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SUBMERSION OF *DUGALDIA* AND *PLUMMERA* IN *HYMENOXYS* (ASTERACEAE: HELIANTHEAE: GAILLARDIINAE)

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ABSTRACT

Dugaldia Cass. and *Plummera* A. Gray are herein recognized as subgenera of *Hymenoxys* Cass. Morphologic, cytologic, and chemical data are all consistent with this treatment. The appropriate new combinations and a new name are presented.

RESUMEN

Se reconocen *Dugaldia* Cass. y *Plummera* A. Gray como subgeneros de *Hymenoxys* Cass. Los datos morfolóicos, citológicos y químicos son consistentes con este tratamiento. Se presentan combinacions nuevas y un nombre nuevo.

INTRODUCTION

Generic level taxonomy in subtribe Gaillardiinae has long been problematic. Depending on which taxa are included in or excluded from the subtribe and how the included taxa are delimited into genera, subtribe Gaillardiinae might contain as few as two genera (*Gaillardia* Foug. and *Helenium* L.) or more than 25 genera.

With regard to *Dugaldia* Cass. and *Plummera* A. Gray, questions have arisen as to whether they should continue to be recognized as genera or submerged within *Hymenoxys* Cass. When I resurrected *Dugaldia* (Bierner 1974), those taxa were being treated as congeneric with *Helenium* by most workers (e.g., Gray 1874; Standley 1940). It has been clear for some time, however, not only that they are morphologically and chemically very different from taxa in *Helenium*, but that they are morphologically and chemically very similar to taxa in *Hymenoxys* (e.g., Bierner 1978). Likewise, the taxa included in *Plummera* have been recognized for quite some time as being very similar to taxa in *Hymenoxys* (Bierner 1978), and it had even been suggested earlier (Turner et al. 1973) that *Plummera* be combined with *Hymenoxys*.

Consideration of these questions in light of recent micromolecular chemical studies (Spring et al. 1994) and chloroplast DNA restriction site analyses (Bierner and Jansen unpublished) has led me to the conclusion that indeed *Dugaldia* and *Plummera* should be combined with *Hymenoxys* and

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recognized as subgenera. For purposes of this discussion, *Hymenoxys* is considered to include taxa that at times have been segregated into the genera *Macdougalia* A. Heller, *Phileozera* Buckley, *Picradenia* Hook., and *Rydbergia* Greene, but not taxa that can be segregated as *Tetraneuris* Greene (see Table 1).

DISCUSSION

Morphology

The taxa of *Dugaldia* are similar morphologically to *Hymenoxys brandegei* (Porter ex A. Gray) K.L. Parker, *H. grandiflora* (Torr. & A. Gray) K.L. Parker, and *H. insignis* (A. Gray ex S. Watson) Cockerell, which are members of *Hymenoxys* subgenus *Rydbergia* (Table 1). In particular, the involucral bracts of these taxa are organized into two to four subequal series, and the outer bracts are usually densely lanate toward their bases. The leaves of the *Dugaldia* taxa tend to be entire, while those of the *Hymenoxys* taxa tend to be divided; however, *Dugaldia integrifolia* (Kunth) Cass. often has upper and middle leaves that are deeply three-toothed, and *Hymenoxys brandegei* sometimes has all of its leaves entire.

The *Plummera* taxa are very similar morphologically to taxa in several of the *Hymenoxys* subgenera (Table 1). These similarities include involucral bracts that are in two unequal series with the outer bracts united, and leaves that are divided into linear segments. The disc florets of *Hymenoxys* and *Dugaldia*, however, are hermaphroditic, while those of *Plummera* are functionally staminate.

Cytology

Except for reports of dysploidy in *Hymenoxys odorata* DC. (e.g., Sanderson and Strother 1973) and *H. texana* (J.M. Coult. & Rose) Cockerell (Strother and Brown 1988) of subgenus *Phileozera*, the taxa of *Hymenoxys*, *Dugaldia*, and *Plummera* consistently have the same chromosome number, $n = 15$ (e.g., Beaman and Turner 1962; Bierner 1974; Sanderson 1973; Speese and Baldwin 1952; Strother 1966; Turner et al. 1973; Table 1). No polyploidy has been reported in any of these taxa, but polyploidy has been reported in some taxa of *Tetraneuris* (Johnston and Bonde 1969; Parker 1970; Speese and Baldwin 1952; Strother 1966, 1972).

Flavonoid, Monoterpene, and Sesquiterpene Lactone Chemistry

Hymenoxys, *Dugaldia*, and *Plummera* are extremely similar chemically (Table 1). All of them produce similar or identical 6-methoxy flavone aglycones, flavonol aglycones, flavonol glycosides, and 3-*O*-acetyl flavonol glycosides (Bierner 1974, 1978, 1994, unpublished; Sanderson 1975; Wagner et al. 1971, 1972a, 1972b). Taxa of *Tetraneuris*, however, have been found to produce 6, 8-dimethoxy flavone aglycones rather than 6-methoxy

TABLE 1. Comparison of *Dugaldia* and *Plummera* with *Hymenoxys* and *Tetraneuris*.

TAXON	MORPHOLOGY	CYTOLOGY	FLAVONOIDS AND MONOTERPENES	SESQUITERPENE LACTONES
Hymenoxys subg. *Hymenoxys*	Annuals Bracts in 2 unequal series Outer bracts united Outer bracts not lanate Plants caulescent Leaves dissected Disc flowers hermaphroditic	$n = 15$	6-Methoxy flavone aglycones Flavonol aglycones Flavonol glycosides Flavonol 3-*O*-acetyl glycosides	Guaianolides Pseudoguaianolides Seco-pseudoguaianolides
Hymenoxys subg. *Phileozera**	Annuals Bracts in 2 unequal series Outer bracts united Outer bracts not lanate Plants caulescent Leaves dissected or entire to toothed (*H. texana*) Disc flowers hermaphroditic	$n = 3, 8, 11, 12, 14, 15$	6-Methoxy flavone aglycones Flavonol aglycones Flavonol glycosides Flavonol 3-*O*-acetyl glycosides Monoterpene glycosides present only in *H. texana*	Guaianolides Pseudoguaianolides Seco-pseudoguaianolides present or absent (*H. texana*)
Hymenoxys subg. *Picradenia*	Biennials and perennials Bracts in 2 unequal series Outer bracts united Outer bracts not lanate Plants caulescent Leaves dissected Disc flowers hermaphroditic	$n = 15$	6-Methoxy flavone aglycones Flavonol aglycones Flavonol glycosides Flavonol 3-*O*-acetyl glycosides	Guaianolides Pseudoguaianolides Seco-pseudoguaianolides
Hymenoxys subg. *Macdougalia*	Perennial Bracts in 2 unequal series Outer bracts free Outer bracts lanate Plants caulescent Leaves entire Disc flowers hermaphroditic	$n = 15$	6-Methoxy flavone aglycones Flavonol aglycones Flavonol glycosides Flavonol 3-*O*-acetyl glycosides	Guaianolides Pseudoguaianolides Seco-pseudoguaianolides

Table 1. Comparison of *Dugaldia* and *Plummera* with *Hymenoxys* and *Tetraneuris*. *(continued)*

TAXON	MORPHOLOGY	CYTOLOGY	FLAVONOIDS AND MONOTERPENES	SESQUITERPENE LACTONES
Hymenoxys subg. *Rydbergia*	Perennials Bracts in 3 subequal series Outer bracts free Outer bracts lanate Plants caulescent Leaves usually dissected Disc flowers hermaphroditic	$n = 15$	6-Methoxy flavone aglycones Flavonol aglycones Flavonol glycosides Flavonol 3-*O*-acetyl glycosides	Guaianolides Pseudoguaianolides Seco-pseudoguaianolides
Dugaldia	Perennials Bracts in 2 to 4 subequal series Outer bracts free or united Outer bracts lanate Plants caulescent Leaves usually entire Disc flowers hermaphroditic	$n = 15$	6-Methoxy flavone aglycones Flavonol aglycones Flavonol glycosides Flavonol 3-*O*-acetyl glycosides	Guaianolides Pseudoguaianolides Seco-pseudoguaianolides
Plummera	Perennials Bracts in 2 unequal series Outer bracts united Outer bracts not lanate Plants caulescent Leaves dissected Disc flowers staminate	$n = 15$	6-Methoxy flavone aglycones Flavonol aglycones Flavonol glycosides Flavonol 3-*O*-acetyl glycosides	Guaianolides Pseudoguaianolides Seco-pseudoguaianolides
Tetraneuris	Annuals and perennials Bracts in 2 subequal series Outer bracts free Outer bracts not lanate Plants caulescent or acaulescent Leaves usually entire Disc flowers hermaphroditic	$n = 14, 15, 28, 30, 45$	6, 8-dimethoxy flavone aglycones Flavonol aglycones Flavonol glycosides Monoterpene glycosides	Guaianolides Pseudoguaianolides

**Hymenoxys texana* is tentatively placed in subgenus *Phileozera* with *H. odorata* and *H. chrysanthemoides*, mainly on the basis of its annual habit. However, it is anomalous in this group with regard to its leaves (entire to toothed), chromosome number ($n = 3$ and 8), and chemistry (monoterpene glycosides present and seco-pseudoguaianolides absent). It has not been examined for flavonoids.

flavone aglycones (Bierner unpublished; Thomas and Mabry 1967, 1968a, 1968b), and none has been found to produce 3-*O*-acetyl flavonol glycosides.

With the exception of *Hymenoxys texana* (tentatively placed in subgenus *Phileozera*), monoterpene glycosides have not be detected in *Hymenoxys*, *Dugaldia*, or *Plummera* (Spring et al. 1994). Monoterpene glycosides have been found, however, in all of the *Tetraneuris* taxa (Spring et al. 1994).

Hymenoxys (except for *H. texana*), *Dugaldia*, and *Plummera* all produce similar or identical guaianolides, pseudoguaianolides, and seco-pseudoguaianolides (Bohlmann et al. 1985; Hill et al. 1977; Ivie et al. 1976; Romo de Vivar et al. 1987; Seaman 1982; Spring et al. 1994). *Tetraneuris* taxa again are somewhat different; they produce guaianolides and pseudoguaianolides, but seco-pseudoguaianolides have not yet been found (Seaman 1982; Spring et al. 1994).

Chloroplast DNA

Recently, I worked with Robert K. Jansen at the University of Texas at Austin on chloroplast DNA restriction site analyses of many of these taxa (this work is being prepared for separate publication). Subgenera *Hymenoxys* and *Rydbergia* were not represented, but one species of *Dugaldia* (*D. hoopesii* [A. Gray] Rydb.) and both species of *Plummera* were included. In the phylogenetic analysis of the data, the *Dugaldia* and *Plummera* taxa were very strongly supported as being in the same branch of the chloroplast DNA phylogenetic tree with the taxa of *Hymenoxys* subgenera *Macdougalia*, *Phileozera*, and *Picradenia*, while the taxa of *Tetraneuris* were separated with strong confidence into a separate branch.

TAXONOMY

Hymenoxys Cass., Dict. Sci. Nat. 55:278. 1828. TYPE SPECIES: *Hymenopappus anthemoides* Juss., Ann. Mus. Natl. Hist. Nat. [Paris] 2:426. 1803.

Hymenoxys subgenus **Dugaldia** (Cass.) Bierner, stat. nov. BASIONYM: Dugaldia Cass., Dict. Sci. Nat. 55:270. 1828. TYPE SPECIES: *Actinea integrifolia* Kunth.

Oxylepis Benth., Pl. Hartw. 87. 1841. TYPE SPECIES: *Oxylepis lanata* Benth.

Hymenoxys integrifolia (Kunth) Bierner, comb. nov. BASIONYM: *Actinea integrifolia* Kunth, Nov. Gen. et Sp. 4:297. t. 410. 1820. *Dugaldia integrifolia* (Kunth) Cass., Dict. Sci. Nat. 55:270. 1828. *Cephalophora integrifolia* (Kunth) Steud., Nom. ed. 2. 1(3):328. 1840. *Helenium integrifolia* [sic] (Kunth) Benth. & Hook. ex Hemsl., Biol. Centr. Amer. Bot. 2:227. 1881. *Heleniastrum integrifolium* (Kunth) Kuntze, Revis. Gen. Pl. 1:342. 1891. TYPE: MÉXICO. HIDALGO: "...inter Omitlán et Serro del Jacal, alt. 1400 hex." *Humboldt & Bonpland s.n.* (HOLOTYPE: P!).

