray **(9)** A, C; 7510–9220′; asf, dlw, dmm, rcf, rsl, sbs, wmm

Helianthus annuus L.; *Nelson 1914*; A; 8000′; rds

Helianthus petiolaris Nutt. var. *petiolaris; R. Newton 2563*; A; 7446′; dry rocky uplands

Helianthus pumilus Nutt. **(1)** A; 8100–8200′; sbs

Heliomeris multiflora Nutt. var. *multiflora* **(4)** C; 8070–8820′; dmm, sbs

Herrickia glauca (Nutt.) Brouillet var. *glauca* **(6)** A, C; 8070–9020′; asf, ccb, lpf, rcf, sfs

Heterotheca fulcrata (Greene) Shinners **(4)** A; 8270–9400′; dmm, rcf

Heterotheca horrida (Rydb.) V. L. Harms **(3)** A, C; 7460–8100′; dlw, sbs

♦ *Heterotheca pumila* (Greene) Semple; *Hartman 19822*; C; 10400–10800′; dam

Heterotheca villosa (Pursh) Shinners var. *villosa* **(19)** A, C; 7510–9370′; asf, dmm, lpf, nmp, rds, sbs

Hieracium albiflorum Hook. **(37)** A, C; 8030–9930′; asf, ccb, dlw, dmm, lpf, rcf, rsl, sfs, wmm

Hieracium triste Willd. ex Spreng. **(34)** A, C; 8760–11750′; ccb, dam, dmm, fen, lpf, pnd, rcf, rds, rsl, sfs, wmm

Hymenoxys grandiflora (Torr. & A. Gray ex A. Gray) K.L. Parker **(5)** A; 10620–11580′; dam, mwa, wmm

* • *Leucanthemum vulgare* Lam. **(5)** A, C; 8030–9430′; dmm, rds, wmm

Liatris punctata Hook. var. *punctata*; *A. Nelson 7952*; A; dry bench lands

Lygodesmia juncea (Pursh) D. Don ex Hook.; *N. Snow 4580*; A; 7500′; rds

Madia glomerata Hook. **(7)** A, C; 8030–9030′; ccb, dmm, rds, sbs, wmm

Matricaria discoidea DC. **(6)** A, C; 7860–9300′; ccb, dmm, rds

Microseris nutans (Hook.) Sch. Bip. **(7)** A, C; 7880–8910′; lpf, rsl, sbs

Mulgedium pulchellum (Pursh) G. Don; *Nelson 13396*; A; 8100′; rds

Oreochrysum parryi (A. Gray) Rydb. (**15**) A, C; 8070–10970′; ccb, dmm, lpf, rcf, wmm

Packera cana (Hook.) W. A. Weber & Á. Löve (**18**) A, C; 7510–10590′; dlw, dmm, lpf, nmp, ppw, rds, sbs

♦ *Packera crocata* (Rydb.) W. A. Weber & Á. Löve; *J. Haines 9430*; A; 10520′; mwa

Packera debilis (Nutt.) W. A. Weber & Á. Löve; *A. Nelson 1492*; A; 7580′

Packera dimorphophylla (Greene) W. A. Weber & Á. Löve var. *dimorphophylla* (**32**) A, C; 8890–11750′; dam, dmm, fen, lpf, mwa, rsl, wmm

Packera fendleri (A. Gray) W. A. Weber & Á. Löve (**32**) A, C; 7460–11750′; ccb, dam, dlw, dmm, lpf, nmp, ppw, rsl, sbs

Packera paupercula (Michx.) Á. Löve & D. Löve (**1**) A; 8260–8600′; lpf

× *Packera paupercula* (Michx.) Á. Löve & D. Löve.× *Packera dimorphophylla* (Greene) W. A. Weber & Á. Löve var. *dimorphophylla* (**1**) C; 8820–8830′; pnd

♦*Packera pseudaurea* (Rydb.) W. A. Weber & Á. Löve var. *flavula* (Greene) D. K. Trock & T. M. Barkley (**1**) A; 7630′; rsl

Packera streptanthifolia (Greene) W. A. Weber & Á. Löve (**5**) A, C; 7460–10710′; dmm, pnd, sbs, wmm

Packera tridenticulata (Rydb.) W. A. Weber & Á. Löve (**1**) C; 8080–8200′; lpf

Packera werneriifolia (A. Gray) W. A. Weber & Á. Löve (**4**) A; 8220–8950′; dmm, lpf, sbs

Petasites sagittatus (Banks ex Pursh) A. Gray (**5**) A; 8930–10490′; dmm, fen, rsl, wmm

Pseudognaphalium viscosum (Kunth) W. A. Weber; *E. Nelson 5270*; A; 8200–9000′

♦ *Pyrrocoma crocea* (A. Gray) Greene var. *crocea* (**3**) C; 8820–9150′; dmm, lpf

Pyrrocoma lanceolata (Hook.) Greene var. *lanceolata*; *H. Hughes H-36*; C; 9000′; dmm

Pyrrocoma uniflora (Hook.) Greene var. *uniflora* (**1**) C; 8910′; dmm

Rudbeckia hirta L. var. *pulcherrima* Farw. (**1**) A; 7630′; rsl

Rudbeckia laciniata L. var. *ampla* (A. Nelson) Cronquist (**1**) A; 7440′; asf

♦ *Senecio bigelovii* A. Gray var. *hallii* A. Gray (**6**) A, C; 8270–8990′; asf, dmm, rcf, rsl, wmm

Senecio crassulus A. Gray (**18**) A, C; 9220–11580′; dam, dmm, wmm

Senecio eremophilus Richardson var. *eremophilus* (**1**) C; 7620′; dlw

Senecio eremophilus Richardson var. *kingii* (Rydb.) Greenm. (**20**) A, C; 8030–9710′; asf, ccb, dlw, dmm, lpf, rcf, sbs, sfs

Senecio fremontii Torr. & A. Gray var. *blitoides* (Greene) Cronquist (**1**) A; 11000–11270′; dam

Senecio hydrophilus Nutt. (**1**) A; 8930–9030′; wmm

Senecio integerrimus Nutt. var. *exaltatus* (Nutt.) Cronquist (**34**) A, C; 7700–10710′; asf, dmm, fen, lpf, nmp, ppw, rsl, sbs, sfs, wmm

Senecio integerrimus Nutt. var. *integerrimus* (**2**) C; 7460–8030′; rsl, sbs

Senecio rapifolius Nutt.; *Nelson 13473*; C; 8300′; rock outcrop

Senecio riddellii Torr. & A. Gray; *N. Snow 4579*; A; 7500′; rds

Senecio serra Hook. var. *admirabilis* (Greene) A. Nelson (**1**) C; 8710′; rcf

Senecio spartioides Torr. & A. Gray; *Nelson 13398*; A; 8100′; rds

Senecio triangularis Hook. (**48**) A, C; 8030–10970′; fen, pnd, rcf, rsl, sfs, wmm

Solidago altissima L. var. *gilvocanescens* (Rydb.) Semple (**1**) C; 7510′; sbs

Solidago gigantea Aiton; *R. Newton 2546*; A; 7360′; rsl

Solidago lepida DC. var. *salebrosa* (Piper) Semple (**4**) A, C; 7460–8570′; rcf, sfs, wmm

Solidago missouriensis Nutt. (**2**) A; 8070–8280′; sbs

Solidago mollis Bartl. (**3**) A, C; 7440–9070′; sbs

Solidago multiradiata Aiton (**23**) A, C; 7640–11580′; ccb, dam, dmm, lpf, mwa, rcf, rsl, sbs, wmm

Solidago nana Nutt.; *R.J. Hill 1232*; A; 9400′; rcf

Solidago simplex Kunth var. *simplex* (**27**) A, C; 7640–11750′; asf, ccb, dam, dmm, lpf, rcf, rds, rsl, sfs, wmm

Solidago velutina DC. ssp. *sparsiflora* (A. Gray) Semple; *L. Goodding 2097*; A; sbs

* • *Sonchus arvensis* L. ssp. *uliginosus* (M. Bieb.) Nyman; *Nelson 1137*; C; 8400′; rds

Stenotus acaulis (Nutt.) Nutt. (**2**) C; 7700–8020′; sbs

Stenotus armerioides Nutt. var. *armerioides*; *Nelson 494*; A; 7800′; with Cercocarpus

Stephanomeria runcinata Nutt. (**1**) A; 8070′; sbs

Stephanomeria tenuifolia (Raf.) H. M. Hall (**1**) A; 7440′; sbs

Symphyotrichum ascendens (Lindl.) G.L. Nesom (**13**) A, C; 8020–9580′; asf, dmm, lpf, rcf, rds, sbs, sfs, wmm

Symphyotrichum campestre (Nutt.) G.L. Nesom; *Nelson 13490*; C; 8250′; dmm

Symphyotrichum eatonii (A. Gray) G.L. Nesom (**2**) A, C; 7510–8220′; ccb, sbs

Symphyotrichum ericoides (L.) G.L. Nesom var. *stricticaule* (Torr. & A. Gray) G.L. Nesom (**1**) C; 8210′; rsl

Symphyotrichum falcatum (Lindl.) G.L. Nesom var. *commutatum* (Torr. & A. Gray) G.L. Nesom (**2**) A; 7380–7400′; nmp

Symphyotrichum foliaceum (DC.) G.L. Nesom var. *apricum* (A. Gray) G.L. Nesom (**13**) A, C; 8070–11750′; ccb, dam, dmm, rcf, sfs, wmm

Symphyotrichum foliaceum (DC.) G.L. Nesom var. *canbyi* (A. Gray) G.L. Nesom (**6**) A, C; 8710–9580′; dmm, rcf, rsl, wmm

Symphyotrichum foliaceum (DC.) G.L. Nesom var. *parryi* (D.C. Eaton) G.L. Nesom (**13**) A, C; 7460–10240′; ccb, dam, dmm, rcf, rsl, sfs, wmm

Symphyotrichum lanceolatum (Willd.) G.L. Nesom var. *hesperium* (A. Gray) G.L. Nesom (**1**) A; 9130′; dmm

Symphyotrichum spathulatum (Lindl.) G.L. Nesom var. *spathulatum* (**5**) A, C; 8270–9890′; dmm, rcf, wmm

Taraxacum ceratophorum (Ledeb.) DC.; *J. Haines 9786*; A; 10485′; wmm

* *Taraxacum erythrospermum* Andrz. ex Besser (**12**) A, C; 7460–10620′; asf, dlw, lpf, rcf, rds, sbs, sfs, wmm

* *Taraxacum officinale* Weber ex F. H. Wigg. (**26**) A, C; 7700–10500′; asf, dmm, fen, lpf, rcf, rds, rsl, sbs, sfs, wmm

Taraxacum scopulorum (A. Gray) Rydb.; *V.J. Wetherell 362*; A; 12000′

Tetradymia canescens DC.; *Hartman 4936*; A; 8300′; sbs

Tetraneuris acaulis (Pursh) Greene var. *acaulis* (**1**) C; 8140–8750′; dmm

Tetraneuris acaulis (Pursh) Greene var. *caespitosa* A. Nelson (**4**) A, C; 7880–9250′; dlw, ppw, sbs

Townsendia hookeri Beaman; *Nelson 5092*; A; 9100′; gravelly slope

♦ *Tonestus pygmaeus* (Torr. & A. Gray) A. Nelson (**3**) A, C; 11180–11750′; dam

* *Tragopogon dubius* Scop. (**23**) A, C; 7460–8970′; asf, ccb, dmm, rds, rsl, sbs, sfs, wmm

* *Tragopogon pratensis* L. (**2**) C; 8020–8030′; dmm, rsl

* *Tripleurospermum maritimum* (L.) W.D.J. Koch ssp. *maritimum* (**1**) A; 7440′; sbs

Wyethia amplexicaulis (Nutt.) Nutt. (**1**) C; 8560′; wmm

× *Xanthisma coloradoense* (A. Gray) D. R. Morgan & R. L. Hartm. × *X. grindelioides* (Nutt.) D. R. Morgan & R. L. Hartm.; *W. Fertig 16724*; A; 7800′; shaley gypsum

Xanthisma grindelioides (Nutt.) D. R. Morgan & R. L. Hartm.var. *grindelioides*; *W.E. Myers 251*; A; 7800–8600′

Xylorhiza glabriuscula Nutt.; *J.F. Brenckle 43-052*; A; 8200′

Berberidaceae

Berberis repens Lindl. (**42**) A, C; 7460–10280′; asf, ccb, dlw, dmm, lpf, ppw, rcf, rds, sbs, sfs, wmm

Betulaceae

Alnus incana (L.) Moench var. *occidentalis* (Dippel) C. L. Hitchc. **(32)** A, C; 7460–9450'; asf, rcf, rsl, sbs, sfs, wmm
Betula glandulosa Michx. **(17)** A, C; 8020–9730'; fen, rcf, rsl, wmm
Betula occidentalis Hook.; *Hartman 24337*; A; 8400–9000'; rsl

Boraginaceae

Cryptantha ambigua (A. Gray) Greene; *Nelson 3004*; A; 8800'; asf
Cryptantha celosioides (Eastw.) Payson **(1)** A; 8070'; sbs
Cryptantha fendleri (A. Gray) Greene; *A. Nelson 8065*; A; 7600'; gravelly slopes
Cryptantha flavoculata (A. Nelson) Payson **(1)** C; 7880'; sbs
Cryptantha kelseyana Greene; *W. Fertig 14304*; C; 8300–8400'; rds
Cryptantha thyrsiflora (Greene) Payson **(2)** A; 8100–8140'; nmp, sbs
Cryptantha virgata (Porter) Payson **(10)** A, C; 7460–8680'; dlw, dmm, nmp, sbs
Cryptantha watsonii (A. Gray) Greene **(1)** C; 7620'; dlw
*• *Cynoglossum officinale* L. **(1)** A; 8510–8530'; rds
Eritrichum nanum (Vill.) Schrad. ex Gaudin var. *elongatum* (Rydb.) Cronquist **(2)** A; 10710–11040'; dam, dmm
Hackelia floribunda (Lehm.) I. M. Johnst **(3)** C; 7460–8210'; rcf, sbs
Hydrophyllum capitatum Douglas ex Benth. var. *capitatum* **(5)** C; 7880–8820'; asf, sbs, wmm
Hydrophyllum fendleri (A. Gray) A. Heller var. *fendleri* **(1)** C; 7890'; asf
Lappula occidentalis (S. Watson) Greene var. *occidentalis* **(2)** A, C; 7460–8070'; sbs
Lappula squarrosa* (Retz.) Dumort. **(2) A, C; 7640–8220'; ccb, rds
Lithospermum incisum Lehm. **(6)** A, C; 7740–8480'; nmp, ppw, sbs,
Lithospermum ruderale Douglas ex Lehm. **(7)** A, C; 7700–8750'; dlw, sbs
Mertensia alpina (Torr.) G. Don **(1)** C; 8480'; dlw
Mertensia ciliata (E. James ex Torr.) G. Don var. *ciliata* **(57)** A, C; 7460–11090'; asf, ccb, fen, mwa, pnd, rcf, rsl, sfs, wmm
Mertensia humilis Rydb. **(8)** A; 7860–11180'; asf, dam, dlw, lpf, nmp, sbs, wmm
Mertensia lanceolata (Pursh) A. DC.; *A.L. Ward 1*; C; 7420'; dmm
Mertensia oblongifolia (Nutt.) G. Don **(2)** C; 10590–11750'; dam, dmm
Mertensia viridis (A. Nelson) A. Nelson **(11)** A, C; 10590–11580'; dam, mwa, sfs, wmm
Nemophila breviflora A. Gray **(3)** C; 7890–8300'; rcf, sbs
♦ *Phacelia alba* Rydb.; *B. Hammel 527*; A; 8100'; rds
♦ *Phacelia denticulata* Osterh.; *N.D. Atwood 1973*; A; 8200'
Phacelia hastata Douglas ex Lehm. var. *hastata* **(6)** A, C; 7460–8680'; dmm, rsl, sbs
Phacelia sericea (Graham ex Hook.) A. Gray var. *ciliosa* Rydb. **(1)** C; 7730'; sbs
Phacelia sericea (Graham ex Hook.) A. Gray var. *sericea* **(12)** A, C; 7880–10280'; asf, dmm, lpf, rds, rsl, sbs
Plagiobothrys scouleri (Hook. & Arn.) I. M. Johnst. var. *hispidulus* (Greene) Dorn **(3)** A, C; 8890–9120'; lpf, wmm