Oxylepis lanata Benth., Pl. Hartw. 87. 1841. *Helenium lanatum* (Benth.) A. Gray, Proc. Amer. Acad. Arts 9:205. 1874. TYPE: GUATEMALA: "In summo monte Cumbre de Argueta dicto," *Hartweg 593* (HOLOTYPE: K!; ISOTYPE: P!).

Hymenoxys hoopesii (A. Gray) Bierner, comb. nov. BASIONYM: *Helenium hoopesii* A. Gray, Proc. Acad. Nat. Sci. Philadelphia 1863:65. 1864. *Heleniastrum hoopesii* (A. Gray) Kuntze, Revis. Gen. Pl. 1:342. 1891. *Dugaldia hoopesii* (A. Gray) Rydb., Mem. New York Bot. Gard. 1:425. 1900. TYPE: UNITED STATES. COLORADO: "South Park and west of Pike's Peak," *Hall & Harbour 272* (HOLOTYPE: GH!; ISOTYPES: MO!, NY!, PH!).

Hymenoxys pinetorum (Standl.) Bierner, comb. nov. BASIONYM: *Helenium pinetorum* Standl., Field Mus. Pub. Bot. 22:127. 1940. *Dugaldia pinetorum* (Standl.) Bierner, Brittonia 26:391. 1974. TYPE: MÉXICO. NUEVO LEÓN: "Sierra Madre Oriental, ascent of Sierra Potosí by north hogback, about 20 mi NE of Galeana, abundant in upper pine forest, alt. 3390 meters." 26 Jul 1934, *C.H. & M.T. Mueller 1258* (HOLOTYPE: F!).

The species of *Hymenoxys* subgenus *Dugaldia* are well defined and have already been treated taxonomically (Bierner 1974).

Hymenoxys subgenus **Plummera** (A. Gray) Bierner, stat. nov. BASIONYM: *Plummera* A. Gray, Proc. Amer. Acad. Arts 17:215. 1882. TYPE SPECIES: *Plummera floribunda* A. Gray.

Hymenoxys microcephala Bierner, nom. nov. BASIONYM: *Plummera floribunda* A. Gray, Proc. Amer. Acad. Arts 17:215. 1882. non *Hymenoxys floribunda* (A. Gray) Cockerell, Bull. Torrey Bot. Club 31:485. 1904. TYPE: UNITED STATES. ARIZONA: Cochise Co.: "Apache Pass, Chirricahua [sic] Mountains," Sep 1881, *Lemmon & Lemmon 352* (HOLOTYPE: GH!; ISOTYPES: BM!, F-207616!, GH!, K [photo at F-1645644!], NDG-061757!, PH-two sheets!, US-47542!; PROBABLE ISOTYPES: F-313722!, MO-3726424!, NDG-061758!, NY!).

Hymenoxys ambigens (S.F. Blake) Bierner, comb. nov. BASIONYM: *Plummera ambigens* S.F. Blake, J. Wash. Acad. Sci. 19:276. 1929. TYPE: UNITED STATES. ARIZONA: Graham Co.: "Fairly common on lower slopes of Mt. Graham, ca. 1370 m, 22 Jul 1927, *Peebles, Harrison & Kearney 4395* (HOLOTYPE: US-1436073!, photo at NMC!; ISOTYPE: GH!).

The two taxa of *Hymenoxys* subgenus *Plummera* could be treated as varieties of a single species, as suggested by Turner et al. (1973). I agree that morphologic differences between the two are slight, but the taxa appear to be geographically isolated from one another without a zone of contact and intergradation. Furthermore, Spring et al. (1994) found several differences between them with regard to sesquiterpene lactone substituents and side chains. For now, the conservative approach of continuing to recognize them as distinct species seems more appropriate.

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BULBIFEROUS *ACONITUM* (RANUNCULACEAE) OF THE WESTERN UNITED STATES

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ABSTRACT

Aconitum columbianum Nutt. is a large and morphologically variable complex of populations extending from southern Canada to northern Mexico, and from California to New York. Bulbiferous populations have a restricted distribution, occurring in the Cascade Range from northern to southern Oregon, in the Klamath Mountains of northern California, and with a small, disjunct group in the California Sierra Nevada south of Lake Tahoe. These bulbiferous aconites are probably the most distinctive group within the *A. columbianum* complex, and they are treated herein as a subspecies.

RESUMEN

Aconitum columbianum Nutt. es un complejo grande y variable morfológicamente de poblaciones que se extienden desde el sur de Canadá hasta el norte de México, y desde California hasta Nueva York. Las poblaciones bulbíferas tienen una distribución restringida, encontrándose en la Cordillera de la Cascada desde el norte al sur de Oregón, en las Montañas Klamath del norte de California, y un pequeño grupo disyunto en al sur del Lago Tahoe en la Sierra Nevada de California. Estos acónitos bulbíferos son probablemente el grupo más distintivo dentro del complejo A. columbinum, y aquí son tratados como una subespecie.

KEY WORDS: *Aconitum columbianum*, bulbifery, taxonomy, distribution.

INTRODUCTION

Aconitum columbianum Nutt. is a polymorphic complex of populations occurring in the mountains of western North America from British Columbia, Canada to Chihuahua, Mexico and from California to South Dakota. Disjunct, outlying populations of *A. columbianum* occur also in the Driftless area of Iowa and Wisconsin (Brink 1982), and in Ohio and New York (Brink & Woods submitted for publication; Iltis 1965). Previous investigations indicated extreme differences among regional groups of populations, particularly in floral morphology and other correlated characters. This variation was continuous, however, with no clearly defined breaks, if populations throughout the range of the species were considered in aggregate (Brink

1975, 1980, 1981, 1982; Brink & deWet 1980). Bulbiferous populations were somewhat different in this regard since they appeared to be consistently distinct from all other *A. columbianum*. The purpose of this investigation was to determine the geographical distribution of these bulbiferous aconites, and to review the taxonomy of this group.

MATERIALS AND METHODS

Aconitum populations of the United States were compared in field, herbarium, laboratory, and uniform nursery investigations. Geographical distribution of bulbiferous populations was determined by field investigation and by mapping locations from herbarium specimens (CAS, CHSC, CLM, ILL, JEPS, OSC, RM, UC, US, UTC, WILLU, WS). *Aconitum* plants from bulbiferous and non-bulbiferous populations were transplanted and grown in growth chambers and greenhouses to study bulbil production under controlled conditions.

RESULTS

In field investigations we found no intergradation between bulbiferous and non-bulbiferous *Aconitum columbianum* (however, see Hitchcock et al. 1964; Abrams 1944). The populations that we have seen were either bulbiferous, with all plants of sufficient size and maturity producing conspicuous bulbils in the leaf axils, or they were completely non-bulbiferous with no bulbil producing plants. In growth chambers and greenhouses, only plants from bulbiferous populations produced bulbils. Bulbils were illustrated in Brink (1980) and Hickman (1993).

Bulbils are an effective means of vegetative reproduction. In natural populations they fall to the ground late in the season where they sprout vigorously, giving rise to new plants. A single leaf axil may produce one or more bulbils. Bulbil production usually is greatest at about the middle of the aerial stem, and diminishes toward the top and bottom of the plant. Most bulbiferous plants bear both bulbils and flowers. On a small percentage of plants, however, bulbifery completely supplants flower production, and bulbils are produced to near the apex of the terminal inflorescence, in place of flowers. A more in-depth description of bulbifery can be found in Brink (1975). Bulbil production should not be confused with the production of one to several small daughter tubers at the first few nodes above the parent tuber, usually below ground. This occurs on a small percentage of the plants in all bulbiferous and non-bulbiferous populations.

Bulbiferous *Aconitum columbianum* have a restricted distribution (Fig. 1), with one group of populations occurring in the Sierra Nevada mountains of California south of Lake Tahoe in El Dorado, Amador and Alpine counties;

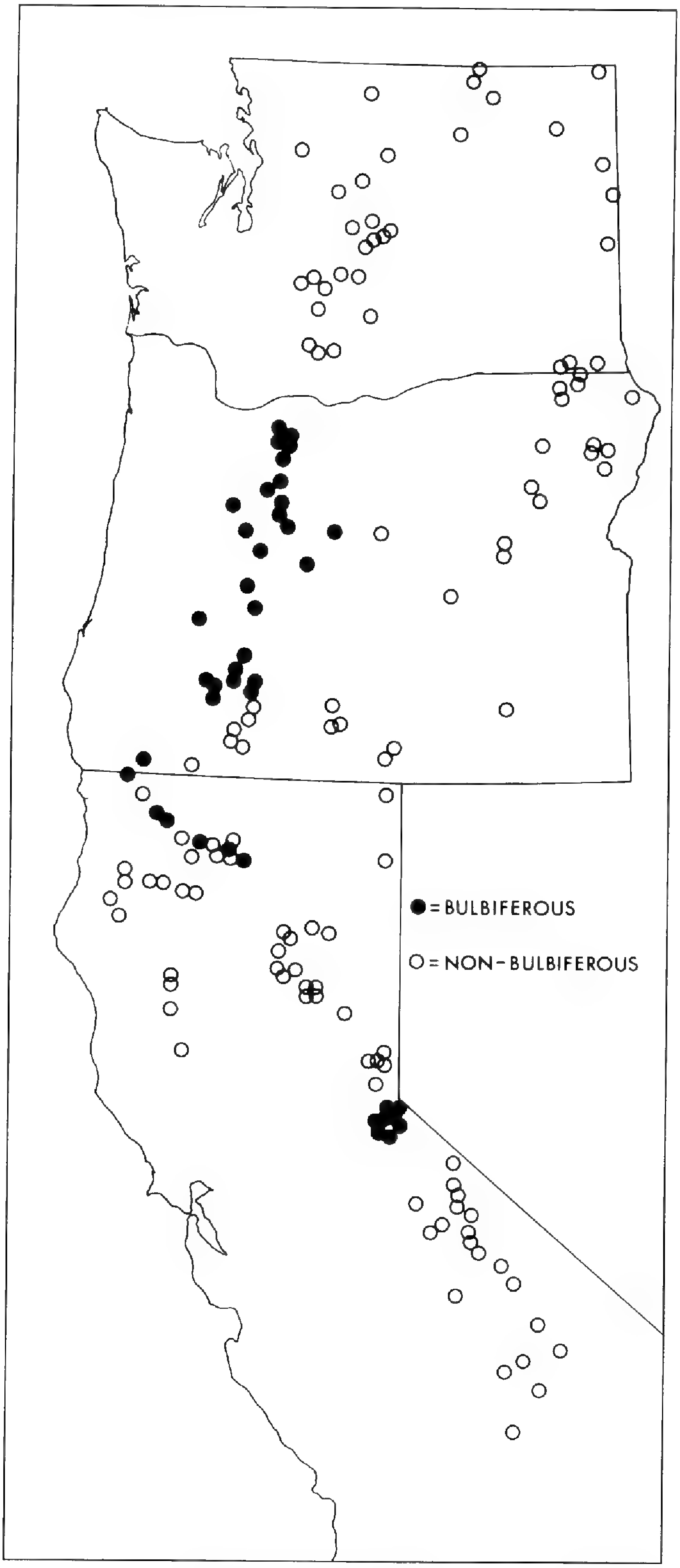

FIG. 1. Distribution of bulbiferous *Aconitum columbianum*.

and another group beginning ca. 350 miles away in northern California in the Klamath Mountains of Siskiyou and Del Norte counties. Bulbiferous populations extend from southern to northern Oregon in the Cascade range in Josephine, Jackson, Klamath, Douglas, Lane, Deschutes, Linn, Jefferson, Marion, Clackamas, Wasco, and Hood River counties.

Munz and Keck (1968) were uncertain whether the two disjunct groups of bulbiferous *Aconitum* in California (Fig. 1) should be treated as separate taxa. We can discern no consistent morphological features separating these two groups (Brink 1975).

DISCUSSION

We have decided to treat bulbiferous *Aconitum columbianum* at the subspecific level, due in part to the nature of the variation within the species as a whole. The *A. columbianum* complex is extremely polymorphic (Brink 1980, 1982; Brink & de Wet 1980). The existence of geographical races led to a proliferation of published names at the specific, subspecific and varietal levels. This nomenclatural proliferation was often the result of regional studies, which did not consider patterns of variation within the entire *Aconitum columbianum* complex. Geographical races that appear quite distinct within a regional context may be indistinguishable from other races occurring hundreds or even thousands of miles away. Robust and diminutive races that are regionally distinct are "connected" by intermediate races if the entire range of the species is considered (Brink 1980, 1981, 1982).

We have treated *Aconitum columbianum* as one, large, polymorphic, intergrading complex. Only one group of populations is consistently distinct from all others. These are the bulbiferous aconites, which occur in California and Oregon. We have chosen to distinguish this group as a subspecies because it is geographically and morphologically distinct. Recognition of these bulbiferous aconites at the species level would not seem to be warranted, especially since we have not accorded formal taxonomic recognition to regional variants that are exceedingly diverse, but in characters that intergrade throughout the range of the complex (Brink 1982).

TAXONOMIC TREATMENT

Aconitum columbianum Nutt. in Torrey and Gray, Fl. N. Amer. 1:34. 1838.

Tuber to ca. 6 × 1.5 cm; "parent" tuber produces 1 (rarely 2) "daughter" tubers with a connective so short the tubers are essentially contiguous. **Stem** erect and stout to twining and reclining, 2–30 dm long. **Leaves** 5–15 cm broad, deeply 3–5 (7) cleft, lobes variously incised and toothed. **Inflorescence** racemic, terminal, or terminal and axillary. **Flowers** typically deep purple to blue, occasionally white, yellowish, or blue-tinged; 18–50 mm high, helmet 11–34 mm high, pendent sepals 6–16 mm long.

KEY TO SUBSPECIES

1a. Without bulbils in leaf axils or inflorescence .... subsp. *columbianum*
1b. With conspicuous bulbils in leaf axils and/or inflorescence .... subsp. *viviparum*

1a. Aconitum columbianum subsp. columbianum

Aconitum arizonicum Greene; *A. bakeri* Greene; *A. cheirophyllum* Greene; *A. columbianum* var. *bakeri* Harrington; *A. columbianum* var. *lutescens* M. E. Jones; *A. columbianum* var. *ochroleucum* A. Nelson; *A. columbianum* subsp. *pallidum* Piper; *A. divaricatum* Rydberg; *A. geranioides* Greene; *A. glaberrimum* Rydberg; *A. gracilentum* Greene; *A. helleri* Greene; *A. infectum* Greene; *A. insigne* Greene; *A. leibergii* Greene; *A. lutescens* A. Nelson; *A. macilentum* Greene; *A. mogollonicum* Greene; *A. noveboracense* A. Gray; *A. noveboracense* var. *quasiciliatum* Fassett; *A. ochroleucum* Rydberg; *A. obtusiflorum* Greene; *A. patens* Rydberg; *A. porrectum* Rydberg; *A. ramosum* A. Nelson; *A. robertianum* Greene; *A. subcaesium* Greene; *A. tenue* Rydberg; *A. tricorne* Greene; *A. uncinatum* subsp. *noveboracense* (A. Gray) Hardin; *A. vestitum* Greene.

Spring-fed bogs, seep areas, meadows, along streams, and in other wet areas in the mountains of western North America from British Columbia, Canada to Chihuahua, Mexico at elevations of ca. 900–4,000 m. Brit. Col., Wash., Ore., Calif., Nev., Mont., Idaho, Utah, Ariz., S. Dak., Wyo., Colo., and N. Mex. Disjunct, outlying, populations occur at lower elevations (as low as 300 m), in Iowa, Wisconsin, Ohio and New York.

Chromosome Number: $n = 8$ [Wiens & Halleck 1962, Cates 1968], $2n = 16$ [Longacre 1942, Kawano 1965, Crawford & Gardner 1974, Brink 1975], $2n = 18$ [Crawford & Gardner 1974].

1b. Aconitum columbianum subsp. viviparum (Greene) Brink comb. nov.

BASIONYM: *A. viviparum* Greene, Feddes Repert. Spec. Nov. Regni Veg. 7:2. 1909. TYPE: OREGON: swamps near Crater Lake, southern Oregon, *Cusick 2972* (LECTOTYPE, designated herein: WS!; ISOLECTOTYPE: UC!).

Aconitum bulbiferum Howell, Fl. NW Amer. 1:25. 1897. Non *A. bulbiferum* Reichenbach, Übers. Acon. 55. 1819. *A. howellii* Nels. & Macbr., Bot. Gaz. 56:473. 1913. *A. columbianum* var. *howellii* (Nelson & Macbride) C.L. Hitchcock, Vasc. Pls. Pacif. NW 2:231. 1964. OREGON: marshes eastern slope Cascade Mountains near Mt. Hood, *Howell*.

A. hanseni Greene, Feddes Repert. Spec. Nov. Regni Veg. 7:3. 1909. CALIFORNIA. Amador Co.: Hope Valley, 1892, *George Hansen*. [Note: Hope Valley is actually in Alpine County.]

A. platysepalum Greene, Feddes Repert. Spec. Nov. Regni Veg. 7:2. 1909. CALIFORNIA: S side Mt. Shasta, northern California, Jul 1897, *H.E. Brown*.

Spring-fed bogs, seep areas, meadows, along streams, and in other wet areas at elevations of ca. 900–2,500 m in the Cascade Range from northern to southern Oregon, in the Klamath Mountains of northern California, and with a small disjunct group of populations in the California Sierra Nevada south of Lake Tahoe.

These bulbiferous aconites were first distinguished as *Aconitum bulbiferum* Howell in 1897, but this name is rejected as a later homonym of *A. bulbiferum* Reichenbach, which is part of *A. variegatum* L., a European aconite. Three specific names were published simultaneously in 1909 by E.L. Greene for bulbiferous *Aconitum*. One of these names (*A. viviparum*), was chosen to serve as the basionym for the new subspecific combination, which refers to all bulbiferous *Aconitum columbianum*. The lectotype was chosen from among the syntypes of the basionym.

Bulbiferous populations in California have small flowers and shallow nectaries (Brink 1975), and we suspected that this would be the case for all bulbiferous *Aconitum columbianum*. We found, however, that bulbiferous aconites in the Mount Hood region of Oregon, at the northern extreme of the range of bulbiferous populations, have relatively large flowers and deep nectaries.

Flower color in *A. columbianum* is typically deep purple to blue; however, color variants include completely white, yellowish, cream-colored, or blue-tinged at the edges of the sepals. Color variants occur occasionally within blue-flowered populations, but there are also white-flowered populations, and groups of populations. For example, a group of white-flowered, non-bulbiferous populations occurs in northeast Oregon and southeast Washington. Consequently, it is not surprising that there are also white-flowered bulbiferous populations, which occur in Alpine and Amador counties of California (see Representative Specimens, below).

Chromosome number: $2n$ = 18, 19, 20 [Brink 1975].

Representative Specimens: *Aconitum columbianum* subsp. *viviparum:* **CALIFORNIA. Alpine Co.**: Hope Valley, 29 Aug 1974, *Brink & Mayer s.n.* (CHSC) [flowers white, blue-tinged at edges]. **Amador Co.**: E of Silver Lake Dam, 14 Aug 1982, *McNeal 2750* (OSC) [white-flowered]. **Del Norte Co.**: Dunn Creek, 6 Aug 1938, *Keck 4793* (DS). **El Dorado Co.**: Lily Lake, 12-14 Aug 1978, *Brink 1469* (CHSC); Echo Summit, 29 Aug 1974, *Brink & Mayer s.n.* (CHSC). **Siskiyou Co.**: Red Rock Creek, 26 Jul 1974, *Brink & Brink s.n.* (CHSC); Kangaroo Lake and vicinity, 24 Jul 1974, *Brink s.n.* (CHSC). **OREGON. Clackamas Co.**: Clackamas Lake, 24 Jul 1927, *Peck 15852* (DS). **Deschutes Co.**: Tumalo Creek, 12 Aug 1906, *Whited 3162* (OSC). **Douglas Co.**: Diamond Lake, 17 Jul 1924, *Applegate 4134* (OSC). **Hood River Co.**: Barlow Pass, Mount Hood, 31 Jul 1934, *Thompson 11208* (US). **Jackson Co.**: Woodruff Meadows, 26 Jul 1925, *Pendleton s.n.* (OSC). **Jefferson Co.**: Camp Sherman, 27 Aug 1962, *Schoth 1929* (OSC). **Josephine Co.**: Lake Creek, Siskiyou Mountains, 18 Jul 1949, *Whittaker SS217* (WS). **Klamath Co.**: Pole Bridge, Crater Lake Park, 31 Jul 1922, *Applegate 3413* (UC). **Lane Co.**: Gold Lake, 1 Sep 1962, *Dennis 2433* (UTC). **Linn Co.**: Monument Peak, 9 Aug 1947, *Aller s.n.* (OSC). **Marion Co.**: Olallie Meadow, 9 Aug 1978, *Dawn 63* (OSC). **Wasco Co.**: Barlow Road, 1 Sep 1964, *French 2604* (OSC).

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We gratefully acknowledge anonymous reviewers, J. Bissell, L. M. Mayer, J.M.J. deWet, R.A. Schlising, the herbaria from which loans were obtained (JEPS, OSC, UC, WILLU, WS), and the herbaria that were visited. We appreciate receiving loans through the herbarium of the Cleveland Museum of Natural History (CLM).

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BOOK NOTICES

KINDSCHER, KELLY. 1992. **Medicinal Wild Plants of the Prairie. An Ethnobotanical Guide.** (ISBN 0-7006-0527-4, pbk.) University Press of Kansas, 2501 West 15th Street, Lawrence, KS 66049-3904. $25.00 (hbk), $9.95 (pbk). 340 pp.

The first part of this well-done, authoritative book considers 43 species in detail: common names, Indian names, scientific name, description, habitat, parts used, Indian use, Anglo folk use, medical history, scientific research, and cultivation (not all of these for every plant). A full-page line drawing illustrates each of these species. The second part, not illustrated, has brief accounts of 60 species less important as medicine. Range maps are given for all the book's species. Closing the volume are a glossary, 15 pages of references (ca. 240 entries), and an index. Data in the book are mainly historical; only a few of the species have been studied recently to learn what biologically active compounds they contain.—*John W. Thieret.*

WASOWSKI, SALLY and ANDY WASOWSKI. 1992. **Requiem for a Lawnmower.** (ISBN 0-87833-811-X, hbk.) Taylor Publishing Company, 1550 West Mockingbird Lane, Dallas, TX 75235. $15.95 (hbk). 182 pp.

This book, written "with Andy Wasowski," is a series of essays about gardening with native plants. The book has a bias toward the Southwest, but the principles presented can be applied just about anywhere. Kinds of plants to use; why and how to use them; attracting hummingbirds; our lost native herbs; defending goldenrods (that they cause hayfever is a "scurrilous, unfounded charge"); trash trees (e.g., mimosa, Russian-olive, tree-of-heaven, Chinese tallowtree, white mulberry) to get rid of; creating habitats; desert gardens; a warning about misinformation in many gardening books; and even bladderworts (*Utricularia*), "a wonderful addition to a natural earthen water garden"—these and many other subjects are interestingly written about. Sixteen of the many plants discussed are illustrated with watercolors. The book, lacking an index, is well worth reading, even by non-gardeners.—*John W. Thieret.*

KIRKPATRICK, ZOE MERRIMAN. 1992. **Wildflowers of the Western Plains.** (ISBN 0-292-79061-9, hbk.) University of Texas Press, Box 7819, Austin, TX 78713-7819. $24.95. 240 pp.