Brassicaceae

Alyssum desertorum* Stapf **(8) A, C; 7460–8630'; asf, dmm, rcf, sbs
Alyssum simplex* Rudolphi **(1) A; 8140'; sbs
Arabis hirsuta (L.) Scop. var. *glabrata* Torr. & A. Gray; *Hartman 4934*; A; 8300'; sbs
Arabis nuttallii B. L. Rob. **(2)** A; 8080–8140'; sbs
Barbarea orthoceras Ledeb. **(2)** A, C; 7460–8220'; sfs, wmm
Barbarea vulgaris* R. Br. **(1) C; 8030'; wmm
Boechera collinsii (Fernald) Á. Löve & D. Löve **(5)** A, C; 7880–9400'; dmm, lpf, sbs
Boechera grahamii (Lehm.) Windham & Al-Shehbaz **(4)** A; 8070–9450'; dlw, dmm, sbs
Boechera holboellii (Hornem.) Á. Löve & D. Löve var. *secunda* (Howell) Dorn **(6)** A, C; 7860–9450'; ccb, dmm, nmp, sbs
Boechera lignifera (A. Nelson) W. A. Weber **(4)** A, C; 8020–8480'; dlw, rsl, sbs
Boechera microphylla (Nutt.) Dorn; *Nelson 13456*; C; 7700'; rock outcrop
Boechera pendulocarpa (A. Nelson) Windham & Al-Shehbaz **(12)** A, C; 7700–9330'; dlw, dmm, nmp, sbs
Boechera pinetorum (Tidestr.) Windham & Al-Shehbaz **(2)** A; 8070–8140'; sbs
Boechera spatifolia (Rydb.) Windham & Al-Shehbaz **(6)** A, C; 7460–9250'; dlw, lpf, ppw, sbs
Boechera stricta (Graham) Al-Shehbaz **(60)** A, C; 7620–10830'; asf, ccb, dam, dlw, dmm, lpf, rcf, rds, rsl, sbs, sfs, wmm
Camelina microcarpa* Andrz. ex DC. **(1) C; 7510'; sbs
Capsella bursa-pastoris* (L.) Medik. **(3) A, C; 7730–7890'; asf, rds, wmm
Cardamine breweri S. Watson **(11)** A, C; 7460–9580'; ccb, rcf, rsl, sfs, wmm
Cardamine cordifolia A. Gray var. *cordifolia* **(5)** A, C; 8230–9930'; rcf, wmm
Cardamine oligosperma Nutt. var. *oligosperma* **(5)** A, C; 7730–9590'; asf, rcf, wmm
Cardaria chalepensis* (L.) Hand.-Mazz. **(1) C; 7510'; sbs
*• *Cardaria draba* (L.) Desv. **(1)** C; 8300'; rds
Descurainia incana (Bernh. ex Fisch. & C. A. Mey.) Dorn **(6)** A, C; 7640–8700'; asf, ccb, dmm, sbs
Descurainia incisa (Engelm.) Britton var. *incisa* **(1)** A; 8220'; sbs
Descurainia longepedicellata (E. Fourn.) O.E. Schulz; *K.K. Hughes 394*; A; 7560–7760'; sbs
Descurainia nelsonii (Rydb.) Al-Shehbaz & Goodson; *A. Nelson 2609*; A; 8800'
Descurainia pinnata (Walter) Britton var. *osmiarum* (Cockerell) Shinners **(1)** A; 8070'; sbs
Descurainia sophia* (L.) Webb ex Prantl **(5) A, C; 7460–9050'; dmm, rcf, sbs
Draba albertina Greene **(18)** A, C; 7700–10590'; asf, dlw, dmm, rcf, rsl, sbs, sfs, wmm
Draba aurea Vahl ex Hornem. **(9)** A, C; 8220–11750'; dam, dmm, sfs, wmm
Draba cana Rydb. **(1)** A; 11040'; dam
Draba crassifolia Graham var. *crassifolia* **(11)** A, C; 9840–11750'; dam, dmm, rcf, wmm
♦*Draba globosus* Payson; *R.D. Dorn 4283*; A; 10800'; dam
Draba lonchocarpa Rydb. var. *lonchocarpa* **(1)** A; 11040'; dam
Draba nemorosa L. **(5)** A, C; 7730–8680'; dlw, sbs, wmm
Draba oligosperma Hook. var. *oligosperma* **(3)** A, C; 7880–10280'; dlw, dmm, sbs
Draba streptocarpa A. Gray; *B. Heidel 2325*; A; 9420'; rcf
**Erucastrum gallicum* (Willd.) O.E. Schulz; *R. Newton 2540*; A; 7360'; rsl
Erysimum capitatum (Douglas ex Hook.) Greene var. *purshii* (T. Durand) Rollins **(16)** A, C; 7620–11480'; dam, dmm, nmp, ppw, sbs
Erysimum cheiranthoides* L. ssp. *altum* Ahti **(1) C; 8210'; rsl
Halimolobos virgata (Nutt.) O.E. Schulz **(1)** A; 8090–9330'; dlw
Lepidium densiflorum Schrad. var. *macrocarpum* G. A. Mulligan **(1)** A; 7380–7400'; nmp
Lepidium ramosissimum A. Nelson var. *ramosissimum*; *A. Nelson 8782*; A; 8100'; bottom lands
Noccaea fendleri (A. Gray) Holub ssp *glauca* (A. Nelson) Al-Shehbaz & M. Koch **(42)** A, C; 7460–11180'; asf, dam, dmm, lpf, mwa, rcf, rsl, sbs, sfs, wmm
Physaria acutifolia Rydb. var. *acutifolia*; **(3)**C; 7520–7950'; nmp, sbs
Physaria arenosa (Richardson) O'Kane & Al-Shehbaz var. *arenosa* **(1)** A; 8630'; dmm
Physaria ludoviciana (Nutt.) O'Kane & Al-Shehbaz **(1)** A; 7900'; sbs
Physaria montana (A. Gray) Greene **(16)** A, C; 7460–9330'; ccb, dlw, dmm, nmp, ppw, sbs

Rorippa alpina (S. Watson) Rydb. **(3)** A, C; 8760–10540′; mwa, pnd, wmm
Rorippa curvipes Greene var. *curvipes* **(5)** A, C; 7460–9510′; rcf, sfs, wmm
Rorippa curvipes Greene var. *integra* (Rydb.) Stuckey **(2)** C; 9020–9990′; pnd, rds
Rorippa palustris (L.) Besser var. *fernaldiana* (Butters & Abbe) Stuckey **(1)** C; 8610–8640′; rcf
Rorippa sphaerocarpa (A. Gray) Britton **(1)** C; 8610–8640′; wmm
* *Sisymbrium altissimum* L. **(1)** C; 7510′; sbs
Thelypodium integrifolium (Nutt.) Endl. ex Walp. var. *integrifolium* **(1)** A; 7380–7400′; nmp
* *Thlaspi arvense* L. **(5)** A, C; 7700–9450′; asf, dmm, rcf, sbs
Turritis glabra L. **(6)** A, C; 7510–9910′; dmm, rsl, sbs, sfs

Cactaceae
Coryphantha vivipara (Nutt.) Britton & Rose **(2)** A; 8070–8140′; sbs, nmp,
Opuntia polyacantha Haw. var. *polyacantha* **(3)** A, C; 7440–8100′; sbs
Pediocactus simpsonii (Engelm.) Britton & Rose **(1)** A; 9330′; ppw

Campanulaceae
Campanula parryi A. Gray **(5)** A, C; 7510–8280′; asf, rcf, rsl, sbs, wmm
Campanula rotundifolia L. **(47)** A, C; 7460–11750′; asf, ccb, dam, dlw, dmm, lpf, rcf, rds, rsl, sbs, sfs, wmm
Campanula uniflora L. **(2)** A; 11010–11580′; dam

Cannabaceae
Humulus lupulus L. var. *neomexicanus* A. Nelson & Cockerell; *Nelson 1915*; A; 7600′; rds

Caprifoliaceae
Linnaea borealis L. var. *longiflora* Torr. **(7)** A, C; 8070–8920′; lpf, rcf
Lonicera involucrata (Richardson) Banks ex Spreng. var. *involucrata* **(39)** A, C; 7460–9810′; asf, fen, lpf, pnd, rcf, rsl, sfs, wmm
Symphoricarpos occidentalis Hook. **(1)** A; 7440′; asf
Symphoricarpos oreophilus A. Gray var. *utahensis* (Rydb.) A. Nelson **(7)** A, C; 7730–8750′; asf, dmm, sbs
Valeriana edulis Nutt. ex Torr. & A. Gray var. *edulis* **(23)** A, C; 7510–10620′; asf, dmm, fen, rcf, rsl, sbs, wmm
Valeriana occidentalis A. Heller **(19)** A, C; 7630–10280′; asf, dmm, rcf, rsl, sbs, sfs, wmm

Caryophyllaceae
Cerastium arvense L. var. *strictum* (Gaudin) W. D.J. Koch **(28)** A, C; 7880–11750′; dam, dlw, dmm, fen, lpf, rcf, rsl, sbs, wmm
* *Cerastium fontanum* Baumg. ssp. *vulgare* (Hartm.) Greuter & Burdet **(14)** A, C; 7460–9580′; asf, dmm, rcf, sfs, wmm
* *Cerastium tomentosum* L. **(1)** A; 8510–8530′; rds
* *Dianthus armeria* L. ssp. *armeria*; *R.L. Williams 606*; C; 7400′; rds
* *Dianthus barbatus* L. ssp. *barbatus*; *L. Strack 136*; A; 8200′; rsl
* *Dianthus deltoides* L. ssp. *deltoids*; *R.D. Dorn 4370*; C; 8300′; rds
Eremogone congesta (Nutt.) Ikonn. var. *congesta* **(54)** A, C; 7460–11090′; asf, ccb, dam, dlw, dmm, lpf, nmp, rds, rsl, sbs, wmm
Eremogone fendleri (A. Gray) Ikonn. **(8)** A; 8070–10280′; dmm, lpf, nmp, rcf, sbs
Eremogone hookeri (Nutt.) W. A. Weber var. *hookeri* **(2)** A; 8070–8200′; sbs
Minuartia nuttallii (Pax) Briq. var. *nuttallii*; *Hartman 2968*; C; 8600′; in sand
Minuartia obtusiloba (Rydb.) House **(19)** A, C; 9890–11750′; dam, dmm, mwa, pnd, sfs, wmm
Minuartia rubella (Wahlenb.) Hiern **(8)** A, C; 10590–11750′; dam, dmm, wmm
Moehringia lateriflora (L.) Fenzl **(8)** A, C; 7460–8760′; fen, rcf, rsl, sbs, sfs, wmm
♦ *Paronychia pulvinata* A. Gray **(2)** A; 11270–11580′; dam
Paronychia sessiliflora Nutt. **(3)** A; 7380–8520′; nmp, sbs
Pseudostellaria jamesiana (Torr.) W. A. Weber & R. L. Hartm.; *Nelson 453*; C; 7800′; lpf
Sagina saginoides (L.) H. Karst **(5)** A, C; 8370–9580′; rcf, rsl
Silene acaulis (L.) Jacq. **(10)** A, C; 10620–11580′; dam, dmm, mwa, wmm
Silene drummondii Hook. var. *drummondii* **(12)** A, C; 7510–9400′; dmm, lpf, ppw, sbs
Silene drummondii Hook. var. *striata* (Rydb.) Bocquet **(10)** A, C; 7890–11580′; asf, dam, dmm, lpf, rcf, rds, rsl, sfs
♦ *Silene hitchguirei* Bocq.; *Nelson 84837*; A; 11600–11700′; dam
* *Silene latifolia* Poir.; *Hartman 3057*; A; 9500′; rds
Silene menziesii Hook. **(2)** A, C; 7460–8220′; sbs, sfs
Silene parryi (S. Watson) C. L. Hitchc. & Maguire **(1)** C; 10970′; dmm
* *Spergularia rubra* (L.) J. Presl & C. Presl **(23)** A, C; 7890–10590′; asf, ccb, dmm, fen, lpf, rds, sbs, sfs, wmm
Stellaria borealis Bigelow var. *borealis* **(4)** A, C; 8370–9590′; rsl, sfs, wmm
Stellaria calycantha (Ledeb.) Bong. **(1)** C; 9730′; fen
Stellaria longifolia Muhl. ex Willd. **(5)** A; 8220–9480′; dmm, rcf, wmm
Stellaria longipes Goldie var. *longipes* **(24)** A, C; 7700–11750′; asf, dam, dmm, mwa, pnd, rcf, rsl, sfs, wmm
Stellaria umbellata Turcz. **(10)** A, C; 8230–11270′; dam, dmm, pnd, wmm

Cleomaceae
Peritoma serrulata (Pursh) DC.; *B. Hammel 725*; A; 7500′; rds

Clusiaceae
Hypericum scouleri Hook. **(1)** A; 8070′; rcf

Colchicaceae
Streptopus amplexifolius (L.) DC. **(22)** A, C; 8030–9730′; asf, rcf, rsl, sfs, wmm

Cornaceae
Cornus sericea L. var. *sericea* **(5)** A, C; 7440–8570′; asf, rcf, sbs, sfs

Crassulaceae
Sedum integrifolium (Raf.) A. Nelson **(1)** A; 11040′; dam
Sedum lanceolatum Torr. **(48)** A, C; 7620–11750′; ccb, dam, dlw, dmm, lpf, mwa, nmp, rds, rsl, sbs, wmm
Sedum rhodanthum A. Gray **(33)** A, C; 8270–11750′; fen, mwa, pnd, rcf, rsl, wmm

Cyperaceae
Carex albonigra Mack. **(3)** C; 10730–11750′; dam, dmm
Carex aquatilis Wahlenb. var. *aquatilis* **(42)** A, C; 7460–10970′; asf, ccb, fen, pnd, rcf, rsl, sfs, wmm
! *Carex arcta* Boott **(3)** C; 9020–9120′; pnd, rcf
Carex atherodes Spreng.; *T. Varcalli 91*; C; 8800′; rsl
Carex athrostachya Olney **(13)** A, C; 7730–9150′; asf, dmm, rcf, rsl, wmm
Carex aurea Nutt. **(19)** A, C; 8030–10970′; asf, fen, pnd, rcf, rsl, wmm
Carex brunnescens (Pers.) Poir. var. *brunnescens* **(1)** C; 9020′; pnd
Carex canescens L. var. *canescens* **(27)** A, C; 8270–10500′; fen, pnd, rcf, rsl, sfs, wmm
Carex capillaris L. **(3)** A, C; 8710–9270′; fen, rcf, rsl
Carex chalciolepis T. Holm **(5)** A, C; 8760–11000′; dmm, rsl, wmm
♦ *Carex diandra* Schrank; *C.L. Porter 9197*; A; 8600′; fen
Carex disperma Dewey **(24)** A, C; 8300–9480′; asf, rcf, rsl, wmm
Carex duriuscula C. A. Mey. **(2)** A, C; 7880–8520′; nmp, sbs
Carex ebenea Rydb. **(16)** A, C; 8710–11580′; dam, dmm, lpf, mwa, pnd, rcf, rds, sfs, wmm
♦ *Carex egglestonii* Mack.; *F.J. Hermann 17168*; A; 9000′; dmm
Carex elynoides Holm **(1)** A; 11010–11580′; dam
Carex epapillosa Mack. **(10)** A, C; 9100–11090′; dmm, fen, mwa, rcf, rsl, wmm

Carex filifolia Nutt.; *W. Fertig 12566*; A; 7800–8000′; dmm

Carex foenea Willd. **(25)** A, C; 8000–11040′; dam, dlw, dmm, lpf, rcf, rsl, sfs, wmm

Carex geyeri Boott **(52)** A, C; 7460–10710′; asf, ccb, dlw, lpf, rcf, rsl, sbs, sfs

Carex gynocrates Wormsk. ex Drejer **(3)** A; 8140–9220′; fen, nmp, rsl

Carex haydeniana Olney **(16)** A, C; 7460–10970′; asf, ccb, dam, dmm, fen, rcf, rsl, sfs, wmm

Carex hoodii Boott **(9)** A, C; 7890–10590′; asf, dmm, sfs, wmm

Carex illota L. H. Bailey **(25)** A, C; 8750–11270′; asf, dmm, fen, pnd, rcf, sfs, wmm

Carex inops L. H. Bailey ssp. *heliophila* (Mack.) Crins **(2)** A; 8200–8530′; sbs

Carex interior L. H. Bailey **(6)** A, C; 8710–10710′; fen, pnd, wmm

Carex jonesii L. H. Bailey **(21)** A, C; 8030–9930′; fen, rcf, rsl, sfs, wmm

Carex lachenalii Schkuhr; *B. Heidel 2435*; C; 9600′; fen

Carex lanuginosa Michx. **(3)** C; 8020–8640′; rcf, sbs, wmm

Carex lasiocarpa Ehrh. **(1)** C; 8820–8830′; pnd

Carex lenticularis Michx. var. *pallida* (Boott) Dorn **(4)** A, C; 8270–9580′; fen, rcf, wmm

Carex leporinella Mack. **(3)** C; 9380–11090′; dam, wmm

♦ *Carex leptalea* Wahlenb. **(1)** A; 9270′; fen

♦ *Carex limosa* L. **(1)** C; 8820–8830′; pnd

Carex macloviana d'Urv. **(18)** A, C; 8070–11580′; dam, dmm, mwa, rcf, rsl, wmm

Carex microptera Mack. var. *limnophila* (F. J. Herm.) Dorn **(4)** A, C; 8370–9210′; dmm, rcf, wmm

Carex microptera Mack. var. *microptera* **(12)** A, C; 8750–11750′; asf, dam, dmm, fen, rcf, rsl, wmm

Carex nardina Fr.; *E. Nelson 5346*; A; 10600′

Carex nebrascensis Dewey **(6)** A, C; 7860–9130′; dmm, rcf, rds, wmm

♦ *Carex nelsonii* Mack. **(1)** C; 10830′; pnd

Carex neurophora Mack.; *A. Nelson 9164*; A; 9000–10500′; rsl

Carex nigricans C. A. Mey. **(10)** A, C; 9710–11020′; dmm, fen, pnd, sfs, wmm

Carex nova L. H. Bailey var. *nova* **(5)** A, C; 9510–10830′; mwa, pnd, wmm

Carex nova L. H. Bailey var. *pelocarpa* (F. J. Herm.) Dorn **(1)** C; 10730–11090′; dam

♦ *Carex occidentalis* L. H. Bailey **(2)** A, C; 8020–8750′; asf, rds

Carex pachystachya Cham. ex Steud. **(14)** A, C; 7640–10020′; ccb, dmm, fen, pnd, rcf, rsl, wmm

Carex parryana Dewey var. *unica* L. H. Bailley; *A. Nelson 7682*; A; 8000′; wmm

Carex paupercula Michx. **(6)** A, C; 8820–9780′; fen, pnd, rcf, wmm

Carex paysonis Clokey **(1)** A; 10620′; wmm

Carex petasata Dewey **(4)** A, C; 8020–11750′; dam, sbs, wmm

Carex phaeocephala Piper **(2)** C; 10970–11750′; dam, dmm

Carex praeceptorum Mack. **(2)** A; 9510–11270′; fen, wmm

Carex praegracilis W. Boott; *A.J. Roderick 2057*; C; 7800′; rsl

Carex praticola Rydb. **(1)** A; 8930–9030′; wmm

Carex pyrenaica Wahlenb. **(4)** A, C; 10970–11750′; dmm, fen, mwa

Carex raynoldsii Dewey **(12)** A, C; 8910–10970′; dmm, sfs, wmm

Carex rossii Boott **(10)** A, C; 8000–10600′; asf, dlw, lpf, ppw, sfs, wmm

Carex rupestris All. **(2)** A; 11010–11580′; dam, rsl

Carex saxatilis L. **(2)** A, C; 10240–10600′; wmm

Carex scopulorum T. Holm var. *scopulorum* **(20)** A, C; 9430–11750′; dam, fen, mwa, pnd, rcf, sfs, wmm

Carex simulata Mack. **(1)** A; 9270′; fen

Carex stenoptila F. J. Herm. **(10)** C; 8820–10970′; ccb, dmm, pnd, rcf, rsl

Carex stevenii (T. Holm) Kalela **(21)** A, C; 8220–11750′; dam, fen, lpf, pnd, rcf, rsl, wmm

Carex utriculata Boott **(46)** A, C; 7460–9930′; asf, ccb, dmm, fen, pnd, rsl, sfs, wmm

Carex vallicola Dewey **(5)** A, C; 7700–9330′; dlw, rds, sbs, sfs

Carex vernacula L. H. Bailey **(1)** C; 9150′; wmm

Carex vesicaria L. **(2)** C; 9650–9810′; fen

Eleocharis acicularis (L.) Roem. & Schult.; *Nelson 18367*; A; 8230′; stream channel

Eleocharis palustris (L.) Roem. & Schult. **(7)** A, C; 8270–9070′; rcf, pnd, wmm

Eleocharis quinqueflora (Hartm.) O. Schwarz **(11)** A, C; 8820–10540′; fen, pnd, rcf, rsl, wmm

Eriophorum angustifolium Honck. **(1)** A; 9270′; fen

♦*Eriophorum gracile* Koch; *B. Heidel 2693*; A; 9180–9220′; fen

Scirpus microcarpus J. Presl & C. Presl **(1)** C; 8210′; rcf

♦*Trichophorum pumilum* (Vahl) Schinz & Thell.; *B. Heidel 2699*; A; 9220–9240′; fen

Elaeagnaceae

Shepherdia canadensis (L.) Nutt. **(28)** A, C; 7640–9300′; asf, dlw, lpf, rcf, rds, rsl, sbs, sfs, wmm

Ericaceae

Arctostaphylos uva-ursi (L.) Spreng. **(25)** A, C; 7460–11180′; asf, dam, dlw, dmm, lpf, mwa, ppw, rds, rsl, sbs, sfs

Chimaphila umbellata (L.) W. P. C. Barton var. *occidentalis* (Rydb.) S. F. Blake **(10)** A, C; 7460–9210′; asf, lpf, pnd, rcf, sfs

Gaultheria humifusa (Graham) Rydb. **(11)** A, C; 9180–11270′; dam, fen, mwa, rcf, wmm

Kalmia microphylla (Hook.) A. Heller **(11)** A, C; 10250–11020′; fen, pnd, sfs, wmm

Moneses uniflora (L.) A. Gray **(3)** A, C; 8750–8970′; asf, rcf, sfs

Monotropa hypopithys L. **(4)** A, C; 7640–9480′; asf, lpf, rcf, sfs

Orthilia secunda (L.) House **(31)** A, C; 8030–9930′; asf, lpf, pnd, rcf, rsl, sfs, wmm

Pterospora andromedea Nutt. **(11)** A, C; 7640–9480′; asf, ccb, lpf, rcf, sfs

Pyrola asarifolia Michx. var. *asarifolia* **(22)** A, C; 8300–9580′; asf, fen, pnd, rcf, rsl, sfs, wmm

Pyrola chlorantha Sw. **(16)** A, C; 8300–9480′; lpf, rcf, rsl, sfs

Pyrola minor L. **(11)** A, C; 7460–11090′; lpf, mwa, rcf, sfs, wmm

Vaccinium cespitosum Michx. **(26)** A, C; 8630–11750′; dam, dmm, lpf, mwa, pnd, rcl, rsl, sfs, wmm

Vaccinium scoparium Leiberg ex Coville **(50)** A, C; 8630–11750′; dam, dmm, fen, lpf, mwa, rcf, rsl, sfs, wmm

Euphorbiaceae

Chamaesyce glyptosperma (Engelm.) Small **(1)** A; 7640–8220′; sbs

Euphorbia brachycera Engelm. **(6)** A, C; 7460–8480′; nmp, ppw, sbs

*• *Euphorbia esula* L. var. *uralensis* (Fisch. ex Link) Dorn; *B. Hammel 586*; C; 7600′; rds

Fabaceae

Astragalus adsurgens Pall. var. *robustior* Hook. **(10)** A, C; 7640–9400′; dmm, nmp, rds, sbs

Astragalus agrestis Douglas ex G. Don **(8)** A, C; 7700–9760′; asf, dmm, sbs, wmm

Astragalus alpinus L. var. *alpinus* **(28)** A, C; 7460–10280′; asf, dmm, fen, lpf, rcf, rsl, sfs, wmm

Astragalus australis (L.) Lam. var. *glabriusculus* (Hook.) Isely **(1)** A; 7860′; dmm

Astragalus bisulcatus (Hook.) A. Gray var. *bisulcatus*; *R. Newton 1165*; A; 7660′; wmm

Astragalus bisulcatus (Hook.) A. Gray var. *major* (M.E. Jones) S. L. Welsh **(1)** A; 8020′; rds

Astragalus bodinii E. Sheld.; *A. Nelson 1529*; A; 7700′;

Astragalus convallarius Greene var. *convallarius* **(1)** C; 7620′; dlw

Astragalus crassicarpus Nutt. var. *crassicarpus* **(1)** C; 7700–8020′; sbs

Astragalus crassicarpus Nutt. var. *paysonii* (E. H. Kelso) Barneby **(2)** A; 7740–8140′; ppw, sbs

Astragalus drummondii Douglas ex Hook. **(2)** A; 8120–9580'; lpf, sbs
Astragalus eucosmus B. L. Rob. **(5)** A, C; 7460–8760'; rcf, sfs, wmm
Astragalus flexuosus (Hook.) Douglas ex G. Don var. *flexuosus* **(9)** A, C; 7440–9450'; dmm, nmp, sbs
Astragalus gracilis Nutt. **(1)** C; 7700–8020'; sbs
Astragalus hyalinus M.E. Jones **(1)** A; 7380–7400'; nmp
♦*Astragalus leptaleus* A. Gray **(1)** A; 7630'; rsl
Astragalus miser Douglas var. *oblongifolius* (Rydb.) Cronquist **(28)** A, C; 7460–9180'; asf, dlw, dmm, lpf, rcf, sbs, sfs, wmm
Astragalus parryi A. Gray **(7)** A; 7860–9450'; asf, dmm, rcf, sbs
Astragalus pectinatus (Hook.) Douglas ex G. Don; *G. B. Ownbey 501*; A
Astragalus purshii Douglas ex Hook. var. *purshii* **(1)** A; 8200–8400'
Astragalus sericoleucus A. Gray **(1)** A; 7740–7880'; ppw
Astragalus shortianus Nutt. **(3)** A, C; 7880–9250'; dlw, ppw, sbs
Astragalus spatulatus E. Sheld. **(4)** A, C; 7700–8480'; dlw, sbs
Astragalus tenellus Pursh **(1)** A; 7740–7880'; ppw
Glycyrrhiza lepidota Pursh **(1)** C; 7510'; sbs
Lathyrus lanszwertii Kellogg var. *leucanthus* (Rydb.) Dorn **(1)** C; 7460'; sfs
Lupinus argenteus Pursh var. *argenteus* **(36)** A, C; 7700–10620'; asf, ccb, dmm, lpf, ppw, rcf, rds, rsl, sbs, sfs, wmm
Lupinus argenteus Pursh var. *argophyllus* (A. Gray) S. Watson **(1)** A; 9450'; rds
Lupinus argenteus Pursh var. *laxiflorus* (Douglas ex Lindl.) Dorn **(10)** A, C; 7640–9580'; asf, ccb, dmm, rds, sbs, wmm
Lupinus argenteus Pursh var. *rubricaulis* (Greene) S. L. Welsh **(15)** A, C; 7640–9370'; asf, ccb, lpf, rcf, rsl, sbs, sfs, wmm
Lupinus lepidus Douglas ex Lindl. var. *utahensis* (S. Watson) C. L. Hitchc. **(13)** A, C; 8020–9930'; dmm, lpf, rcf, rsl, sbs, wmm
Lupinus polyphyllus Lindl. var. *humicola* (A. Nelson) Barneby **(4)** C; 7880–8300'; dlw, sbs, sfs
Lupinus polyphyllus Lindl. var. *prunophilus* (M.E. Jones) L. Ll. Phillips **(3)** C; 8560–10590'; lpf, wmm
**Medicago falcata* L.; *Nelson 1482*; C; 8200'; rds
Medicago lupulina* L. **(3) A, C; 7890–9450'; rcf, sbs
Medicago sativa* L. **(1) C; 8560'; wmm
**Melilotus albus* Medik.; *Nelson 1080*; A; 8600'; rds
Melilotus officinalis* (L.) Pall. **(4) A, C; 8020–9300'; ccb, rds
Oxytropis campestris (L.) DC. var. *spicata* Hook. **(10)** A, C; 8080–10280'; asf, dmm, lpf, rcf, sbs
Oxytropis deflexa (Pall.) DC. var. *sericea* Torr. & A. Gray **(1)** A; 7630'; rsl
Oxytropis lagopus Nutt. var. *atropurpurea* (Rydb.) Barneby **(6)** A, C; 7860–9330'; dlw, dmm, sbs
Oxytropis lambertii Pursh var. *bigelovii* A. Gray **(17)** A, C; 7640–9450'; dmm, lpf, nmp, rds, sbs
Oxytropis multiceps Nutt.; *Hartman 24296*; A; 7800–9500'; granitic rock slope
Oxytropis sericea Nutt. var. *sericea* **(8)** A, C; 7730–9330'; ccb, lpf, ppw, sbs
Thermopsis montana Nutt. var. *divaricarpa* (A. Nelson) Dorn **(2)** C; 7890'; sbs
Trifolium dasyphyllum Torr. & A. Gray **(10)** A, C; 8400–11750'; dam, dmm, mwa, ppw, sfs, wmm
Trifolium gymnocarpon Nutt. var. *gymnocarpon* **(1)** A; 8200–8400'
Trifolium hybridum* L. **(29) A, C; 7460–9910'; asf, ccb, dmm, fen, lpf, pnd, rcf, rds, rsl, sbs, sfs, wmm
Trifolium longipes Nutt. var. *reflexum* A. Nelson **(4)** A, C; 7700–8700'; rcf, rsl, wmm
Trifolium parryi A. Gray var. *parryi* **(13)** A, C; 10020–11180'; dam, dmm, mwa, pnd, sfs, wmm
Trifolium pratense* L. **(2) C; 8030–8920'; dmm, wmm
Trifolium repens* L. **(46) A, C; 7460–9760'; asf, ccb, dmm, lpf, pnd, rcf, rds, rsl, sbs, sfs, wmm
Vicia americana Muhl. ex Willd. var. *americana* **(21)** A, C; 7460–8920'; asf, dmm, rcf, rsl, sbs, sfs, wmm
Vicia americana Muhl. ex Willd. var. *minor* Hook. **(1)** A; 7630'; rsl