TVETEN, JOHN and GLORIA TVETEN. 1993. **Wildflowers of Houston.** (ISBN 0-89263-319-0, pbk.) Rice University Press, P.O. Box 1892, Houston, TX 77251. $18.50 (pbk), $29.85 (hbk). 309 pp.

To paraphrase Ecclesiastes: of making many wildflower books there is no end. These two are fine examples of this genre. *Wildflowers of the Western Plains* illustrates about 180 species arranged alphabetically by family; its text includes, for each, detailed description of the plant, flower, and fruit; notes on range; and remarks. The composites occupy nearly 1/4 of the book, attesting to the prevalance of members of that family among at least the more showy flowers of the region. *Wildflowers of Houston* includes about 200 species grouped by flower color, briefer descriptions than *Western Plains,* and remarks. Both volumes are splendidly illustrated with color photographs of high quality. Both have a bibliography and a detailed index; *Western Plains* has a glossary. One can do naught but recommend these books highly.—*John W. Thieret.*

ON THE IDENTITY OF TWO TAXA OF *BERBERIS* (BERBERIDACEAE) FROM TIBET

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ABSTRACT

The identity of two taxa of *Berberis*, *B. replicata* var. *dispar* and *B. griffithiana* var. *pallida* is discussed.

RESUMEN

Se discute la identidad de dos taxa del género *Berberis, B. replicata* var. *dispar y B. griffithiana* var. *pallida.*

While examining type specimens of *Berberis* on loan from the British Museum (BM), the authors came across two sheets from Tibet, both annotated by C.M. Hu as *Berberis griffithiana* Schneid. var. *pallida* (Hk.f. & Th.) Chamberlain & Hu and were included in the systematic treatment of *Berberis* by Chamberlain & Hu (1985). Critical examination of these two type sheets revealed considerable differences between them. One sheet (*Ludlow* & *Sherriff 1274*) was annotated by Ahrendt as *B. replicata* W.W. Sm. var. *dispar* Ahrendt (Fig. 1), and the other sheet (*Ludlow*, *Sherriff* & *Elliot 12518*) annotated by Ahrendt as *B. atrocarpa* Schneid. var. *trimensis* Ahrendt (Fig. 2).

Chamberlain & Hu (1985) separated the two species, *Berberis replicata* and *B. griffithiana* as below:

1a. Leaves distinctly white below, dull green above, enervate, strongly revolute; shoots slender, terete .... *B. replicata*
1b. Leaves glaucous below, not strongly revolute, with lateral veins visible and reticulate; shoots ± angled .... *B. griffithiana*

Further examination of *L.* & *S. 1274* revealed all characters of *Berberis replicata* whereas *L. S.* & *E. 12518* clearly revealed the characters of *B. griffithiana*. Even Ahrendt (1961) had kept *B. replicata* var. *dispar* under *B. griffithiana* without citing this particular type specimen under this taxon.

Further, the study of floral characters reveals that the apices of the stamens are truncate with long connectives in *L. S.* & *E. 12518* while such character is not noticed in *L.* & *S. 1274*. The gland on the petals of *L. S.* & *E. 12518* are ovoid, 1.25 mm long, with rounded apices, whereas in *L.* & *S. 1274* the glands on the petals are distinctly ovate, much longer, and with acute apices.

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FIG. 1. Holotype of *Berberis replicata* var. *dispar* (*Ludlow & Sherriff 1274*, BM).

These characters clearly support the separation of these two taxa as distinct. The evidence suggests that Chamberlain & Hu (1985) were correct in reducing *B. taronensis* var. *trimensis* to a synonym of *B. griffithiana* var. *pallida*, but that *B. replicata* var. *dispar* is closer to var. *replicata* than it is to *B. griffithiana*.

FIG.2. *Berberis griffithiana* var. *pallida* (*Ludlow, Sherriff & Elliotut 12518*, BM).

Further, data through SEM studies of the epidermis of mature leaves of the two taxa also revealed significant differences (Fig. 3), supporting the above view. In case of *Berberis replicata* var. *dispar* (Fig. 3, A) the lower epidermal cells of leaves exhibited the convex nature of the periclinal wall cells, with more or less regular cell boundaries and smooth cuticle, whereas in case of

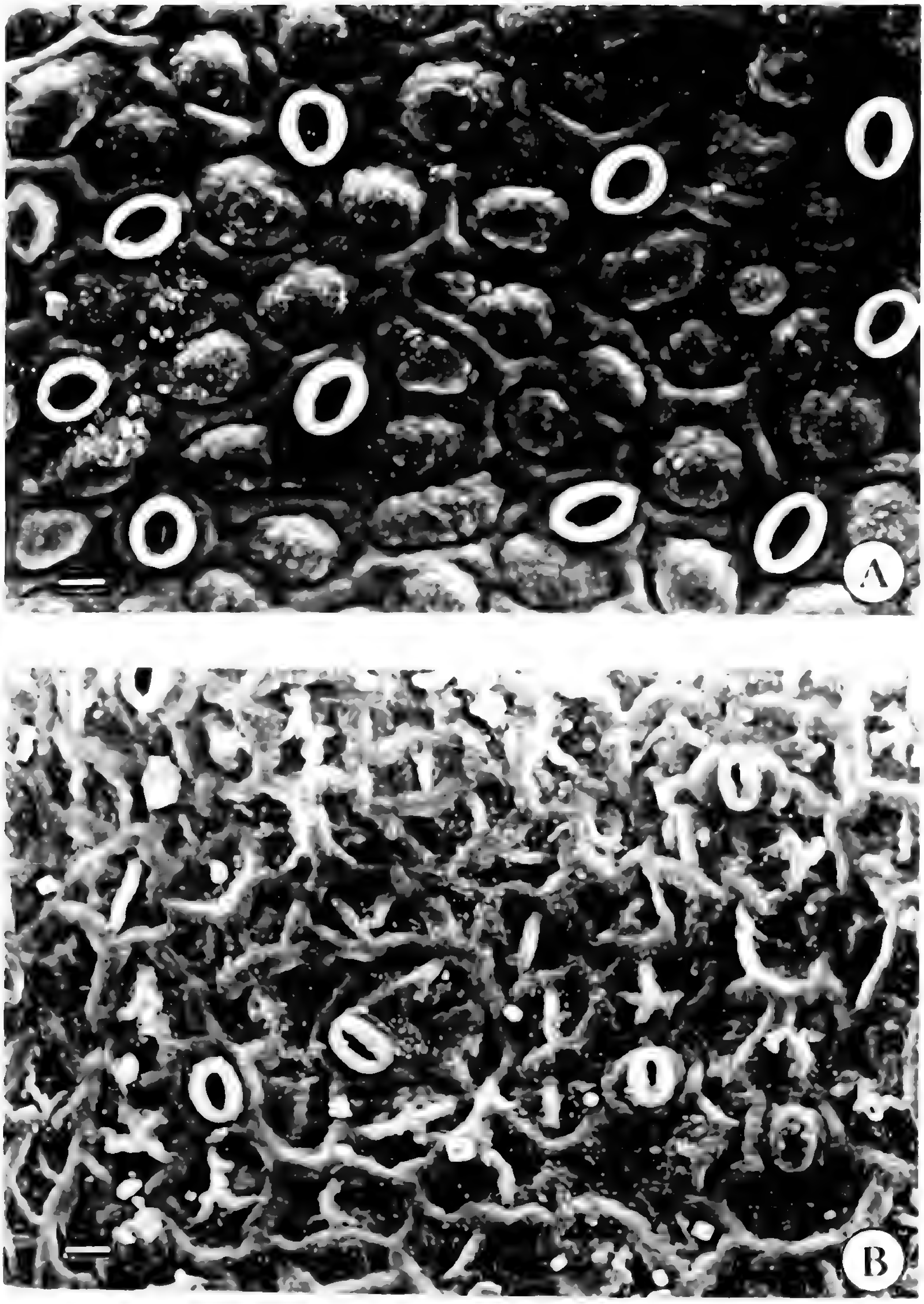

FIG. 3 Scanning electron micrographs of the abaxial surface of the leaf, (A) *Berberis replicata* var. *dispar (Ludlow & Sherriff 1274,* BM); (B) *Berberis griffithiana* var. *pallida (Ludlow, Sherriff & Elliot 12518,* BM). Bar = 10 µm.

B. griffithiana var. *pallida* (Fig. 3, B) the periclinal wall cells are concave in nature, with irregular cell boundaries and the cuticle is more or less striate. The number of stomata also varied in the two species. The former with ten stomata in one field and the latter with six.

Berberis replicata var. *replicata, B. replicata* var. *dispar* and *B. griffithiana* var. *pallida* are separated by the morphological characters in Table 1.

Table 1. *Berberis replicata* var. *replicata*, *B. replicata* var. *dispar* and *B. griffithiana* var. *pallida* are separated by the morphological characters.

S. No.	***B. replicata*** **var.** ***replicata***	***B. replicata*** **var.** ***dispar***	***B. griffithiana*** **var.** ***pallida***
1.	Shoots slender, terete	Shoots slender, terete	Shoots angled
2.	Leaves white below, enervate, margin strongly revolute	Leaves white below, enervate, margin strongly revolute	Leaves grey below, with lateral veins clearly visible, margin not revolute
3.	Inflorescence usually 8–12 flowered	Inflorescence 2–6 flowered	Inflorescence 4–8 flowered
4.	Outer sepals 4 mm long, apices subacute	Outer sepals 4–5 mm long, apices acute	Outer sepals 5 mm long, apices rounded
5.	Glands on petals 0.5 mm long	Glands on petals 1.5–2 mm long	Glands on petals 1.2 mm long

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The authors are thankful to the Director, National Botanical Research Institute, Lucknow, for facilities and to the British Museum of Natural History (BM), and the Royal Botanic Garden, Edinburgh (E), for loan of specimens.

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CHAMBERLAIN, D.F. and C.M. HU. 1985. A synopsis of *Berberis* section Wallichianae. Notes Roy. Bot. Gard. Edinburgh 42:529–557.

BOOK NOTICES

LONARD, ROBERT I. 1993. **Guide to the Grasses of the Lower Rio Grande Valley, Texas.** (ISBN 0-938738-08-9, pbk.) University of Texas-Pan American Press, Edinburg, TX 78539. Price not given. 240 pp.

The introduction to this guide to 63 genera and 183 species of grasses considers environment, how to use the book, morphology of grasses, and grasses as elements in vegetation. Following the key to genera are descriptions of these genera and keys to their species. The keys "worked" well for the 15 species I tried to key out; the descriptions are original and largely adequate. Closing the book are a glossary and illustrations of entire plants and/or diagnostic structures of about 100 grass species, four per page. These illustrations, appearing to be negative photos of line drawings, are of variable quality, some being useful aids, others less so. The index precedes the glossary and illustrations, a user-unfriendly innovation.—*John W. Thieret.*

BARBOUR, MICHAEL, BRUCE PAVLIK, FRANK DRYSDALE AND SUSAN LINDSTROM. 1993. **California's Changing Landscapes: Diversity and Conservation of California Vegetation.** (ISBN 0-943460-17-4, pbk). California Native Plant Society, Sacramento, CA 95814. $24.95. 224 pp.

Gary Snyder, the wise California poet, in the preface notes the "elegance and economy" with which this important book makes California's "vast and complex landscape available to us." And that the book provides a "vision of a California whose native plant populations do not become entirely degraded, and whose grasslands and forests are sustainable." It is very significant that the authors address the landscape of vegetation and the natural dynamics that both sustain those landscapes and are perturbed by human influences. Because it is from that perspective, starting with understanding, that we can develop the management practices to protect, restore, and maintain native biodiversity. In this way the book is a model to lead other states, a role taken by the California Native Plant Society, publishers of this book, and several partner conservation organizations for several decades.