Gentianaceae

Frasera speciosa Douglas ex Griseb. **(12)** A, C; 7510–10280'; dmm, ppw, rcf, rsl, sbs, sfs, wmm
Gentiana affinis Griseb. **(2)** A; 8070–9130'; dmm, rcf
Gentiana algida Pall. **(3)** A, C; 10240–11750'; dam, mwa
Gentiana aquatica L.; *G. Osterhout 1026*; A; 7700'
Gentiana parryi Engelm. **(9)** A; 8270–10540'; dmm, fen, mwa, sbs, wmm
Gentianella amarella (L.) Börner var. *acuta* (Michx.) Herder **(24)** A, C; 8070–11750'; asf, ccb, fen, lpf, mwa, pnd, rcf, rsl, sfs, wmm
Gentianella tenella (Rottb.) Börner; *W.C. Leavenworth 220*; A; 10200'; dam
Gentianopsis barbellata (Engelm.) H. H. Iltis; *A. Nelson 1138*; A; 9000–10000'; sfs
Gentianopsis detonsa (Rottb.) Ma var. *elegans* (A. Nelson) N.H. Holmgren **(19)** A, C; 8270–10600'; asf, fen, mwa, rcf, rsl, wmm
♦*Lomatogonium rotatum* (L.) Fr.; *S. Markow s.n.*; A; 9000'; pnd
Swertia perennis L. **(16)** A, C; 8710–10970'; fen, mwa, rcf, rsl, wmm

Geraniaceae

Geranium atropurpureum A. Heller var. *cowenii* (Rydb.) Dorn; *W.G. Solheim 242*; A; 8700'; ccb,
Geranium caespitosum E. James **(3)** A; 7640–8520'; dlw, sbs
Geranium richardsonii Fisch. & Trautv. **(43)** A, C; 7460–9930'; asf, ccb, dmm, rcf, rsl, sfs, wmm
Geranium viscosissimum Fisch. & C. A. Mey. ex C. A. Mey. var. *incisum* (Torr. & A. Gray) N.H. Holmgren **(11)** A, C; 7440–8820'; asf, dmm, rds, sbs, sfs

Grossulariaceae

Ribes aureum Pursh var. *aureum*; *W.B. Jones 161*; A; 8500'; dlw
Ribes aureum Pursh var. *villosum* DC. **(2)** C; 7000–7320'; rsl
Ribes cereum Douglas **(26)** A, C; 7440–9450'; asf, dlw, dmm, lpf, rds, sbs, wmm
Ribes inerme Rydb. var. *inerme* **(14)** A, C; 7460–8760'; asf, ccb, rcf, rsl, sbs, wmm
Ribes lacustre (Pers.) Poir. **(30)** A, C; 8030–11750'; asf, dam, dmm, rcf, rsl, sfs, wmm
Ribes montigenum McClatchie **(20)** A, C; 9590–11180'; dam, dmm, mwa, pnd, rcf, sfs, wmm
Ribes oxyacanthoides L. var. *setosum* (Lindl.) Dorn **(2)** A, C; 7510–10540'; mwa, sbs

Haloragaceae

Myriophyllum sibiricum Kom.; *A. Nelson 971*; A; 10100'; pnd

Hydrocharitaceae

Elodea canadensis Michx.; *J. Haines 10167*; A; 10700'; pnd

Iridaceae

Iris missouriensis Nutt. **(11)** A, C; 7630–9910'; asf, dmm, rcf, rsl, sbs, wmm
Sisyrinchium montanum Greene var. *montanum* **(5)** A, C; 7460–8760'; rsl, sfs, wmm

Juncaceae

Juncus alpinoarticulatus Chaix; *B. Heidel 2672*; A; 9780'; fen
Juncus arcticus Willd. var. *balticus* (Willd.) Trautv. **(48)** A, C; 7460–10540'; asf, ccb, fen, lpf, mwa, rcf, rsl, sbs, sfs, wmm
Juncus articulatus L. **(1)** A; 8270–8280'; rcf
Juncus bufonius L.; *Nelson 13412*; C; 8000'; wmm
Juncus castaneus Sm.; *J. Haines 10492*; A; 10780'; mwa
Juncus confusus Coville **(20)** A, C; 8230–9760'; asf, ccb, dmm, rcf, rds, rsl, wmm
Juncus drummondii E. Mey. **(31)** A, C; 8820–11750'; dam, dmm, fen, mwa, pnd, rcf, rsl, sfs, wmm

Juncus ensifolius Wikstr. var. _ensifolius_ (**11**) A, C; 8370–9200′; rcf, rsl, wmm

Juncus ensifolius Wikstr. var. _montanus_ (Engelm.) C. L. Hitchc. (**7**) C; 8070–9760′; asf, rcf, rsl, wmm

♦ _Juncus filiformis_ L. (**1**) A; 8270–8280′; rcf

*_Juncus gerardii_ Loisel.; _Hartman 92168;_ A; 8960′; wmm

Juncus hallii Engelm. (**4**) A, C; 8760–9480′; pnd, rcf, wmm

Juncus interior Wiegand; _G.A. Goodwin s.n._; C; 8600′; ccb

Juncus longistylis Torr. (**6**) A, C; 7640–9130′; ccb, pnd, rcf, rsl, wmm

Juncus mertensianus Bong. (**20**) A, C; 8740–11270′; asf, fen, lpf, pnd, rcf, rsl, sfs, wmm

Juncus nevadensis S. Watson (**13**) A, C; 7460–9477′; dmm, fen, pnd, rcf, sfs, wmm

Juncus nodosus L. (**1**) C; 9580–9930′; rcf

Juncus parryi Engelm. (**5**) A, C; 9510–10710′; mwa, sfs, wmm

♦ _Juncus triglumis_ L. var. _albescens_ Lange; _J. Haines 10493_; A; 10770′; mwa

Luzula comosa E. Mey. (**12**) A, C; 8020–11090′; fen, lpf, mwa, rcf, rsl, wmm

Luzula parviflora (Ehrh.) Desv. (**53**) A, C; 8020–11090′; asf, fen, mwa, pnd, rcf, rsl, sfs, wmm

Luzula spicata (L.) DC. (**20**) A, C; 9890–11750′; dam, dmm, mwa, sfs, wmm

Juncaginaceae

Triglochin maritima L. (**1**) A; 7630′; rcf

Triglochin palustris L. (**2**) A; 9250–9580′; fen

Lamiaceae

Agastache urticifolia (Benth.) Kuntze var. _urticifolia_ (**1**) A; 7440′; asf

Dracocephalum parviflorum Nutt. (**2**) A, C; 7640–8220′; ccb, lpf

Mentha arvensis L. (**7**) A, C; 8070–9030′; pnd, rcf, wmm

Prunella vulgaris L. var. _lanceolata_ (W. P. C. Barton) Fernald (**12**) A, C; 8030–9930′; rcf, wmm

Scutellaria brittonii Porter; _K.K. Hughes 387_; A; 7560–7760′; near creek

Scutellaria galericulata L.; _A. Nelson 1760_; A; 8100′

Stachys palustris L. var. _pilosa_ (Nutt.) Fernald (**1**) C; 8210′; rsl

Lentibulariaceae

♦_Utricularia minor_ L.; _B. Heidel 2659_; C; 9640′; fen

Utricularia vulgaris L. ssp. _macrorhiza_ (Le Conte) R. T. Clausen (**5**) C; 8820–9070′; pnd

Liliaceae

Calochortus gunnisonii S. Watson var. _gunnisonii_ (**11**) A, C; 7510–9180′; asf, ccb, dmm, lpf, rds, sbs

Calochortus nuttallii Torr. & A. Gray (**4**) A, C; 8070–8750′; dlw, sbs

Erythronium grandiflorum Pursh var. _grandiflorum_ (**20**) A, C; 8160–11180′; dam, dmm, lpf, pnd, rcf, sbs, sfs, wmm

Fritillaria atropurpurea Nutt. (**6**) A, C; 7880–8680′; asf, sbs

Lilium philadelphicum L.; _B. Hammel 509_; A; 8870′; rsl

Prosartes trachycarpa S. Watson (**2**) C; 7890–8750′; asf

Limnanthaceae

Floerkea proserpinacoides Willd.; _C.L. Porter 6682_; C; 8500′; wmm

Linaceae

Linum kingii S. Watson; _Nelson 1380_; C; 8500′; dlw

Linum lewisii Pursh var. _lewisii_ (**19**) A, C; 7380–9250′; dmm, nmp, rds, rsl, sbs, wmm

Loasaceae

Mentzelia decapetala (Pursh ex Sims) Urb. & Gilg ex Gilg; _A. Nelson 8074_; A; 7580′; rds

Mentzelia dispersa S. Watson; _Nelson 2999_; A; 8400′; sbs

Mentzelia montana (Davidson) Davidson (**1**) C; 7460′; sbs

♦ _Mentzelia rusbyi_ Wooton; _B. Hammel 88_; A; 7500′; rds

Mentzelia sinuata (Rydb.) R.J. Hill; _R.J. Hill 1578_; A; 7580′; rds

Malvaceae

Iliamna rivularis (Douglas ex Hook.) Greene; _Nelson 1483_; C; 8200′; rds

Sidalcea candida A. Gray var. _candida_ (**5**) A, C; 8030–9130′; asf, dmm, rcf, wmm

Sidalcea candida A. Gray var. _glabrata_ C. L. Hitchc. (**2**) A, C; 8970–8980′; rcf

Sidalcea neomexicana A. Gray var. _neomexicana_ (**2**) A, C; 7510–7630′; rsl, sbs

Sphaeralcea coccinea (Nutt.) Rydb. (**4**) A, C; 7510–8200′; nmp, sbs

Melanthiaceae

Zigadenus elegans Pursh (**35**) A, C; 8230–10830′; dmm, lpf, pnd, rcf, sfs, wmm

Zigadenus venenosus S. Watson var. _gramineus_ (Rydb.) O. S. Walsh ex M. Peck (**5**) A, C; 7880–8530′; nmp, sbs

Menyanthaceae

Menyanthes trifoliata L. (**2**) C; 8820–9050′; pnd

Myrsinaceae

Glaux maritima L.; _G. Ownbey 613_; A; 8700′; along stream

Nymphaeaceae

Nuphar polysepala Engelm. (**6**) C; 8820–9650′; pnd

Onagraceae

Chamerion angustifolium (L.) Holub var. _angustifolium_ (**15**) A, C; 8080–11580′; asf, ccb, dam, dmm, lpf, rcf, rds, sfs, wmm

Chamerion angustifolium (L.) Holub var. _canescens_ (A.W. Wood) N.H. Holmgren & P.K. Holmgren (**15**) A, C; 7510–10540′; asf, ccb, dam, dmm, mwa, pnd, rcf, rds, sbs, sfs

Epilobium anagallidifolium Lam. (**4**) A, C; 9730–11580′; dam, fen, mwa

Epilobium brachycarpum C. Presl (**8**) A, C; 7460–9450′; ccb, dmm, sbs, wmm

Epilobium ciliatum Raf. var. _ciliatum_ (**13**) A, C; 7640–9930′; ccb, fen, pnd, rcf, rds, rsl, wmm

Epilobium ciliatum Raf. var. _glandulosum_ (Lehm.) Dorn (**5**) A, C; 8920–9480′; rcf, rsl, wmm

Epilobium clavatum Trel. (**4**) A, C; 8710–10710′; fen, wmm

Epilobium halleanum Hausskn. (**13**) A, C; 8230–10590′; asf, dmm, fen, lpf, rsl, wmm

Epilobium hornemannii Rchb. var. _hornemannii_ (**13**) A, C; 8610–10500′; dmm, fen, rcf, rds, rsl, wmm

Epilobium lactiflorum Hausskn. (**4**) C; 8770–9220′; rcf, wmm

Epilobium oregonense Hausskn. (**3**) A; 9250–10540′; fen, pnd, rcf

Epilobium palustre L. var. _palustre_ (**1**) C; 8820–8830′; pnd

Epilobium saximontanum Hausskn.; _J. Haines 10155_; A; 10940′; mwa

Gayophytum decipiens F. H. Lewis & Szweyk. (**1**) C; 7730′; sbs

Gayophytum diffusum Torr. & A. Gray var. _strictipes_ (Hook.) Dorn (**21**) A, C; 8020–9480′; asf, ccb, dmm, lpf, rcf, rds, rsl, sbs, sfs, wmm

Gayophytum racemosum Torr. & A. Gray; _J. Haines 9748_; A; 10420′; dam, sfs

Gayophytum ramosissimum Torr. & A. Gray (**8**) A, C; 7460–9450′; dmm, ppw, sbs

Oenothera cespitosa Nutt. var. _cespitosa_ (**2**) A, C; 7510–8140′; sbs

Oenothera cespitosa Nutt. var. _macroglottis_ (Rydb.) Cronquist (**8**) A, C; 7460–9250′; dmm, nmp, ppw, sbs

Oenothera coronopifolia Torr. & A. Gray (**3**) A, C; 7460–8290′; sbs

Oenothera flava (A. Nelson) Garrett (**1**) C; 8140–8750′; dmm

Oenothera nuttallii Sweet (**2**) A, C; 7510–9130′; rds, sbs

Oenothera suffrutescens (Ser.) W. L. Wagner & Hoch (**1**) A; 7740–7880′; ppw

Oenothera villosa Thunb. var. _strigosa_ (Rydb.) Dorn (**1**) A; 7630′; rsl

Orchidaceae

Calypso bulbosa (L.) Oakes var. *americana* (R. Br.) Luer **(2)** A, C; 8950–9140′; sfs
Coeloglossum viride (L.) Hartm **(1)** A; 8660–8760′; rcf
Corallorhiza maculata (Raf.) Raf. var. *maculata* **(1)** C; 9020′; sfs
Corallorhiza maculata (Raf.) Raf. var. *occidentalis* (Lindl.) Ames **(17)** A, C; 7460–9480′; asf, ccb, lpf, rcf, sfs, wmm
Corallorhiza striata Lindl. var. *vreelandii* (Rydb.) L. O. Williams; *A. Nelson 10914*; A; 8500–8700′; sfs
Corallorhiza trifida Châtel **(2)** A; 9140–9250′; wmm
♦*Cypripedium fasciculatum* Kellogg ex S. Watson **(2)** C; 8610–8840′; lpf, sfs
Goodyera oblongifolia Raf.; *H.D. Morris 174*; C; 8800′; sfs
Listera borealis Morong **(1)** A; 9250–9580′; rcf
♦ *Listera convallarioides* (Sw.) Elliott; *A. Nelson 1694*; A; 8200′
Listera cordata (L.) R. Br. **(4)** A, C; 9140–9450′; rcf, wmm
Piperia unalascensis (Spreng.) Rydb. **(3)** C; 8030–8910′; asf, lpf
Platanthera aquilonis Sheviak **(3)** A, C; 8210–9140′; rcf, wmm
Platanthera dilatata (Pursh) Lindl. ex L. C. Beck var. *albiflora* (Cham.) Ledeb. **(36)** A, C; 8020–10970′; asf, fen, pnd, rcf, rsl, sfs, wmm
Platanthera dilatata (Pursh) Lindl. ex L. C. Beck var. *dilatata* **(13)** A, C; 8630–9890′; fen, rcf, rsl, wmm
Platanthera huronensis (Nutt.) Lindl. **(16)** A, C; 7460–9730′; asf, fen, lpf, rcf, rsl, sfs, wmm
Platanthera obtusata (Banks ex Pursh) Lindl.; *Nelson 13232*; A; 9300′; sfs
Platanthera stricta Lindl.; *C.L. Porter 7933*; C; 9000′; rsl
Spiranthes romanzoffiana Cham. **(11)** A, C; 8270–9930′; fen, pnd, rcf, rsl, wmm