The book is readable and informative, for both lay and technical audiences. An introductory chapter describes the environmental forces that have shaped California's landscapes as well as the changes that have occurred since European settlement. The following chapters describe general regions, well illustrated with interesting maps, photos, and diagrams. Two closing chapters raise new and important topics: the first on past influences on the vegetation by Native Californians, previously thought to have lived for many millennia in California's lush vegetation without significant influence on its structure or function; the second on attempts and opportunities to restore degraded places, a goal that will become ever more important to achieve the very practical and reasonable vision encouraged by Gary Snyder.—*Larry Ford.*

HEMEROCALLIS HAKUUNENSIS (LILIACEAE) IN KOREA

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ABSTRACT

Principal components analysis shows that the type of *Hemerocallis micrantha* Nakai is included in the continuous range of morphological variation of populations of *H. hakuunensis* Nakai (southern, central, and northwestern Korea). *Hemerocallis hakuunensis* has priority and is the correct name for this taxon. Also, the result shows that *H. middendorffii* (central and northeastern Korea) is distinct from *H. hakuunensis* by having a capitate-type inflorescence, large inflorescence bracts, short perianth tube and a different flowering period. Synonymy, descriptions, and distribution pattern of *H. hakuunensis* are included.

RESUMEN

El análisis de componentes principales muestra que el tipo de *Hemerocallis micrantha* Nakai está incluido en el rango continuo de variación morfológica de las poblaciones de *H. hakuunenis* Nakai (sur, central y noroeste de Korea). *Hemerocallis hakuunensis* tiene prioridad y es el nombre correcto para este taxon. Los resultados muestran también que *H. middendorffii* (centro y noreste de Korea) se diferencia de *H. hakuunensis* por tener inflorescencias de tipo capitado, brácteas de la inflorescencia grandes, tubo del perianto corto y un periodo de floración diferente. Se incluyen sinonimias, descripciones y patrones de distribución de *H. hakuuensis*.

INTRODUCTION

Hemerocallis L. is an economically important genus of approximately 30 species restricted to mainly eastern Asia (Matsuoka and Hotta 1966). Many species and cultivars are widely grown in gardens in Asia, Europe, and North America (Cohen 1986). Numerous nomenclatural and taxonomic problems exist within the genus (Matsuoka and Hotta 1966; J. Noguchi pers. comm.). The taxonomic difficulty has been attributed to the relative paucity of diagnostic characters, the fact that many species (e.g., *H. aurantiaca* Baker, *H. flava* L., *H. fulva* L., and *H. thunbergii* Baker) were described from cultivated plants of unknown origin (Kitamura et al. 1986; Matsuoka and Hotta 1966), the extreme difference in appearance between living plants and dried herbarium specimens, and possible widespread hybridization (Kitamura et al. 1986). In addition, many species of *Hemerocallis* are so variable ecologically and morphologically that a proper species concept requires morphological, ecological and biosystematic studies. Over 27,000 cultivars further confound the taxonomic status of several *Hemerocallis*

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species. Matsuoka and Hotta (1966) noted that Baily (1930), Nakai (1932), and Stout (1941) did not consider the variability of natural populations when developing their classification. Based on the taxonomic literature on the genus *Hemerocallis* (e.g., Nakai 1932; Matsuoka and Hotta 1966; Hotta 1986; Kitamura et al. 1986), the geographical and ecological distribution of the Japanese *Hemerocallis* is relatively well known. On the other hand, little is known of the Korean *Hemerocallis*. After Nakai's (1932) description of *H. coreana* Nakai as the endemic *Hemerocallis* species in Korea, he (Nakai 1943) described two other taxa; *H. hakuunensis* Nakai and *H. micrantha* Nakai. Matsuoka and Hotta (1966) recognized *H. fulva* var. *minor* (Miller) M. Hotta, *H. flava* var. *coreana* (Nakai) M. Hotta, *H. dumortieri* Morren var. *middendorffii* (Tr. et Mey.) Kitamura, and *H. hakuunensis* as the indigenous species in Korea. Lee (1985) reported 6 species and two cultivated plants from Korea: *H. fulva* L. (cultivated plant), *H. fulva* var. *kawanso* Regel (cultivated plant), *H. flava*, *H. littorea* Makino, *H. dumortieri*, *H. middendorffii*, *H. minor* and *H. thunbergii*. The recognition of Korean *Hemerocallis* species has varied depending on authors. Consequently, there is an obvious need to study the group in detail to understand better the taxonomy of *Hemerocallis*. Principal components analysis of morphological data has been widely used to study species delimitation; e.g., Noguchi (1986) for the *Hemerocallis dumortieri* complex and Chung et al. (1991) for the Korean *Hosta* (Liliaceae).

The goals of this study were to 1) analyze morphological variation between *H. hakuunensis* and *H. middendorffii;* 2) determine the overall geographic distribution patterns for *H. hakuunensis* and *H. middendorffii*; and 3) more closely conform the descriptions to the typical morphology of *H. hakuunensis*. More specifically, do the two species *H. hakuunensis* and *H. micrantha* merit taxonomic distinction at the rank of species?

MATERIALS AND METHODS

Several morphological characters were measured for five individuals from 16 populations in Korea from 1988 to 1993 (Fig. 1; Table 1). Observations were also made of the habitats, and notes were taken on characteristics (e.g., soil types) of the populations. Voucher specimens of all collections are deposited at GNUC. In addition, five herbarium specimens of *H. middendorffii* and the two types of *H. hakuunensis* and *H. micrantha* (Table 1) were used to determine if 1) the types of the latter two names fall within one continuous field of variation and 2) *H. hakuunensis* and *H. micrantha* are morphologically distinct by comparison with *H. middendorffii*. The herbaria of Seoul National University (SNU) and Tokyo University (TI) were visited in order to search type specimens of *H. hakuunensis* and *H. micrantha* and determine the total range of geographic variation and the distribution of North Korean *Hemerocallis* (Fig. 1).

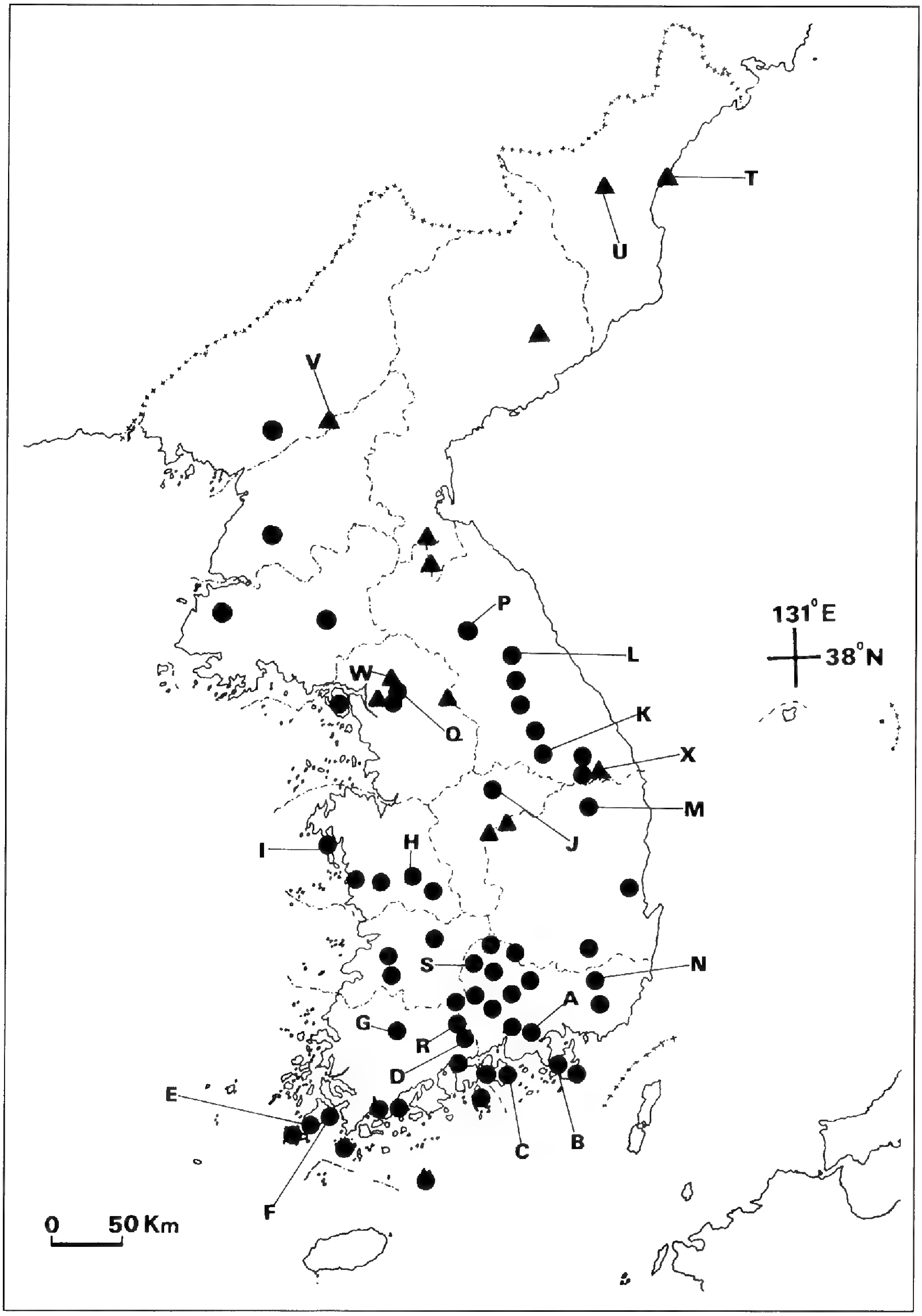


FIG. 1. Geographical distribution of *Hemerocallis hakuunensis* and *H. middendorffii* in Korea. Arrows with alphabetic codes (A-N, P and Q) indicate locations of populations from which samples were collected by M. G. Chung and S. S. Kang. Arrows with codes (R-X) indicate locations from which herbarium specimens were collected. See Table 1 for the explanation of 23 alphabetic codes.

TABLE 1. Locations of 16 populations and seven herbarium specimens examined for morphological phenetic analysis. All collections by M. G. Chung and S. S. Kang except others noted.

Code	Locations	Collection number
1)	*Hemerocallis hakuunensis*, southern, central and northwestern Korea	
A	Bongam-ri, Chincheon-myeon, Uich'ang-gun, Gyeongsangnam-do	1850
B	Sorang-ri, Koje-myeon, Koje-gun, Koje Island, Gyeongsangnam-do	1851
C	Mizo-myeon, Namhae-gun, Namhae Island, Gyeongsangnam-do	1852
D	Masa-ri, Bonggang myeon, Kwangyang-gun, Chollanamdo	1853
E	Pyeongmok-ri, Imwhe-myeon, Chindo-gun, Chin Island, Chollanam-do	1863
F	Ch'osang-ri, Uishin-myeon, Chindo-gun, Chin Island, Chollanam-do	1864
G	Gurea-ri, Leeyang-myeon, Whasun-gun, Chollanam-do	1866
H	Yongdam-ri, Kumnam-myeon, Yeongi-gun, Ch'ungch'ongnam-do	1871
I	Changgi-ri, Anmyeon-eup, Seosan-gun, Ch'ungch'ongnam-do	1874
J	Hwayangdong Provincial Park, Ch'ungch'ongbuk-do	1875
K	Danyang-gun, Sobaksan National Park, Ch'ungch'ongbuk-do	1878
L	Yuljeon-ri, Dae-myeon, Hongch'on-gun, Kangwon-do	1881
M	Angi-ri, Bookhu-myeon, Andong-gun, Gyeongangbuk-do	1884
N	Sangbuk-myeon, Uljoo-gun, Gagisan Provincial Park, Gyrongsangnam-do	1887
P	Komnam-myeon, Ch'olwon-gun, Kangwon-do	2001
Q	Kwangnung, Sohul-myeon, Poch'on-gun, Gyeonggi-do	2002
R	Holotype, Mt. Baekun, Chollanam-do	*Nakai s.n.* (TI)
2)	*Hemerocallis micrantha*, Hamyang-gun, Gyeongsangnam-do	
S	Holotype, Hamyang-gun, Gyeongsangnam-do	*O. Syogo s.n.*(TI)
3)	*Hemerocallis middendorffii*, central and northeastern Korea, Manchuria, Amur	
T	Ch'ungjin-shi, Hamgyeongbuk-do	*Nakai s.n.* (TI)
U	Mt. Kwanmyobong, Gyeongsung-gun, Hamgyeongbuk-do	*Toh 4507* (SNU)
V	Mt. Myohwang, Hwich'un-gun, P'yeonganbuk-do	*Toh & Shim 12784* (SNU)
W	Kwangnung, Poch'un-gun, Gyeonggi-do	*Toh 900* (SNU)
X	Mt. Myeon, Taebaek-shi, Kangwon-do	*Oh s.n.* (SNU

Previous studies (Matsuoka and Hotta 1966; Hotta et al. 1966; Hotta 1986; and Noguchi 1986) revealed that several qualitative (e.g., flowering time and period, shape of roots, odor, and type of an inflorescence) and quantitative characters (e.g., floral and leaf morphologies and wintering conditions of leaves) are important characters in recognizing *Hemerocallis* taxa. As most qualitative characters were not available from the herbarium specimens, only 14 morphological characters were selected in this study (Table 2).