Orobanchaceae

Castilleja angustifolia (Nutt.) G. Don var. *dubia* A. Nelson **(12)** A, C; 7700–9330′; dlw, dmm, nmp, sbs
Castilleja flava S. Watson var. *flava* **(18)** A, C; 7640–9180′; ccb, dlw, dmm, lpf, nmp, sbs, wmm
Castilleja linariifolia Benth. **(16)** A, C; 7890–9450′; asf, dmm, rds, rsl, sbs
Castilleja miniata Douglas ex Hook. var. *miniata* **(14)** A, C; 8030–9760′; dmm, rcf, rsl, sfs, wmm
Castilleja rhexifolia Rydb. **(13)** A, C; 8820–10970′; dmm, rcf, sfs, wmm
Castilleja sulphurea Rydb. **(46)** A, C; 7460–11090′; asf, fen, lpf, mwa, rcf, rsl, sbs, sfs, wmm
Cordylanthus ramosus Nutt. ex Benth.; *Nelson 13479*; C; 7870′; sbs
Orobanche uniflora L.; *J. Haines 9950*; A; 10500′; wmm
Orthocarpus luteus Nutt. **(5)** A, C; 8070–8820′; asf, dmm, sbs
Pedicularis bracteosa Benth. var. *paysoniana* (Pennell) Cronquist **(22)** A, C; 8230–11090′; dam, dmm, rcf, rsl, sfs, wmm
Pedicularis crenulata Benth.; *A. Nelson 1528*; A; 7580′
Pedicularis groenlandica Retz. **(64)** A, C; 8030–11750′; asf, fen, lpf, mwa, pnd, rcf, rsl, wmm
Pedicularis parryi A. Gray var. *parryi* **(16)** A, C; 8890–11750′; dam, dmm, lpf, mwa, pnd, sfs, wmm
Pedicularis procera A. Gray **(1)** A; 8120–8520′; asf
Pedicularis racemosa Douglas ex Benth. var. *alba* (Pennell) Cronquist **(12)** A, C; 9250–10970′; dmm, fen, lpf, rcf, sfs, wmm

Papaveraceae

Corydalis aurea Willd. var. *aurea* **(7)** A, C; 7640–8760′; ccb, dmm, lpf, rcf

Parnassiaceae

Parnassia fimbriata König var. *fimbriata* **(2)** C; 8710–10500′; rcf, wmm

Phrymaceae

Mimulus breweri (Greene) Coville **(1)** A; 8680′; sbs
Mimulus floribundus Lindl.; *A. Nelson 8828*; A; 8000–8100′; wet, stony draws
Mimulus glabratus Kunth var. *jamesii* (Torr. & A. Gray ex Benth.) A. Gray **(1)** A; 7640–8220′; sbs
Mimulus guttatus DC. **(10)** A, C; 8030–9580′; rcf, wmm
Mimulus lewisii Pursh **(2)** C; 9220–9710′; rcf, wmm
Mimulus suksdorfii A. Gray **(1)** A; 8400–9250′; ppw

Plantaginaceae

♦ *Besseya alpina* (A. Gray) Rydb. **(1)** A; 11270–11580′; dam
Besseya wyomingensis (A. Nelson) Rydb. **(9)** A, C; 7700–9330′; dlw, sbs
Callitriche hermaphroditica L. **(1)** C; 10710′; pnd
Callitriche heterophylla Pursh **(1)** A; 10250–10540′; pnd
Callitriche palustris L. **(4)** A, C; 9020–10240′; pnd
♦ *Chionophila jamesii* Benth. **(6)** A, C; 10620–11180′; dam, dmm, mwa, wmm
Collinsia parviflora Lindl. **(19)** A, C; 7460–9450′; asf, ccb, dlw, dmm, lpf, rcf, sbs, sfs, wmm
Hippuris vulgaris L. **(1)** C; 9700′; pnd
Limosella aquatica L.; *M. Roberts 4757*; A; 8090′; mud of creek bank
* • *Linaria dalmatica* (L.) Mill. var. *dalmatica*; *L. Strack 130*; A; 8200′; rds
* • *Linaria vulgaris* Mill. **(8)** A, C; 7460–9710′; ccb, dmm, rcf, rds, sbs, wmm
Penstemon angustifolius Nutt. ex Pursh var. *angustifolius* **(1)** C; 7880′; sbs
♦ *Penstemon cyathophorus* Rydb. **(1)** C; 7700–8020′; sbs
Penstemon eriantherus Pursh var. *eriantherus* **(1)** C; 7880′; sbs
Penstemon glaber Pursh var. *alpinus* (Torr.) A. Gray; *B. Hammel 69*; A; 9000′; rds
Penstemon humilis Nutt. ex A. Gray var. *humilis*; *Hartman 24287*; A; 9000–9500′; dlw/lpf
Penstemon laricifolius Hook. & Arn. var. *exilifolius* (A. Nelson) Payson **(3)** A, C; 7640–8750′; dmm, sbs
Penstemon procerus Douglas ex Graham var. *procerus* **(19)** A, C; 7630–10280′; asf, dmm, rsl, sbs, sfs, wmm
Penstemon radicosus A. Nelson **(4)** A, C; 7700–8990′; dmm, sbs
Penstemon rydbergii A. Nelson var. *aggregatus* (Pennell) N.H. Holmgren **(2)** A, C; 8760–9150′; lpf, wmm
Penstemon rydbergii A. Nelson var. *rydbergii* **(2)** A; 8270–9510′; sbs
Penstemon saxosorum Pennell **(3)** A; 8220–9400′; dmm, sbs
Penstemon secundiflorus Benth. **(7)** A, C; 7700–9330′; dmm, nmp, ppw, sbs
Penstemon strictus Benth. **(17)** A, C; 7460–9220′; dmm, ppw, rcf, rds, rsl, sbs
Penstemon virens Pennell ex Rydb. **(19)** A, C; 7460–9450′; dlw, dmm, lpf, nmp, ppw, sbs, sfs
Penstemon virgatus A. Gray var. *asa-grayi* (Crosswh.) Dorn **(1)** A; 9050′; dmm
Penstemon whippleanus A. Gray **(33)** A, C; 7890–11750′; asf, dam, dmm, mwa, pnd, rcf, rds, rsl, sfs, wmm
Plantago eriopoda Torr. **(1)** C; 9300′; ccb
Plantago tweedyi A. Gray **(18)** A, C; 7890–10710′; dmm, rcf, rsl, sfs, wmm
Veronica americana Schwein. ex Benth. **(21)** A, C; 7460–9930′; asf, ccb, fen, rcf, rsl, sfs, wmm
Veronica peregrina L. var. *xalapensis* (Kunth) H. St. John & F. W. Warren; *Nelson 13242*; A; 9300′; dried out puddles, disturbed area
Veronica scutellata L. **(2)** A; 8270–9030′; pnd, rcf
Veronica serpyllifolia L. var. *humifusa* (Dicks.) Vahl **(32)** A, C; 7730–10830′; asf, fen, mwa, pnd, rcf, rsl, wmm
Veronica wormskjoldii Roem. & Schult. **(46)** A, C; 8230–11750′; fen, mwa, pnd, rcf, rsl, wmm

Poaceae

Achnatherum contractum (B. L. Johnson) Barkworth; *Hartman 24303*; A; 9000–9500′; ppw

Achnatherum hymenoides (Roem. & Schult.) Barkworth **(5)** A, C; 7460–8520′; dlw, sbs

Achnatherum lettermanii (Vasey) Barkworth **(7)** A, C; 8100–10590′; dmm, sbs, wmm

Achnatherum nelsonii (Scribn.) Barkworth ssp. *dorei* (Barkworth & J. Maze) Barkworth **(3)** C; 8290–8820′; asf, sbs

Achnatherum nelsonii (Scribn.) Barkworth ssp. *nelsonii* **(23)** A, C; 7640–9910′; asf, ccb, dlw, dmm, lpf, rcf, rsl, sbs, wmm

Achnatherum occidentale (Thurb.) Barkworth; *E. Nelson 457*; A; 9000′; dmm

Achnatherum richardsonii (Link) Barkworth **(1)** C; 8080–8200′; asf

**Agropyron cristatum* (L.) Gaertn. var. *cristatum*; *Nelson 698*; A; 8400′; rds

* *Agropyron cristatum* (L.) Gaertn. var. *desertorum* (Fisch. ex Link) Dorn **(3)** A, C; 8020–8760′; ccb, rds

**Agropyron cristatum* (L.) Gaertn. var. *fragile* (Roth) Dorn; *K.K. Hughes 720*; A; 7600–7800′; rds

Agrostis exarata Trin. **(14)** A, C; 8660–9930′; fen, pnd, rcf, rsl, wmm

Agrostis idahoensis Nash **(6)** A, C; 8610–11090′; mwa, rsl, sfs, wmm

♦ *Agrostis mertensii* Trin. **(1)** C; 11750′; dam

Agrostis scabra Willd. **(26)** A, C; 7460–9930′; ccb, dmm, fen, lpf, pnd, rcf, rds, rsl, sfs, wmm

Agrostis stolonifera* L. **(8) A, C; 7640–9030′; ccb, rcf, rsl, sfs, wmm

Agrostis variabilis Rydb. **(6)** A, C; 9100–11580′; dam, fen, rsl, wmm

Alopecurus aequalis Sobol. var. *aequalis* **(7)** A, C; 7460–9400′; dmm, pnd, rcf, rsl, sfs, wmm

* *Alopecurus arundinaceus* Poir. **(5)** A, C; 7630–9430′; ccb, rcf, rds, wmm

Alopecurus magellenicus Lam. **(2)** A; 8970–9910′; wmm

Alopecurus pratensis* L. **(4) A, C; 8560–9300′; ccb, wmm

Anthoxanthum hirtum (Schrank) Y. Schouten & Veldkamp **(2)** A, C; 9120–9730′; fen, rsl

Aristida purpurea Nutt. var. *fendleriana* (Steud.) Vasey; *W.B. Jones 29*; A; 7900′; gravelly soil

Beckmannia syzigachne (Steud.) Fernald **(2)** A, C; 8930–9660′; fen, wmm

Bouteloua gracilis (Kunth) Lag. ex Griffiths **(1)** A; 7380–7400′; nmp

Bromus carinatus Hook. & Arn. **(13)** A, C; 7890–9450′; asf, ccb, dmm, rds, rsl, sbs, wmm

Bromus ciliatus L. **(28)** A, C; 7620–9930′; asf, ccb, dlw, dmm, lpf, rcf, rsl, sbs, wmm

Bromus commutatus* Schrad. **(2) C; 8710–8820′; dmm

Bromus inermis* Leyss. **(25) A, C; 7460–9920′; ccb, dmm, lpf, pnd, rcf, rds, sbs, sfs, wmm

Bromus porteri (J.M. Coult.) Nash **(12)** A, C; 7640–9580′; asf, dmm, rsl, sbs, wmm

Bromus tectorum* L. **(11) A, C; 7460–9330′; dlw, dmm, ppw, rds, sbs

Calamagrostis canadensis (Michx.) P. Beauv. var. *canadensis* **(44)** A, C; 7460–10540′; asf, fen, lpf, mwa, pnd, rcf, rsl, sfs, wmm

Calamagrostis inexpansa A. Gray **(3)** A, C; 8270–9210′; rsl, sfs, wmm

Calamagrostis purpurascens R. Br. **(7)** A, C; 8220–11750′; dam, dmm, lpf, wmm

Calamagrostis rubescens Buckley; *G. Hallsten 480*; C; 8100′; asf

Calamagrostis stricta (Timm) Koeler **(1)** A; 9130′; dmm

Catabrosa aquatica (L.) P. Beauv.; *Nelson 785*; A; 8900′; pnd

Cinna latifolia (Trevir. ex Göpp.) Griseb. **(3)** C; 8750–8920′; asf, rcf

* *Dactylis glomerata* L. **(18)** A, C; 7890–9430′; asf, ccb, dmm, rcf, rds, sfs, wmm

Danthonia californica Bol. **(2)** C; 8820–8910′; dmm

Danthonia intermedia Vasey **(17)** A, C; 8120–10500′; asf, dmm, fen, pnd, rcf, wmm

Danthonia parryi Scribn.; *Nelson 13259*; A; 9170′; dmm

Danthonia unispicata (Thurb.) Munro ex Macoun **(1)** A; 8120–8520′; sbs

Deschampsia cespitosa (L.) P. Beauv. var. *cespitosa* **(69)** A, C; 8220–11750′; fen, lpf, mwa, pnd, rcf, rsl, sfs, wmm

Elymus albicans (Scribn. & J. G. Sm.) Á. Löve **(3)** A, C; 7700–9220′; nmp, sbs

Elymus canadensis L. var. *canadensis* **(3)** C; 8710–9220′; wmm

Elymus cinereus Scribn. & Merr. **(5)** A, C; 7460–8210′; rcf, rds, sbs

Elymus elongatus* (Host) Runemark var. *ponticus* (Podp.) Dorn **(2) A, C; 7640–9300′; ccb

Elymus elymoides (Raf.) Swezey var. *brevifolius* (J. G. Sm.) Dorn **(23)** A, C; 7460–9580′; asf, ccb, dlw, dmm, lpf, rcf, rds, sbs, wmm

Elymus elymoides (Raf.) Swezey var. *elymoides* **(9)** A, C; 7730–9930′; ccb, lpf, rcf, rsl, sbs

Elymus glaucus Buckley var. *glaucus* **(22)** A, C; 8030–9930′; asf, ccb, lpf, pnd, rcf, rds, rsl, sfs, wmm

Elymus hispidus* (Opiz) Melderis var. *hispidus* **(4) A, C; 8560–9430′; dmm, rcf, sbs

* *Elymus junceus* Fisch.; *C.L. Porter 9816*; A; 8500′; rds

Elymus lanceolatus (Scribn. & J. G. Sm.) Gould var. *lanceolatus*; *K.K. Hughes 437*; A; 7440–7640′; asf

Elymus lanceolatus (Scribn. & J. G. Sm.) Gould var. *riparius* (Scribn. & J. G. Sm.) Dorn **(3)** A, C; 7620–8990′; dmm, rsl, sbs

Elymus × macounii Vasey; *A. Nelson 8992*; C; 8200–8500′; hillsides

* • *Elymus repens* (L.) Gould **(4)** A, C; 8290–10970′; dmm, sfs, wmm

Elymus × saundersii Vasey **(1)** C; 8820′; dmm

Elymus scribneri (Vasey) M.E. Jones **(5)** A, C; 9890–11750′; dam, dmm, mwa

Elymus smithii (Rydb.) Gould **(3)** A, C; 8020–8520′; dmm, rds, sbs

Elymus spicatus (Pursh) Gould **(15)** A, C; 7460–9180′; asf, ccb, dlw, dmm, lpf, sbs

× *Elymus trachycaulus* (Link) Gould ex Shinners. × *Elymus scribneri* (Vasey) M.E. Jones **(1)** A; 9890–10280′; dmm

Elymus trachycaulus (Link) Gould ex Shinners ssp. *subsecundus* (Link) Á. Löve & D. Löve **(7)** A, C; 8120–9580′; asf, dmm, rcf, sbs, wmm

Elymus trachycaulus (Link) Gould ex Shinners var. *trachycaulus* **(44)** A, C; 7460–11090′; asf, ccb, dam, dmm, rcf, rds, rsl, sbs, sfs, wmm

Festuca brachyphylla Schult. ex Schult. & Schult. f. var. *coloradensis* (Fred.) Dorn **(6)** A, C; 10620–11090′; dam, dmm, wmm

♦ *Festuca hallii* (Vasey) Piper; *W. Fertig 18618*; A; 9600′; dmm

Festuca idahoensis Elmer **(22)** A, C; 7700–10589′; asf, dlw, dmm, lpf, nmp, rcf, rsl, sbs, wmm

Festuca minutiflora Rydb. **(2)** C; 10020–10500′; dmm, sfs

Festuca rubra L. ssp. *rubra* **(1)** C; 10730–11090′; mwa

Festuca saximontana Rydb. var. *saximontana* **(32)** A, C; 7620–11580′; ccb, dam, dlw, dmm, lpf, rcf, rds, sbs, wmm

Festuca thurberi Vasey **(3)** A, C; 8020–8280′; rcf, rsl, sbs

Glyceria borealis (Nash) Batch. **(4)** C; 8940–9120′; pnd, rcf

Glyceria elata (Nash ex Rydb.) M.E. Jones **(7)** A, C; 8070–9930′; fen, rcf, rsl

Glyceria grandis S. Watson **(9)** A, C; 7460–10240′; pnd, rcf, rsl, sfs

Glyceria striata (Lam.) Hitchc. **(18)** A, C; 7640–10540′; asf, ccb, pnd, rcf, rsl

Hesperostipa comata (Trin. & Rupr.) Barkworth var. *comata* **(11)** A, C; 7460–8700′; dmm, lpf, nmp, rsl, sbs

Hesperostipa comata (Trin. & Rupr.) Barkworth var. *intermedia* (Scribn. & Tweedy) Dorn **(7)** A, C; 7620–9450′; dmm, rsl, sbs

Hordeum brachyantherum Nevski **(13)** A, C; 8030–9760′; dmm, rsl, wmm

Hordeum jubatum L. ssp. *intermedium* Bowden **(1)** A; 9120–9370′; dmm

Hordeum jubatum L. ssp. *jubatum* **(4)** C; 8030–9300′; ccb, rds

Koeleria macrantha (Ledeb.) Schult. **(39)** A, C; 7460–9450′; asf, dlw, dmm, lpf, nmp, rcf, rsl, sbs, wmm

Leucopoa kingii (S. Watson) W. A. Weber **(33)** A, C; 7460–10280′; asf, dlw, dmm, lpf, nmp, rcf, rds, sbs, sfs

Melica bulbosa Geyer ex Porter & J.M. Coult. **(6)** A, C; 7880–10710′; asf, dmm, sbs, sfs
Melica spectabilis Scribn. **(2)** C; 8300–8910′; dmm, sbs
Melica subulata (Griseb.) Scribn. **(3)** C; 7890–8370′; asf, rcf
Muhlenbergia andina (Nutt.) Hitchc.; *B. Heidel 2698*; A; 9180′; fen
Muhlenbergia filiculmis Vasey **(2)** A, C; 8070–8570′; sbs
Muhlenbergia filiformis (Thurb. ex S. Watson) Rydb. **(4)** A, C; 8270–9030′; fen, rsl, wmm
Muhlenbergia richardsonis (Trin.) Rydb.; *C. Goodding 205*; A; 7600′; sbs
Oryzopsis asperifolia Michx. **(7)** A, C; 8230–8950′; dmm, lpf, rcf, wmm
Phalaris arundinacea L. **(1)** A; 7630′; rcf
Phleum alpinum L. var. *alpinum* **(53)** A, C; 7890–11750′; asf, ccb, dam, dmm, fen, lpf, mwa, pnd, rcf, rsl, sfs, wmm
* *Phleum pratense* L. var. *pratense* **(35)** A, C; 7460–9990′; asf, ccb, dmm, lpf, rcf, rds, rsl, sbs, sfs, wmm
Piptatherum exiguum (Thurb.) Dorn **(8)** A, C; 8220–9920′; dmm, lpf, rcf, sbs
Piptatherum micranthum (Trin. & Rupr.) Barkworth **(3)** A, C; 7460–8100′; dlw, ppw, sbs
Poa abbreviata R. Br. ssp. *pattersonii* (Vasey) Á. Löve, D. Löve, & B. M. Kapoor **(2)** A, C; 10620–11750′; dam, wmm
Poa alpina L. var. *alpina* **(19)** A, C; 8750–11750′; asf, dam, dmm, mwa, pnd, rsl, sfs, wmm
* *Poa annua* L. **(3)** A, C; 8820–9480′; rcf
Poa arctica R. Br. ssp. *arctica* **(2)** A, C; 9460–11750′; mwa, rcf
Poa arctica R. Br. ssp. *grayana* (Vasey) Á. Löve, D. Löve, & B. M. Kapoor **(3)** A; 9120–9910′; lpf, sfs, wmm
Poa arida Vasey **(19)** A, C; 7700–9760′; asf, ccb, dlw, dmm, sbs, wmm
* *Poa compressa* L. **(13)** A, C; 8120–10590′; asf, dmm, lpf, rsl, wmm
Poa cusickii Vasey ssp. *epilis* (Scribn.) W. A. Weber **(24)**; A, C; 9990–11580′; dam, dmm, mwa, pnd, sfs, wmm
Poa cusickii Vasey ssp. *pallida* Soreng **(8)** A, C; 7880–11580′; dam, dmm, mwa, pnd, ppw, sbs sfs, wmm
Poa fendleriana (Steud.) Vasey ssp. *fendleriana* **(4)** A, C; 7890–8680′; dmm, nmp, sbs
Poa fendleriana (Steud.) Vasey ssp. *longiligula* (Scribn. & T.A. Williams) Soreng **(25)** A, C; 7700–10590′; dlw, dmm, nmp, ppw, sbs
Poa glauca Vahl. var. *rupicola* (Nash ex Rydb.) B. Boivin **(9)** A, C; 8000–11580′; dam, dlw, dmm, ppw, sfs, wmm
Poa interior Rydb. **(23)** A, C; 7460–11090′; asf, ccb, dam, dlw, dmm, lpf, rcf, rds, rsl, sbs, sfs
Poa leptocoma Trin. **(17)** A, C; 8230–11750′; fen, mwa, pnd, rcf, rsl, sbs, sfs, wmm
Poa palustris L. **(30)** A, C; 7460–10710′; asf, ccb, dlw, dmm, lpf, rcf, rsl, sfs, wmm
Poa pratensis L. **(50)** A, C; 7460–9930′; asf, ccb, dlw, dmm, lpf, ppw, rcf, rds, rsl, sbs, sfs, wmm
Poa reflexa Vasey & Scribn. **(39)** A, C; 8030–11750′; dam, dmm, fen, lpf, mwa, pnd, rcf, sfs, wmm
Poa secunda J. Presl ssp. *juncifolia* (Scribn.) Soreng **(22)** A, C; 7700–9370′; asf, ccb, dlw, dmm, ppw, rcf, rsl, sbs, sfs, wmm
Poa secunda J. Presl ssp. *secunda* **(41)** A, C; 7460–10830′; asf, dam, dlw, dmm, lpf, nmp, rcf, rsl, sbs, sfs, wmm
* *Poa trivialis* L. **(12)** A, C; 7890–10970′; dlw, dmm, rcf, rds, rsl, sbs, wmm
Poa wheeleri Vasey **(59)** A, C; 7620–11090′; asf, ccb, dam, dlw, dmm, fen, lpf, mwa, pnd, rcf, rsl, sbs, sfs, wmm
Podagrostis humilis (Vasey) Björkman **(22)** A, C; 8790–11270′; dmm, fen, pnd, rcf, rsl, wmm
Schedonorus arundinaceus* (Schreb.) Dumort. **(2) C; 9300–9430′; ccb, rcf
Sporobolus cryptandrus (Torr.) A. Gray; *B. Hamel 534*; A; 8300′; among rocks above creek
Torreyochloa pallida (Torr.) G.L. Church var. *pauciflora* (J. Presl) J. I. Davis; *J. Haines 10377*; A; 10490′; wmm
Trisetum spicatum (L.) K. Richt. **(66)** A, C; 8030–11750′; asf, ccb, dam, dmm, fen, lpf, pnd, rcf, sfs, wmm
Trisetum wolfii Vasey **(13)** A, C; 8220–10500′; dmm, fen, pnd, rcf, rsl, sfs, wmm
Vahlodea atropurpurea (Wahlenb.) Fr. ex Hartm. **(3)** C; 9380–9730′; fen, wmm

Polemoniaceae

Aliciella pinnatifida (Nutt. ex A. Gray) J.M. Porter **(2)** A; 8270–8630′; dmm, rcf
Collomia linearis Nutt. **(22)** A, C; 7460–9910′; asf, ccb, dmm, rcf, rsl, sbs, sfs, wmm
Gilia tweedyi Rydb.; *Nelson 13388*; A; 7780′; rds
Ipomopsis aggregata (Pursh) V. E. Grant ssp. *aggregata* **(11)** A, C; 7460–8760′; dmm, lpf, sbs
Ipomopsis aggregata (Pursh) V. E. Grant ssp. *attenuata* (A. Gray) V. E. Grant & A. D. Grant **(5)** A, C; 7510–8750′; ppw, rds, rsl, sbs
Ipomopsis spicata (Nutt.) V. E. Grant var. *spicata* **(4)** A, C; 7880–9330′; dlw, sbs
♦ *Ipomopsis tenuituba* (Rydb.) V. E. Grant ssp. *tenuituba* **(3)** C; 8140–9220′; dmm, sbs
Leptosiphon septentrionalis (H. Mason) J.M. Porter & L. A. Johnson **(4)** A, C; 8300–9220′; lpf, rds, rsl, sbs
Linanthus pungens (Torr.) J.M. Porter & L. A. Johnson **(3)** A, C; 7700–8680′; sbs
Microsteris gracilis (Hook.) Greene var. *humilior* (Hook.) Cronquist **(3)** A, C; 8300–9450′; dlw, dmm, sbs
Phlox hoodii Richardson **(4)** A, C; 7880–8530′; dlw, nmp, sbs
Phlox multiflora A. Nelson ssp. *multiflora* **(21)** A, C; 7700–10590′; ccb, dlw, dmm, lpf, rsl, sbs, wmm
Phlox pulvinata (Wherry) Cronquist **(7)** A; 9890–11480′; dam, dmm, wmm
Polemonium brandegeei (A. Gray) Greene **(1)** A; 8000–8100′; dlw
Polemonium occidentale Greene var. *occidentale* **(4)** A, C; 8620–8970′; rsl, wmm
Polemonium viscosum Nutt. **(9)** A, C; 10620–11750′; dam, mwa, wmm

Polygonaceae

Bistorta bistortoides (Pursh) Small **(40)** A, C; 8220–11750′; dam, dmm, lpf, mwa, rsl, sbs, sfs, wmm
Bistorta vivipara (L.) Delarbre **(12)** A, C; 8220–11750′; dam, dmm, fen, mwa, rsl, wmm
Eriogonum alatum Torr. var. *alatum* **(6)** A, C; 7380–8750′; dmm, nmp, ppw, sbs
Eriogonum arcuatum Greene var. *arcuatum* **(1)** A; 8120–8520′; sbs
Eriogonum brevicaule Nutt. var. *brevicaule* **(1)** A; 7380–7400′; nmp
Eriogonum cernuum Nutt., **(1)** A; 7905′; sbs
♦ *Eriogonum exilifolium* Reveal; *B. Heidel 245*; A; 7800′; rds
Eriogonum flavum Nutt. var. *flavum* **(8)** A, C; 7380–9210′; dmm, nmp, sbs
Eriogonum microthecum Nutt. var. *effusum* (Nutt.) Torr. & A. Gray **(1)** A; 7380–7400′; nmp
Eriogonum ovalifolium Nutt. var. *purpureum* (Nutt.) T. Durand **(2)** C; 7880–10590′; dmm, sbs
Eriogonum umbellatum Torr. var. *aureum* (Gand.) Reveal **(11)** A, C; 7460–8760′; ccb, dlw, dmm, sbs
Eriogonum umbellatum Torr. var. *dichrocephalum* Gand. **(1)** C; 8930–9220′; sbs
Eriogonum umbellatum Torr. var. *majus* Hook. **(36)** A, C; 7460–9580′; asf, ccb, dlw, dmm, lpf, nmp, rsl, sbs, wmm
Eriogonum umbellatum Torr. var. *umbellatum* **(15)** A, C; 7640–9450′; dlw, dmm, lpf, nmp, sbs
Oxyria digyna (L.) Hill **(6)** A, C; 10550–11750′; dam, dmm

Persicaria amphibia (L.) Gray **(2)** C; 8940–9030′; pnd
Polygonum austiniae Greene **(1)** C; 10400–10500′; sfs
* *Polygonum aviculare* L. **(7)** A, C; 7640–9580′; ccb, dmm, lpf, sbs, wmm
Polygonum douglasii Greene **(17)** A, C; 7460–10500′; asf, ccb, dlw, dmm, rcf, sbs, wmm
Polygonum engelmannii Greene **(1)** C; 8030′; dmm
Polygonum polygaloides Meisn. ssp. *kelloggii* (Greene) J. C. Hickman **(1)** C; 8820–8830′; pnd
Polygonum polygaloides Meisn. var. *confertiflorum* (Nutt. ex Piper) J. C. Hickman **(4)** A, C; 8140–10710′; dmm, pnd, rds, wmm
Polygonium ramosissimum Michx.; *A. Nelson 9044*; A; 7580′; stream bank
Polygonum sawatchense Small ssp. *sawatchense*; *Nelson 13441*; C; 8000′; grassy sagebrush area
* *Rumex acetosella* L. **(11)** A, C; 7730–8970′; asf, ccb, dmm, pnd, sbs, wmm
* *Rumex crispus* L. **(7)** A, C; 8220–9580′; dmm, pnd, rsl, sbs
Rumex densiflorus Osterh. **(11)** A, C; 9250–10970′; dmm, mwa, rcf, rsl, wmm
Rumex fueginus Phil.; *C.L. Porter 5938*; C; 7800′; rsl
Rumex occidentalis S. Watson **(5)** A, C; 8740–9030′; dmm, pnd, rcf, wmm
Rumex paucifolius Nutt. **(2)** C; 8760–10020′; pnd, wmm
Rumex triangulivalvis (Danser) Rech. f. **(11)** A, C; 8370–10620′; dmm, lpf, rcf, rsl, wmm
Rumex utahensis Rech. f.; *J. Haines 9842;* A; 10590′; wmm

Portulacaceae

Cistanthe rosea (S. Watson) Hershkovitz **(1)** C; 7225–7320′; ppw
Claytonia lanceolata Pursh **(10)** A, C; 7880–10830′; dam, dmm, rcf, sbs, sfs, wmm
Claytonia megarhiza (A. Gray) Parry ex S. Watson; *E. Nelson 5240*; A
Lewisia pygmaea (A. Gray) B. L. Rob. **(31)** A, C; 7880–11580′; asf, dam, dmm, lpf, rcf, sbs, sfs, wmm
Lewisia rediviva Pursh var. *rediviva* **(9)** A, C; 7700–9220′; dmm, sbs
Lewisia triphylla (S. Watson) B. L. Rob.; *J. Haines 7502*; A; 10800′; sfs
Montia chamissoi (Ledeb. ex Spreng.) Greene **(16)** A, C; 7460–9930′; asf, dmm, rcf, rsl, sfs, wmm