Phenetic analyses were utilized to assess the morphological variation present in 87 OTUs (operational taxonomic units) of *H. hakuunensis*, *H. micrantha*, and *H. middendorffii*. Principal components analyses (PCAs) were performed to identify characters contributing to the separation of each taxon and assess inter-taxon variation using the Statistical Analysis System (SAS 1987). The data were standardized for each character, with the raw data matrix transformed such that each character had a mean of zero as a standard deviation (Sneath and Sokal 1973). The first three principal components were extracted by the PCAs.

TABLE 2. List of 14 characters used in the morphological analysis.

Acronym	Character derivation	Unit or Category
PSH	Plant (scape) height	> 50cm=0; < 50cm=1
LSI	Length of inflorescence minus flowers	> 1cm=0; 2-20cm=1
NFS	Number of flowers/scape	#
LLB	Length of the lowest bracts	cm
WLB	Width of the lowest bracts	cm
LPO	Length of the perianth tube enclosing ovary	cm
LIP	Length of the inner perianth	cm
WIP	Width of the inner perianth	cm
LOP	Length of the outer perianth	cm
WOP	Width of the outer perianth	cm
WWL	Width of the widest leaves	cm
ROL	Ratio of inner to outer lobe length	ratio
ROW	Ratio of inner to outer lobe width	ratio
SOI	Shape of inflorescence	head or cap type=0; Y-type or branched=1

RESULTS

The cumulative variance of the first three principal components (64.8%) and the contributing value of each of 14 characters are shown in Table 3. Characters weighted heavily in the first principal component (27.4%) are width of the outer perianth (WOP), width of the inner perianth (WIP), shape of inflorescence (SOI), and plant height (PSH). The second component accounts for 25.0% of the total variation and is mostly concerned with length of the perianth tube enclosing the ovary (LPO), SOI, PSH, length of inflorescence minus flowers (LSI), length of the outer perianth (LOP) and length of inner perianth (LIP). The third component accounts for 12.4% of the total variation and number of flower per scape (NFS), length of the lowest bracts (LLB), and width of the widest leaves (WWL) are highly weighted.

Results from two-dimensional plots of component 2 against components 1 and 3 (Figs. 2 and 3) show that the type specimen of *H. micrantha* is marginally included in the continuous range of variation described by the OTUs of *H. hakuunensis* (populations A-N, P and Q) including the type (R). The range of variation for *H. hakuunensis* is distinct from that of *H. middendorffii.*

TAXONOMIC DISCUSSION

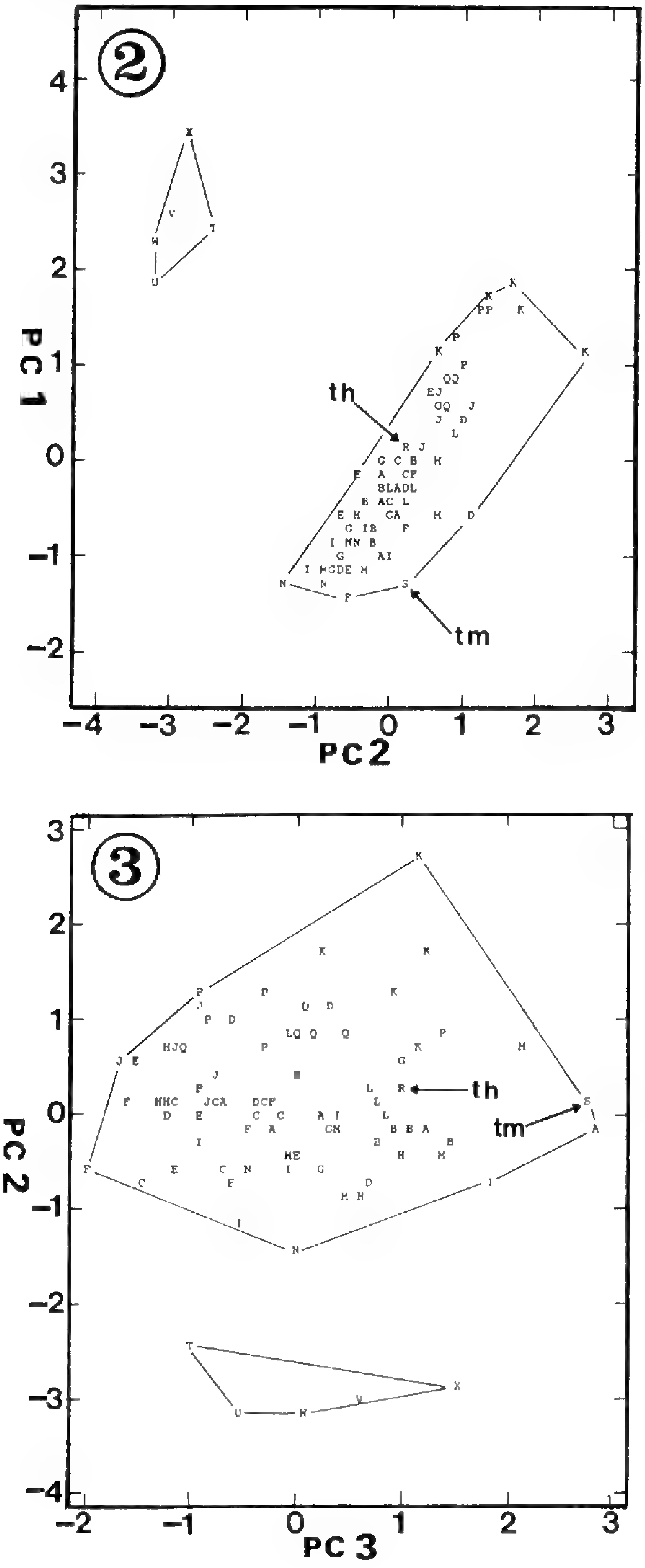
Hemerocallis middendorffii, found on open areas of central and northeastern mountains in Korea (S.S. Kang pers. obs.; S.H. Oh pers. comm.), differs from *H. hakuunensis* by having a capitate-type inflorescence; large inflorescence bracts (2.0–4.0 cm long, 1.0–3.0 cm wide); short perianth tube (1.0–1.8 cm long); short scape (30–47 cm long); and a different flowering period from middle May to June. The results from principal components analysis revealed these two species are distinct from each other (Figs. 2–3).

TABLE 3. First three principal components composed of 87 OTUs derived from 14 morphological characters.

Acronym[a]	PC 1	PC 2	PC 3
PSH	-0.625	0.724	-0.034
LSI	-0.503	0.694	0.207
NFS	-0.434	0.098	0.608
LLB	0.048	0.140	0.580
WLB	0.602	-0.194	0.502
LPO	-0.075	0.722	-0.072
LIP	0.574	0.657	-0.317
WIP	0.790	0.271	-0.115
LOP	0.569	0.668	-0.308
WOP	0.828	0.313	0.159
WWL	0.231	0.445	0.572
ROL	-0.131	-0.301	0.082
ROW	-0.453	-0.196	-0.406
SOI	-0.625	0.724	-0.034
Eigenvalue	3.830	3.496	1.742
Proportion of variance	27.4%	25.0%	12.4%
Cumulative variance	27.4%	52.4%	64.8%

[a]See Table 2 for character explanation.

Nakai (1943) originally described *H. micrantha* based on only one herbarium specimen collected by O. Syogo from Hamyang, Prov. Gyeongsang Nam of southern Korea. He noted that *H. micrantha* is distinct from other species by having small-sized orange-yellow flowers and a highly branched inflorescence. For example, he reported that the length and width of perianth lobes are 4 cm and 5–6 mm, respectively, and the length of inflorescence is 23 cm long. These values are included in the continuous range of variation observed during our field trips for *H. hakuunensis*. Individuals with 20–30 cm long inflorescences were encountered within the populations of D, K, and M. Individuals with small-sized (ca. 4–6 cm long) length of perianth lobes were also observed within the populations of A, B, D, E, I, M, and N. In addition, the flowering date (17 July) and collection location (Prov. Gyeongsang Nam of southern Korea) for *H. micrantha* fall within the range of flowering period (June to July, August in the mountainous areas) and geographic distribution (southern, central, and northwestern Korea) of *H. hakuunensis*. It is highly probable that the type of *H. micrantha* is one of the variable individuals observed for *H. hakuunensis* as revealed by PCAs (Figs. 2–3). Although *H. hakuunensis* and *H. micrantha* were published in 1943 on the same volume of *Journal of Japanese Botany* (pp. 315–316), *H. hakuunensis* has priority over *H. micrantha* because the former was described ahead of the latter. So *H. hakuunensis* is the correct name for the taxon.



FIGS. 2-3. Diagrams showing the results of PCAs. **th** and **tm** = holotype of *Hemerocallis hakuunensis* and *H. micrantha*. FIG. 2. PCA (components 1 and 2) composed of 87 OTUs. FIG. 3. PCA (components 2 and 3) composed of 87 OTUs.

Matsuoka and Hotta (1966, p. 37) also considered *H. micrantha* as a synonymy of *H. hakuunensis*. The nomenclature is as follows:

Hemerocallis hakuunensis Nakai, J. Jap. Bot. 19:315. 1943. TYPE: KOREA. PROV. CHOLLA NAM: Mt. Baekun, 22 Aug 1934, *Nakai s.n.* (HOLOTYPE: TI!; ISOTYPE: TI!). PARATYPE: **KOREA.** PROV. CHOLLA NAM: Mt. Chiri, 25 Jul 1937, *O. Syogo s.n.* (TI!).

Hemerocallis micrantha Nakai, J. Jap. Bot. 19:315–316. 1943. TYPE: KOREA. PROV. GYEONGSANG NAM: Hamyang, 17 Jul 1937, *O. Syogo s.n.* (HOLOTYPE: TI!).

Herbaceous perennials. Roots usually tuberous (ca. 1.5–2.0 cm long, 0.8 cm wide), grayish yellow. Leaves 40–100 cm long, 1.2–2.5 cm wide, greenish yellow. Scapes ascendant or erect, 32–145 (80 ± 15.62, mean ± SD) cm long, nearly as long as or shorter than leaves, usually 1–2 lanceolate bracts below the inflorescence, 1.2–6.0 (9.5) cm long, 0.7–1.8 cm wide; inflorescence branched (rarely Y-type) with 4–27-flowers, 3–30 (10.82 ± 4.43) cm long; bracts ovate, greenish, membranous on margin. Perianth (fresh) orange-yellow, 7–10 cm long, tube 1.5–3.0 cm long, green with orange tint; throat orange yellow; inner perianth lobes 4.5–9.0 cm long, 1.6–2.6 cm wide. Stamens 3–4 cm long, inserted; filaments orange-yellow, attached to the base of the perianth tube; anthers ca. 6 mm long, dark brown with purple tint. Style filiform, ca. 8.5 cm long, exerted beyond the stamens. Capsule usually oblong-oval, 2.0–2.5 cm long and 1.1–1.5 cm wide, cross-wrinkled when dried, surface usually covered with wart-like projections, apex emarginate; seeds shining black, angled, 6 mm long, 4 mm wide. Flowering from June to July (August in the mountainous areas) in Korea; fruit ripening late July to September.

Korean name: Baekunsan-wonch'uri

This species is commonly found on the humus or granitic soils and open areas or under pine-oak forests on hillsides of southern, central, and northwestern Korea, including Kojae, Namhae, Komun, Dolsan, Pogil, Chin, Anmyeon, and Kangwha islands (Korean endemic species).

ACKNOWLEDGMENTS

We thank Jungo Noguchi and Mitsuru Hotta for discussions on the classification of *Hemerocallis*. Special thanks go to Sun Gi Chung, Duk Seo Gu, and Ou Kun Chin for their company on field trips. Also, appreciation is extended to Barney Lipscomb and two anonymous reviewers for comments on the manuscript. We are also grateful to the directors and staffs of the National Parks and the Department of National Monuments of Culture Property preservation Bureau of Korea for permission to collect samples from Hallasan, Hanryohaesang, Sobaeksan, Sokrisan, Tadohaesang National Parks and Hong and Cheju islands. We especially thank the herbaria directors and curators of GA, KYO, MO, SNU and TI. This research was supported in part by a National Science Foundation Dissertation Improvement Grant (BSR-8914430) to MGC, a Korea Research Foundation Non Directed Research Fund (1992) to MGC, and a Korea Science and Engineering Foundation Grant (931-0500-031-2) to MGC.

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BOOK NOTICES

INTERNATIONAL INSTITUTE FOR SUSTAINABLE DEVELOPMENT (IISD). 1992. **Sourcebook on Sustainable Development.** (ISBN 1-895536-04-9, pbk). IISD, Winnipeg, Manitoba, Canada R3B 0Y4. $20.00. 133 pp.

The sourcebook is an invaluable reference for individuals and organizations seeking information related to the goals and issues of "sustainable development," which was raised to international attention at the United Nations Conference on Environment and Development. The sourcebook also provides lists and guidance for networking with worldwide organizations working in this field. In addition to concise descriptions of such organizations and an extensive bibliography categorized by topics and regions, the sourcebook describes audio-visual organizations and materials available as well as a detailed guide to relevant computer networks, conferencing systems, and databases. *Larry Ford.*

BANURI, TARIQ AND FREDERIQUE APFFEL MARGLIN (Eds). 1993. **Who Will Save the Forests?: Knowledge, Power and Environmental Destruction.** (ISBN 185649-159-5, hbk; 1985649-160-9, pbk). The United Nation University, World Institute for Development Economics Research, Helsinki, Finland; Zed Books Ltd., London, England. $55.00 (hbk); $17.50 (pbk). 195 pp.

The editors of this academically-oriented volume compiled four case studies of forest communities to examine "the contrasting visions and attitudes toward resource conservation implicit in modern and non-modern societies [and] the lessons that these visions and practices provide for coping with the environmental crisis." The case studies are: (1) a hill tribe practicing shifting cultivation in India; (2) a peasant community living in a modernized afforested region of India; (3) smallholders and corporations sharing a forest area in Finland; and (4) forest workers and foresters in Maine. —*Larry Ford.*

AN UNDESCRIBED *SACCHARUM* (POACEAE: ANDROPOGONEAE) FROM JAMMU AND KASHMIR, NORTHWEST HIMALAYA, INDIA

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ABSTRACT

A new species of Poaceae, *Saccharum stewartii* Rajeshwari, R.R. Rao & Garg from Jammu & Kashmir, northwest Himalaya, India, is described and illustrated. Palynology of the new species is analyzed and compared with its closely allied *S. griffithii* Munro ex Boiss.

RESUMEN

Se describe e inconografía una especie nueva de *Poaceae. Saccharum stewartii* Rajeshwari, R.R. Rao & Garg, de Jammu y Cachemira, noroeste del Himalaya, India. Se analiza y compara la palinología de esta especie con la de su pariente cercana *S. griffithii* Munro ex Boiss.

The genus *Saccharum* L. (sensu lato), with ca. 35–40 species, is distributed in the tropics but extends to warm temperate regions of the world. In India, the genus has ca. 16 species mostly in the tropical belt (Bor 1960). During a taxonomic study on grasses of Jammu & Kashmir, the authors came across an interesting specimen of the genus collected from the Kashmir Valley and carrying a determinavit slip by N.L. Bor bearing the name *Erianthus stewartii* Bor. Critical examination of the specimen indicated that this is an unique species morphologically very near to *Saccharum griffithii* Munro ex Boiss. However, the binomial *Erianthus stewartii* was never published and further, as the species of *Erianthus* are now transferred under *Saccharum,* a new binomial, *Saccharum stewartii* is necessary and described here.

Saccharum stewartii Rajeshwari, R.R. Rao & Garg, sp. nov. (Fig. 1).
Erianthus stewartii Bor, nom. nud.

Proxime affinis *S. griffithii* Munro ex Boiss. sed differt racemis perlongioribus, pedunculis pilosis, callo cum pilis usque ad 6.8 mm longis, aristis usque ad 3 mm longis, antherisque usque ad 2 mm longis.

Perennial; culms up to 3 m high. Leaf blades up to 50 cm long, tough, long attenuate at the tip. Panicle ca. 20 cm long; peduncle villous; racemes

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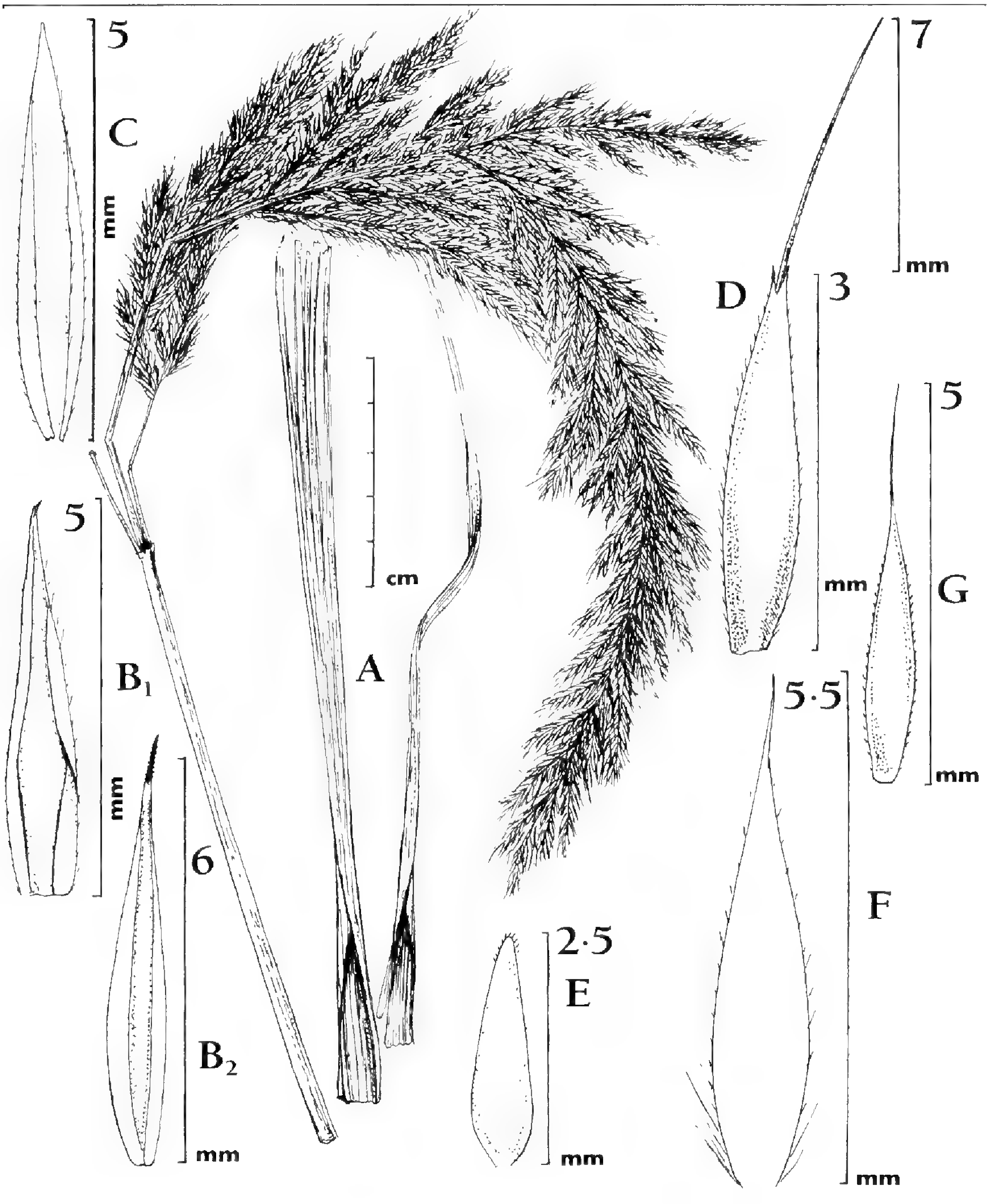

FIG. 1: *Saccharum stewartii* Rajeshwari, Rao & Garg. A. Portion of Inflorescence, B$_1$, B$_2$ upper and lower glumes; C. lower lemma; D. upper lemma with awn; E. palea; F.&G. lower glume and lower lemma of the pedicelled spikelet.

6–7.5 cm long; internodes hairy; hairs up to 6 mm long. Sessile spikelets up to 8 mm long; callus bearded with silky hairs; hairs up to 6.8 mm long, usually shorter than the spikelets and not concealing them; glumes equal, ovate-lanceolate, keeled, 1–3 nerved, scabrid on the keels, hairy on the back or glabrous; lower lemma 3 mm long, 3-nerved, ciliate at the margins, hyaline; lower palea membranous, as long as the lower lemma, ciliate at the margin; upper palea membranous, hyaline; upper lemma 2 mm long, entire, ciliate at the margins, awned; awn 3 mm long, straight; anthers 2 mm long. Pedicelled spikelets male only or bisexual; lodicules 2, cuneate or ovate-oblong, faintly ciliate; caryopsis not observed.

TYPE: INDIA. KASHMIR: Rupal to Gurikot, 2500 m, 23 Aug 1939, *R.R. Stewart* & *I.D. Stewart 18893* (HOLOTYPE: DD).

Saccharum stewartii closely resembles *S. griffithii* Munro ex Boiss in having awned spikelets in short, articulate racemes borne on long panicles, acute or acuminate, membranous glumes, and lower florets all neuter. The two species can be separated as follows:

Panicle more than 20 cm; peduncle glabrous; racemes up to 2.5 cm long; callus hairs yellow or cream colored, 3–4 mm long; awn of upper lemma 4 mm long .... *S. griffithii*
Panicle up to 20 cm; peduncle hairy; racemes 6–7 cm long; callus hairs white, 6–8 mm long; awn of the upper lemma less than 3 mm long .... *S. stewartii*

Palynology

In addition to the above morphological differences the new species also reveals certain palynological differences with that of *S. griffithii*. The morphology of the pollen grains in the two species is discussed below.

Saccharum stewartii Rajeshwari, R.R. Rao & Garg

Grains 29.3 µm (29–29.6 µm) in diam, spheroidal with circular outline; typically monoporate, pores operculate, annulate. Annulus conspicuous. Exine surface finely granulate, granules of low relief, grouped in close proximity, sparse at annulus; exine 1 µm thick, thicker at the annulus region (2.25 µm), (Figs. 2 & 3).

Saccharum griffithii Munro ex Boiss

Grains 16 µm (15–18 µm) in diam, spheroidal with circular outline, typically monoporate, pores operculate, annulate. Annulus faint. Exine surface psilate with few punctae distantly scattered having a negative reticulum. Exine 1 µm thick, slightly varying in thickness near the aperture (Figs. 4 & 5).