Potamogetonaceae

Potamogeton alpinus Balb. **(1)** C; 9120′; wmm
Potamogeton epihydrus Raf. **(2)** C; 9020–9720′; pnd
♦ *Potamogeton friesii* Rupr.; *C.L. Porter 6636*; C; 8000′; pnd
Potamogeton gramineus L. **(1)** C; 9030′; pnd
Potamogeton natans L.; *C.L. Porter 6517*; C; 8000′; pnd
♦ *Potamogeton praelongus* Wulfen; *W. Fertig 19856;* A; 10700′; pnd
Potamogeton pusillus L. var. *pusillus*; *B. Heidel 2432*; C; 9590′; pnd
Potamogeton pusillus L. var. *tenuissimus* Mert. & W. D.J. Koch **(1)** C; 9625′; pnd
Potamogeton richardsonii (A. Benn.) Rydb. **(1)** C; 9630′; pnd
♦ *Potamogeton robbinsii* Oakes; *C.L. Porter 6812*; C; 10000′; pnd
Stuckenia filiformis (Pers.) Börner ssp. *alpina* (Blytt) R. R. Hayes, Les, & M. Král; *C.L. Porter 6189*; A; 10000′; pnd

Primulaceae

Androsace filiformis Retz. **(15)** A, C; 7460–10710′; asf, rcf, rsl, sbs, sfs, wmm
Androsace septentrionalis L. **(21)** A, C; 7620–11620′; asf, ccb, dam, dlw, dmm, ppw, rcf, sbs, sfs, wmm
Primula conjugens (Greene) A. R. Mast & Reveal var. *conjugens* **(7)** A, C; 8020–10280′; rcf, wmm
Primula incana M.E. Jones **(1)** A; 9130–9150′; rsl
Primula parryi A. Gray **(2)** A; 10620–11020′; wmm
Primula pauciflora (Greene) A. R. Mast & Reveal var. *pauciflora* **(15)** A, C; 7460–9910′; asf, dmm, rcf, rsl, sfs, wmm

Ranunculaceae

Aconitum columbianum Nutt. ssp. *columbianum* **(24)** A, C; 8020–9910′; asf, lpf, rcf, rsl, sfs, wmm
Actaea rubra (Aiton) Willd. **(10)** A, C; 7440–9450′; asf, rcf, rsl, sfs
Anemone multifida Poir. var. *multifida* **(14)** A, C; 7630–10280′; asf, rcf, rsl, sbs, sfs, wmm
Anemone parviflora Michx.; *M. Ownbey 867*; A; 10500′; rsl
Anemone patens L. var. *multifida* Pritz. **(17)** A, C; 7620–11750′; dam, dlw, dmm, ppw, sbs, sfs, wmm
Aquilegia coerulea E. James var. *coerulea* **(18)** A, C; 7460–11750′; asf, dam, dlw, dmm, lpf, rcf, sbs, sfs, wmm
Aquilegia coerulea E. James var. *ochroleuca* Hook. **(3)** A; 10620–11270′; dam, wmm
Caltha leptosepala DC. **(42)** A, C; 8220–11750′; fen, mwa, pnd, rcf, rsl, sfs, wmm
Clematis hirsutissima Pursh var. *hirsutissima* **(2)** A, C; 8020–8140′; sbs
Clematis ligusticifolia Nutt.; *Nelson 1916*; A; 7600′; rsl
Clematis occidentalis (Hornem.) DC. var. *grosseserrata* (Rydb.) J. S. Pringle **(12)** A, C; 7460–9450′; asf, dlw, ppw, rcf, sbs, sfs
Delphinium barbeyi (Huth) Huth **(6)** A, C; 8630–10590′; dmm, rcf, rsl, wmm
Delphinium geyeri Greene **(1)** A; 7740–7880′; ppw
Delphinium glaucum S. Watson **(7)** A, C; 7890–8970′; asf, dmm, rcf, sbs
Delphinium nuttallianum Pritz. **(22)** A, C; 7700–10710′; dmm, lpf, nmp, rsl, sbs, sfs, wmm
Ranunculus abortivus L. **(1)** C; 8630–11750′; mwa, rsl
Ranunculus acriformis A. Gray var. *acriformis* **(1)** A; 7630′; rsl
Ranunculus adoneus A. Gray **(1)** C; 10590′; wmm
Ranunculus alismifolius Geyer ex Benth. var. *montanus* S. Watson **(26)** A, C; 8030–11270′; dam, dmm, fen, lpf, mwa, rcf, rsl, sfs, wmm
Ranunculus aquatilis L. var. *diffusus* With. **(4)** A, C; 8210–8630′; pnd
Ranunculus cardiophyllus Hook. **(7)** A, C; 7860–9580′; rsl, wmm
Ranunculus cymbalaria Pursh; *R. Newton 951*; A; 7690′; rsl
Ranunculus eschscholtzii Schltdl. var. *eschscholtzii* **(13)** A, C; 9120–10710′; dmm, lpf, mwa, rcf, rds, rsl, sfs, wmm
Ranunculus flammula L. var. *ovalis* (J.M. Bigelow) L. D. Benson; **(8)** A, C; 8210–10240′; pnd, rcf
Ranunculus glaberrimus Hook. var. *ellipticus* (Greene) Greene **(5)** A, C; 8160–9810′; asf, ccb, fen, sbs, wmm
Ranunculus gmelinii DC.; *A. Nelson 8003*; A; 7900–8200′; pnd
Ranunculus inamoenus Greene var. *inamoenus* **(13)** A, C; 7860–10970′; dmm, lpf, rds, rsl, sbs, sfs, wmm
Ranunculus macounii Britton **(11)** A, C; 7460–8980′; asf, ccb, rcf, sfs, wmm
Ranunculus pedatifidus Sm. var. *affinis* (R. Br.) L. D. Benson **(1)** A; 9590–9910′; dmm
Ranunculus pygmaeus Wahlenb.; *W.C. Leavenworth 265*; A; 12000′
Ranunculus ranunculinus (Nutt.) Rydb. **(1)** A; 9330′; ppw
Ranunculus sceleratus L. var. *multifidus* Nutt. **(1)** A; 7905′; in a draw
Ranunculus uncinatus D. Don **(33)** A, C; 7460–9930′; asf, dmm, rcf, sfs, wmm
Thalictrum alpinum L. **(4)** A; 8930–9370′; fen, rsl
Thalictrum fendleri Engelm. ex A. Gray **(5)** A, C; 7860–9450′; rcf, sbs, wmm
Thalictrum occidentale A. Gray **(2)** C; 8610–8750′; sfs
Thalictrum sparsiflorum Turcz. ex Fisch. & C.A. Mey. **(8)** A, C; 8070–9210′; asf, rcf, wmm
Thalictrum venulosum Trel. **(4)** A, C; 8220–8760′; rcf, rsl, wmm
Trollius albiflorus (A. Gray) Rydb. **(40)** A, C; 8630–11750′; fen, lpf, mwa, pnd, rcf, rsl, sfs, wmm

Rhamnaceae

Ceanothus velutinus Douglas ex Hook. var. *velutinus* **(14)** A, C; 7880–8970'; asf, ccb, dlw, dmm, lpf, sbs, sfs

Rosaceae

* ! *Alchemilla filicaulis* Buser ssp. *filicaulis* **(1)** A; 8860–8890'; rcf

Amelanchier alnifolia (Nutt.) Nutt. ex M. Roem. var. *alnifolia* **(5)** A, C; 7460–8570'; asf, dmm, rcf, sbs

Amelanchier alnifolia (Nutt.) Nutt. ex M. Roem. var. *pumila* (Torr. & A. Gray) A. Nelson **(4)** A, C; 7700–9450'; dmm, rds, rsl, sbs

Amelanchier utahensis Koehne var. *utahensis* **(14)** A, C; 7730–8680'; asf, dlw, dmm, lpf, ppw, rds, sbs

Cercocarpus montanus Raf. var. *montanus* **(10)** A, C; 7440–9330'; dlw, ppw, sbs

Chamaerhodos erecta (L.) Bunge; *Hartman 24348*; A; 7800–7900'; rocky plains

Comarum palustre L. **(3)** C; 8820–9630'; pnd, wmm

Dasiphora fruticosa (L.) Rydb. **(29)** A, C; 7510–9580'; asf, dmm, fen, lpf, rcf, rsl, sbs, wmm

Drymocallis arguta (Pursh) Rydb. **(2)** A, C; 8020–8280'; rsl, sbs

Drymocallis convallaria (Rydb.) Rydb. **(1)** C; 8290'; sbs

Drymocallis fissa (Nutt.) Rydb. **(24)** A, C; 7700–9580'; ccb, dlw, dmm, lpf, nmp, ppw, rcf, rsl, sbs

Drymocallis glabrata Rydb. **(1)** C; 7460'; sbs

Drymocallis glandulosa (Lindl.) Rydb. var. *glandulosa* **(1)** C; 8950'

Drymocallis pseudorupestris (Rydb.) Rydb. var. *pseudorupestris* **(1)** C; 7620'; dlw

Fragaria vesca L. **(7)** A, C; 7620–9810'; dlw, fen, rcf

Fragaria virginiana Mill. **(55)** A, C; 7730–10280'; asf, ccb, dmm, fen, lpf, pnd, rcf, rsl, sbs, sfs, wmm

Geum aleppicum Jacq. **(3)** C; 7510–8950'; rcf, rsl, sbs

Geum macrophyllum Willd. var. *perincisum* (Rydb.) Raup **(43)** A, C; 7460–9910'; asf, fen, lpf, rcf, rsl, sfs, wmm

Geum rivale L. **(10)** A, C; 8030–9450'; fen, rcf, rsl, wmm

Geum rossii (R. Br.) Ser. var. *turbinatum* (Rydb.) C. L. Hitchc. **(13)** A, C; 10620–11750'; dam, dmm, rsl, wmm

Geum triflorum Pursh var. *ciliatum* (Pursh) Fassett **(19)** A, C; 7620–9910'; asf, dlw, dmm, rsl, sbs, wmm

Geum triflorum Pursh var. *triflorum* **(7)** A, C; 7460–9150'; dmm, lpf, rcf, rsl, sbs, sfs

Potentilla anserina L. **(1)** C; 8210'; rcf

Potentilla biennis Greene; *B. Hammel 733*; A; 7500'; rsl

Potentilla bipinnatifida Douglas ex Hook. var. *bipinnatifida*; *Nelson 13404*; A; 8160'; rds

Potentilla concinna Richardson var. *bicrenata* (Rydb.) S. L. Welsh & B. C. Johnst. **(1)** A; 8680'; sbs

Potentilla concinna Richardson var. *concinna* **(4)** A; 8080–9250'; ppw, sbs, wmm

Potentilla diversifolia Lehm. var. *diversifolia* **(41)** A, C; 8220–11750'; dam, dmm, fen, lpf, mwa, pnd, rcf, rsl, sfs, wmm

Potentilla gracilis Douglas ex Hook. var. *brunnescens* (Rydb.) C. L. Hitchc.; *H. Hughes H-33*; C; 9000'; dmm

Potentilla gracilis Douglas ex Hook. var. *elmeri* (Rydb.) Jeps. **(2)** A, C; 7510–7630'; rsl

Potentilla gracilis Douglas ex Hook. var. *fastigiata* (Nutt.) S. Watson **(18)** A, C; 7890–11180'; asf, dam, dmm, mwa, rcf, rds, rsl, sbs, wmm

Potentilla gracilis Douglas ex Hook. var. *pulcherrima* (Lehm.) Fernald **(32)** A, C; 7460–9580'; asf, ccb, dmm, lpf, rcf, rsl, sbs, sfs, wmm

Potentilla hippiana Lehm. var. *effusa* (Douglas ex Lehm.) Dorn **(17)** A, C; 7440–9580'; dmm, lpf, rsl, sbs

Potentilla hippiana Lehm. var. *hippiana* **(7)** A, C; 7460–9580'; dmm, lpf, nmp, sbs, sfs, wmm

Potentilla hookeriana Lehm.; *J. Haines 9325*; A; 10900'; dmm

Potentilla nivea L. var. *pentaphylla* Lehm. **(1)** A; 11270–11580'; dam

Potentilla norvegica L. ssp. *monspeliensis* (L.) Asch. & Graebn. **(3)** A, C; 8070–9400'; rcf, rsl

Potentilla ovina Macoun var. *decurrens* (S. Watson) S. L. Welsh & B. C. Johnst. **(2)** A, C; 9890–10590'; dmm

Potentilla ovina Macoun var. *ovina* **(2)** C; 7880–8480'; dlw, sbs

Potentilla rubricaulis Lehm. **(7)** A, C; 8220–11040'; dam, dmm, lpf, rcf, wmm

Prunus virginiana L. var. *melanocarpa* (A. Nelson) Sarg. **(22)** A, C; 7460–9450'; asf, dlw, dmm, lpf, rcf, rds, sbs, sfs, wmm

Purshia tridentata (Pursh) DC. **(27)** A, C; 7440–9450'; asf, dlw, dmm, nmp, ppw, rds, rsl, sbs

Rosa arkansana Porter var. *arkansana* **(3)** C; 7510–8750'; dlw, rsl

Rosa nutkana C. Presl var. *hispida* Fernald **(14)** A, C; 7890–9210'; asf, ccb, dmm, rcf, rds, rsl, sbs, sfs, wmm

Rosa sayi Schwein. **(36)** A, C; 7460–9760'; asf, ccb, dlw, dmm, lpf, ppw, rcf, rsl, sbs, sfs

Rosa woodsii Lindl. var. *ultramontana* (S. Watson) Jeps. **(3)** C; 8930–9220'; sbs

♦ *Rubus acaulis* Michx.; *K. Roche s.n.*; A; 9130'; lpf

Rubus idaeus L. var. *aculeatissimus* Regel & Tiling **(17)** A, C; 7460–10970'; asf, dmm, lpf, rcf, rds, rsl, sbs, sfs, wmm

Rubus idaeus L. var. *peramoenus* (Greene) Fernald **(5)** A, C; 7890–11090'; dam, rcf, rsl

Rubus parviflorus Nutt. var. *parviflorus* **(5)** C; 8020–8970'; lpf, rcf, sfs

Sibbaldia procumbens L. **(33)** A, C; 8580–11750'; dam, dmm, fen, lpf, mwa, pnd, sfs, wmm

Sorbus scopulina Greene **(1)** C; 8630'; rcf

Spiraea betulifolia Pall. var. *lucida* (Douglas ex Hook.) C. L. Hitchc. **(1)** C; 8940'; sfs

Rubiaceae

Galium bifolium S. Watson **(4)** C; 7730–10590'; asf, sbs, wmm

Galium boreale L. **(60)** A, C; 7460–9760'; asf, ccb, dlw, dmm, fen, pnd, ppw, rcf, rsl, sbs, sfs, wmm

Galium trifidum L. var. *subbiflorum* Wiegand **(19)** A, C; 8020–10710'; fen, pnd, rcf, rsl, sbs, wmm

Galium trifidum L. var. *trifidum*; *J. Haines 9780*; A; 10485': wmm

Galium triflorum Michx. **(13)** A, C; 7460–9070'; asf, rcf, rsl, sfs, wmm

Salicaceae

Populus angustifolia E. James **(6)** A, C; 7440–8400'; asf, rsl, sbs

Populus balsamifera L. var. *balsamifera* **(1)** C; 8560'; sbs

Populus tremuloides Michx. **(54)** A, C; 7460–9580'; asf, ccb, dlw, lpf, ppw, rcf, rsl, sbs, sfs, wmm

Salix arctica Pall. var. *petraea* (Andersson) Bebb **(1)** A; 10250–10540'; mwa

Salix bebbiana Sarg. **(4)** C; 7460–8570'; asf, rsl, sfs

Salix boothii Dorn **(11)** A, C; 7730–9630'; asf, fen, pnd, rcf, rsl, sbs, wmm

Salix brachycarpa Nutt. var. *brachycarpa* **(9)** A, C; 9140–11750'; mwa, rsl, wmm

♦ *Salix candida* Flüeggé ex Willd. **(1)** A; 9270'; fen

Salix cascadensis Cockerell **(1)** A; 11000–11270'; mwa

Salix discolor Muhl.; *R.D. Dorn 7109*; C; 8000'; rsl

Salix drummondiana Barratt ex Hook. **(11)** A, C; 7890–9710'; asf, rcf, wmm

Salix eriocephala Michx. var. *ligulifolia* (C. R. Ball) Dorn **(6)** A, C; 8710–9580'; asf, rcf, rsl, wmm

Salix eriocephala Michx. var. *watsonii* (Bebb) Dorn; *B. Heidel 2592*; A; 8950'; fen

Salix exigua Nutt. ssp. *exigua* **(10)** A, C; 7460–9130'; rcf, rsl, sfs, wmm

Salix geyeriana Andersson var. *geyeriana* **(16)** A, C; 7630–9300'; ccb, pnd, rsl, sbs, sfs, wmm

Salix glauca L. var. *villosa* Andersson **(12)** A, C; 9180–11750'; mwa, rsl, wmm

Salix lasiandra Benth. var. *caudata* (Nutt.) Sudw. **(11)** A, C; 7460–9450'; asf, rcf, rsl, sfs
Salix monticola Bebb **(2)** C; 9760'; wmm
Salix planifolia Pursh **(28)** A, C; 8820–11180'; fen, mwa, pnd, rcf, rsl, wmm
Salix reticulata L. var. *nana* Andersson; *A. Nelson 11599*; A; 10500'
Salix scouleriana Barratt ex Hook. **(7)** A, C; 8300–10240'; rcf, rsl, wmm
Salix wolfii Bebb var. *wolfii* **(14)** A, C; 8220–11040'; rcf, rsl, wmm

Santalaceae

Arceuthobium americanum Nutt. ex Engelm. **(9)** A, C; 8260–9300'; lpf, rcf,
Arceuthobium cyanocarpum (A. Nelson ex Rydb.) A. Nelson **(4)** A, C; 8000–8520'; dlw, sfs
Comandra umbellata (L.) Nutt. var. *pallida* (A. DC.) M.E. Jones **(10)** A, C; 7640–8750'; dmm, ppw, sbs

Sapindaceae

Acer glabrum Torr. var. *glabrum* **(17)** A, C; 7460–9330'; asf, dlw, ppw, rcf, sbs, sfs

Sarcobataceae

Sarcobatus vermiculatus (Hook.) Torr. **(1)** A; 8020'; rds

Saxifragaceae

Heuchera parvifolia Nutt. ex Torr. & A. Gray **(16)** A, C; 7460–10280'; dlw, dmm, lpf, nmp, ppw, sbs, sfs
Lithophragma glabrum Nutt. var. *ramulosum* (Suksd.) B. Boivin **(6)** A, C; 7880–10590'; lpf, sbs, wmm
Lithophragma parviflorum (Hook.) Nutt. ex Torr. & A. Gray **(3)** C; 7880–8030'; rsl, sbs
Mitella pentandra Hook. **(31)** A, C; 8030–10500'; asf, fen, pnd, rcf, rsl, sfs, wmm
Saxifraga cernua L.; *E. Nelson 5238*; A; 10500–11000'
Saxifraga flagellaris Willd. ex Sternb. var. *crandallii* (Gand.) Dorn; *R. D. Dorn 1474*; A; 11000'; rock ledge
Saxifraga occidentalis S. Watson; *B. Pieper 34*; A; 10870'; mwa
Saxifraga odontoloma Piper **(33)** A, C; 8030–11270'; fen, mwa, rcf, rsl, sfs, wmm
Saxifraga rhomboidea Greene **(19)** A, C; 7700–11180'; dam, dmm, lpf, mwa, rcf, sbs, sfs, wmm
Saxifraga rivularis L. var. *debilis* (Engelm. ex A. Gray) Dorn; *J. Haines 7717*; A; 10700'; mwa
♦ *Saxifraga serpyllifolia* Pursh var. *chrysantha* (A. Gray) W. A. Weber; *W. Fertig 14260*; C; 11640'; dam

Scrophulariaceae

Scrophularia lanceolata Pursh; *Nelson 765*; C; 7800'; rds
* *Verbascum thapsus* L. **(1)** A; 7905'; sbs

Solanaceae

Solanum triflorum Nutt.; **(1)** A; 7905'; sbs

Typhaceae

Sparganium angustifolium Michx. **(3)** A, C; 9630–10240'; pnd
Sparganium emersum Rehmann; *K. Costello s.n.*; A; 9000'; pnd
♦ *Sparganium natans* L. **(2)** C; 9020–9120'; pnd, wmm

Urticaceae

Parietaria pensylvanica Muhl. ex Willd.; *Nelson 13443*; C; 8100'; base of cliff
Urtica dioica L. var. *procera* (Muhl. ex Willd.) Wedd. **(6)** A, C; 7460–9450'; asf, ccb, rcf, sbs

Verbenaceae

Verbena bracteata Lag. & Rodr. **(1)** A; 7905'; sbs
Verbena stricta Vent.; *Nelson 1913*; A; 8000'; rds

Violaceae

Viola adunca Sm. var. *adunca* **(36)** A, C; 7460–10970'; asf, dam, dmm, fen, lpf, rcf, rsl, sbs, sfs, wmm
Viola canadensis L. **(2)** C; 7460–7730'; asf, sfs
Viola macloskeyi Lloyd var. *pallens* (Banks ex DC.) C. L. Hitchc. **(12)** A, C; 8070–10710'; dmm, fen, rcf, rsl, sfs, wmm
Viola nephrophylla Greene; **(1)** A; 7860'; wmm
Viola nuttallii Pursh **(4)** A; 8070–10620'; dlw, sbs, wmm
Viola palustris L. **(2)** C; 8950–9300'; rcf
Viola praemorsa Douglas ex Lindl. **(2)** C; 8160–8300'; rcf, sbs
Viola vallicola A. Nelson **(7)** A, C; 7640–10710'; ccb, sbs, sfs, wmm

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ANNOUNCEMENTS

2012 DELZIE DEMAREE TRAVEL AWARD RECIPIENTS

The 24th Annual Delzie Demaree Travel Award was presented at the 57th Annual Systematics Symposium (13–14 Oct. 2012) at the Missouri Botanical Garden, St. Louis. One student was presented the Travel Award: **Elizabeth Georgian,** University of Wisconsin-Madison.

The 2012 Travel Award was underwritten by **1)** Delzie Demaree Travel Award Endowment, and **2)** Members of the Delzie Demaree Travel Award Committee.

Anyone interested in making a contribution to Delzie Demaree Endowment Fund, which supports the travel award, may make contributions by VISA or MasterCard or by a check, payable to Botanical Research Institute of Texas, to Barney Lipscomb, 1700 University Drive, Fort Worth, TX 76107-3400, U.S.A. 1-817-332-7432; Email: barney@brit.org. Thank you.

THE 2013 APPLICATIONS FOR THE DELZIE DEMAREE TRAVEL AWARD

Applications for the 2013 Delzie Demaree Travel Award should include a letter from the applicant telling how symposium attendance will benefit his/her graduate work and letter of recommendation sent by the major professor. Please send letters of application to: Dr. Donna M.E. Ware, P.O. Box 8795, Herbarium, Biology Department, The College of William and Mary, Williamsburg, VA 23185-8795, U.S.A. 1-757-221-2799; Email: ddmware@wm.edu. Applications may be sent to: Barney Lipscomb, 1700 University Drive, Fort Worth, TX 76107-3400, U.S.A. 1-817-332-7432; Email: barney@brit.org. The period for receiving applications will end three weeks prior to the date of the symposium if a sufficient number of applications are in hand at that time. Anyone wishing to apply after that date should inquire whether applications are still being accepted before applying. The Systematics Symposium dates for 2013 are 11–12 October 2013.

The Delzie Demaree Travel Award was established in 1988 honoring **Delzie Demaree** who attended 35 out of a possible 36 symposia before he died in 1987. Delzie Demaree was a frontier botanist, explorer, discoverer, and teacher. His teaching career as a botanist began in Arkansas at Hendrix College in 1922. He also taught botany at the University of Arkansas, Navajo Indian School, Yale School of Forestry, Arkansas A&M, and Arkansas State University at Jonesboro where he retired as professor emeritus in 1953. One of the things he enjoyed most as a botanist was assisting students with their field botany research.

J. Bot. Res. Inst. Texas 6(2): 788. 2012

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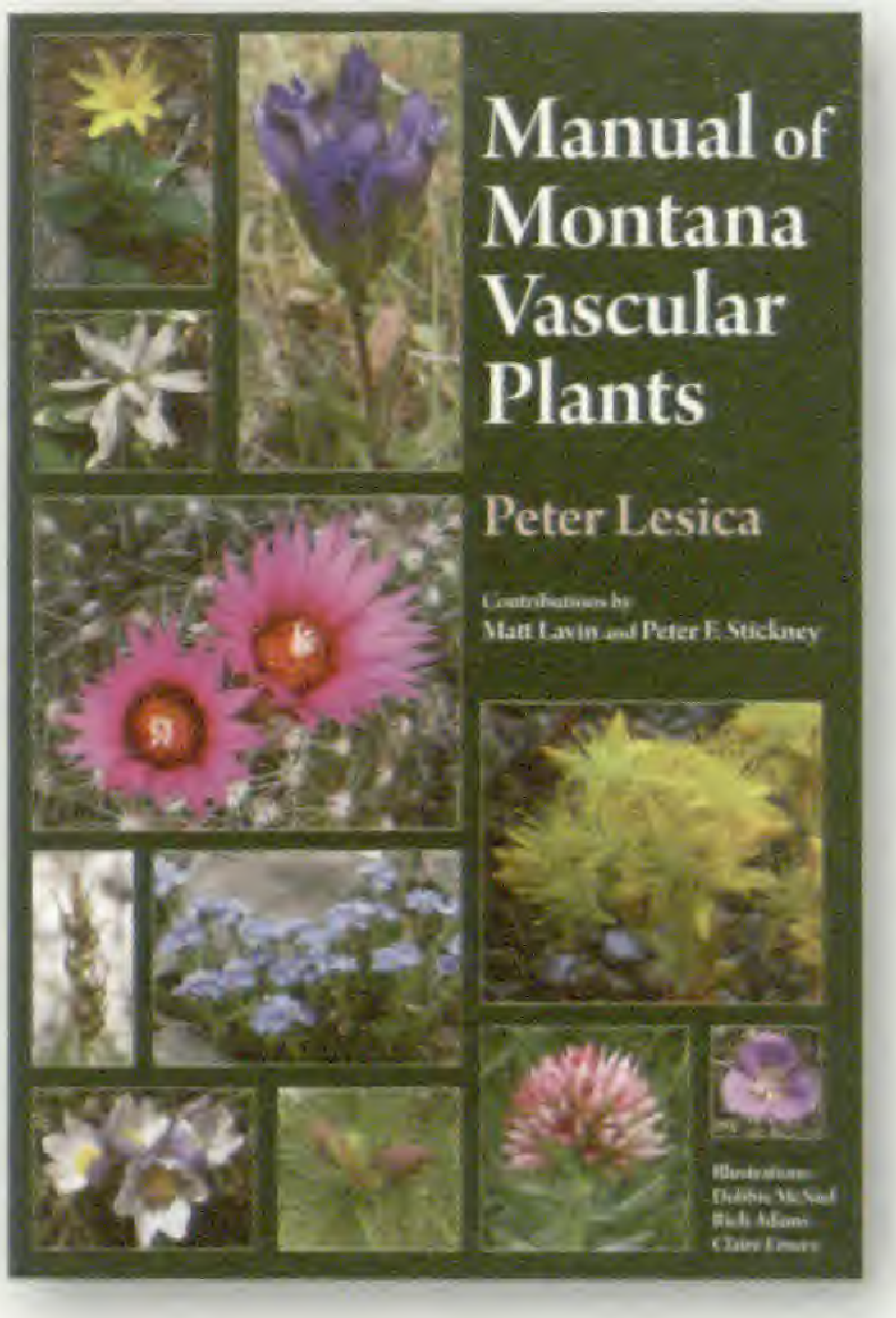

Manual of Montana Vascular Plants
June 30, 2012

Montana is the fourth largest state in the United States. It includes portions of the Northern Great Plains and the Rocky Mountains. The vegetation of Montana is diverse, due primarily to the size of the state and its great topographic relief which provide strong variation in environmental factors. Montana has a relatively large flora for a northern continental region due to being at the intersection of the Cordilleran, Great Plains and Boreal floristic provinces. This book is a comprehensive field guide to the more than 2,500 species of Montana's vascular plants. It contains descriptions as well as habitat and distribution information based on specimens housed at the state's two major herbaria. Portraits or illustrations of diagnostic structures are provided for nearly one-third of the species.

Lesica, P., with contributions by M. Lavin and P.F. Stickney. Illustrations by Debbie McNiel, Rich Adams, Claire Emery. 2012. *Manual of Montana Vascular Plants*. (ISBN-13: 978-1-889878-39-3, pbk.). Botanical Research Institute of Texas Press, 1700 University Dr., Fort Worth, Texas 76107-3400, U.S.A. (Orders: orders@brit.org, 817-332-4441 ext. 232, fax 817-332-4112, http://www.brit.org/brit-press/books/montana). $50.00, 6.5"×9.5" (pbk), 779 pp., 2000 + maps + 128 plates. $6.00 shipping ($3.00 each additional copy), Outside the U.S.A. contact orders@brit.org, Texas residents add 8.25% to subtotal including postage.

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Foundation of the Flora of Virginia Project Inc. and Botanical Research Institute of Texas Press are collaborating to publish the *Flora of Virginia*.

The *Flora of Virginia*, with publication targeted for December 2012, will describe approximately 3,200 taxa in 200 families and feature 1,400 captioned, scaled, and botanically accurate illustrations. Introductory material will include essays on the natural history and vegetation of Virginia and a historical account of botanical exploration in the state, as well as a key to the vascular plant families represented in the Flora. A glossary, bibliography, and comprehensive index will also be provided.

Weakley, A.S., Ludwig, J.C., and Townsend, J.F. 2012. *Flora of Virginia*. (ISBN-13: 978-1-889878-38-6, hbk.). Botanical Research Institute of Texas Press, 1700 University Dr., Fort Worth, Texas 76107-3400, U.S.A. (Orders: orders@brit.org, 817-332-4441 ext. 232, fax 817-332-4112, http://www.brit.org/brit-press/books/virginia). $79.99, 7.5"×10.5" (hbk), 1500+pp., 1400 b/w figures. $6.50 shipping ($3.00 each additional copy), Outside the U.S.A. contact orders@brit.org, Texas residents add 8.25% to subtotal including postage.

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