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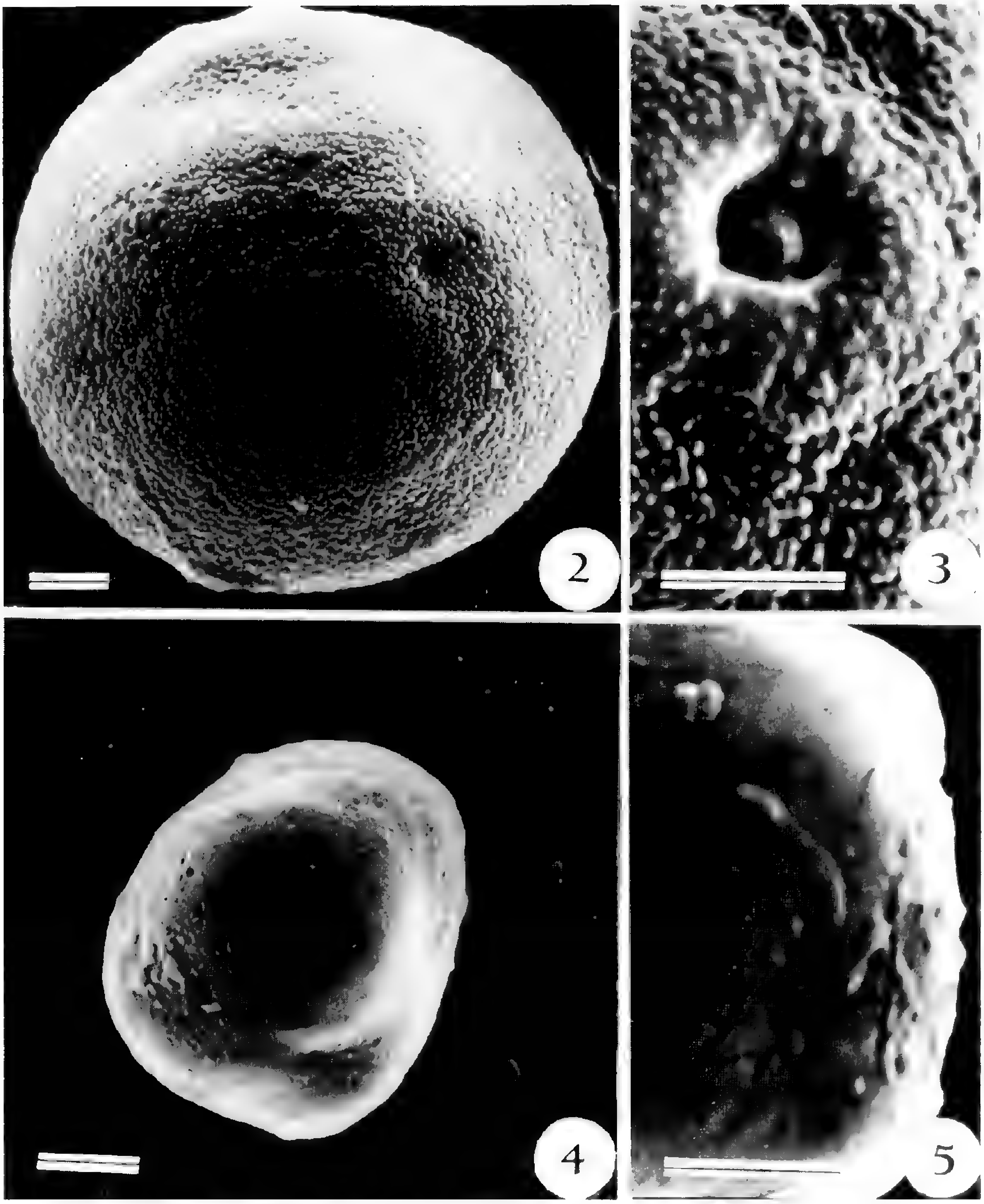

FIGS. 2–5. Scanning Electron Micrographs of pollen of *Saccharum stewartii* Rajeshwari, R.R. Rao & Garg (Figs. 2 & 3) and *Saccharum griffithii* Munro ex Boiss (Figs. 4 & 5). Scale lines = 3 µm

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POPULATION AND SITE CHARACTERISTICS OF A RECENTLY DISCOVERED DISJUNCT POPULATION OF *CROTON ALABAMENSIS* (EUPHORBIACEAE)

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ABSTRACT

A disjunct population of *Croton alabamensis* E. A. Smith ex Chapman, a Category 2 Candidate species being considered for addition to the List of Endangered and Threatened Plants, was discovered over 1000 km from any previously known population. This paper describes the extent and status of this disjunct population. The *Croton* population is situated along canyon bottoms and appears healthy and self-sustaining. *Croton* occurrence exhibits no association with overstory gaps, disturbance, or particular fluvial geomorphic features. The species appears to be restricted to canyon bottoms characterized only by mesic conditions provided by the presence of overstory cover and deep soils. Differences between the ecology of this newly discovered population and those of the heretofore considered endemic Alabama populations are discussed.

RESUMEN

Una población alopátrica de *Croton alabamensis* E. A. Smith ex Chapman, Categoría 2 de Especie Candidata, que está siendo considerada para ser agregada a la Lista de Plantas en Peligro de Extinción, fue descubierta a una distancia de 1000 km de la población previamente conocida. En este trabajo se describe la extensión y estado de la población alopátrica. La población de *Croton* esta situada a lo largo del fondo de un cañon aparentando poder sobrevivir y crecer en buenas condiciones. La ocurrencia de *Croton* no parece tener asociación con espacios desnudos, perturbaciones o características fluviales geomórficas

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particulares. La especie parece estar restringida al fondo del cañon caracterizado solamente por condiciones mesomórficas debidas a la presencia de cobertura y suelos profundos. Las diferencias entre las características de esta población recientemente descubierta y las de población heterofítica en Alabama, antes considerada endémica, son discutidas.

INTRODUCTION

Croton alabamensis E. A. Smith ex Chapman (Euphorbiaceae) has been described as "one of the rarest shrubs in the United States" (Farmer and Thomas 1969). It is a short-lived (<20 y), multi-stemmed, monoecious shrub <3 m tall found primarily on limestone and shale outcrops along the Warrior and Cahaba Rivers, Tuscaloosa and Bibb counties, Alabama. It was collected once in 1899 in Tullahoma, Coffee County, Tennessee, but has not been reported from there subsequently. *Croton alabamensis* has long been thought to grow only in isolated populations within these two neighboring counties. Due to its restricted range, it is being considered for addition to the List of Endangered and Threatened Plants under the Endangered Species Act of 1973, as amended. It currently is designated as a Category 2 Candidate, which means that "there is some evidence for vulnerability, but ... there are not enough data to support listing proposals at this time" (USDI 1991).

In early 1990, *Croton alabamensis* was discovered over 1000 km from any previously known population on the U.S. Army's Fort Hood, Texas. The population was discovered by John Cornelius, a wildlife biologist with the Fort Hood Resource Management Department, during an excursion to view bird habitat in the Owl Creek Mountains. Cornelius showed the population several weeks later to Carol Beardmore of the U.S. Fish and Wildlife Service and Rex Wahl of Texas Parks and Wildlife. Ginzbarg (1992) mistakenly credited the discovery to Beardmore and Wahl. Not long afterwards, a second and a third population were discovered in Travis County, to the south. The species identity was determined by Steve Ginzbarg, a graduate student in botany at the University of Texas, Austin. Ginzbarg (1992) subsequently determined that the Texas plants are sufficiently distinct to merit varietal status. He consequently described them as *Croton alabamensis* E. A. Smith ex Chapman var. *texensis* Ginzbarg (Ginzbarg 1992). Key characteristics of the Texas variety are represented in Figures 1 and 2.

In June 1991, we undertook to describe the extent and status of the population at Fort Hood as part of the Department of Defense's Legacy Resource Management Program. The Legacy Program was established to enhance conservation of biologically and culturally significant resources on military lands. Our study is aimed at gathering the requisite information to effect proper stewardship of this species at Ft. Hood. We therefore restricted our analysis to only one of the three Texas populations (i.e. the Ft. Hood population). We recommend that similar studies be undertaken in both

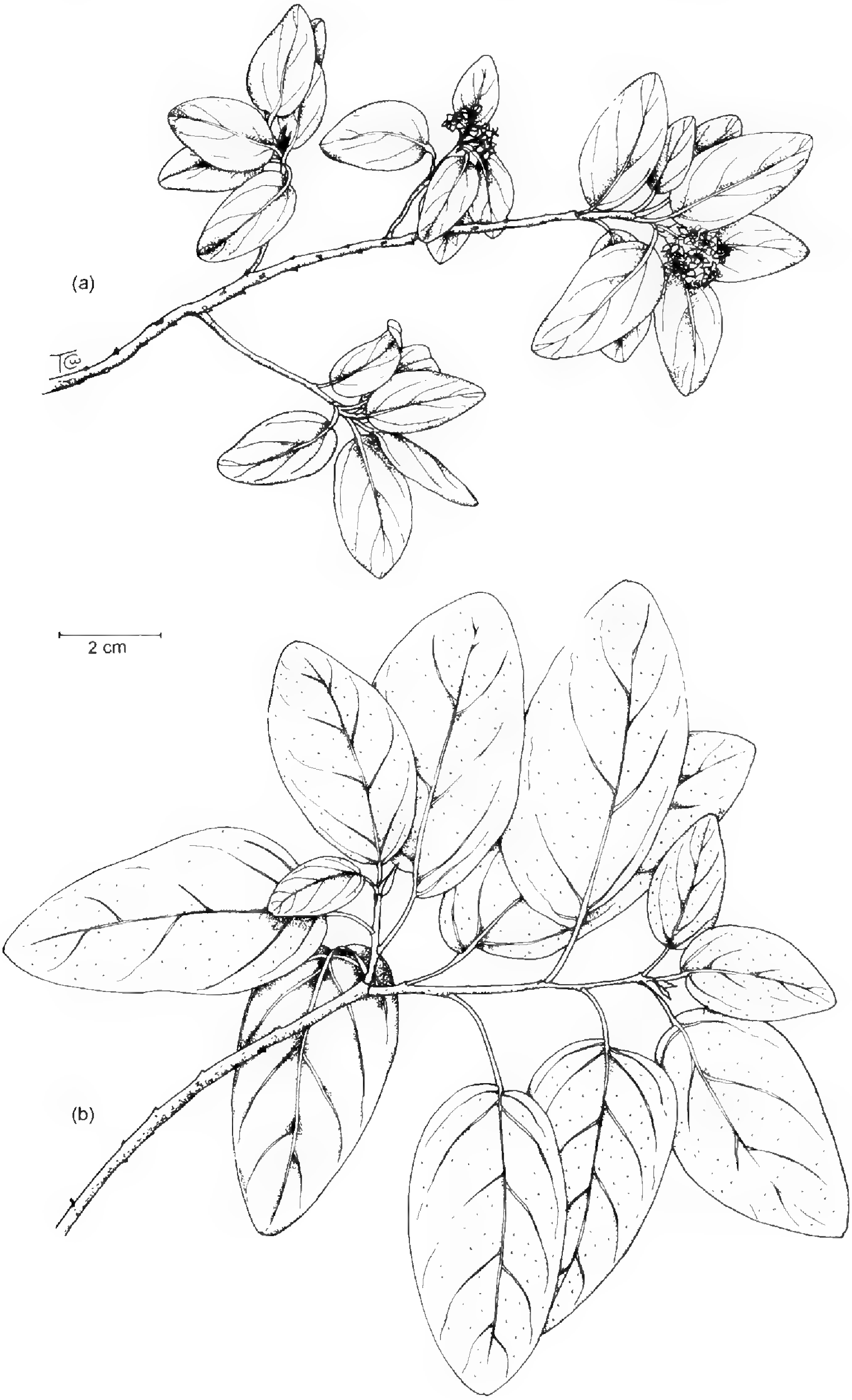

FIG. 1. *Croton alabamensis* var. *texensis*: (a) stem with flowers clustered at the apex of primary and secondary branches (flowers open before leaves are fully expanded), (b) stem showing fully developed leaves.

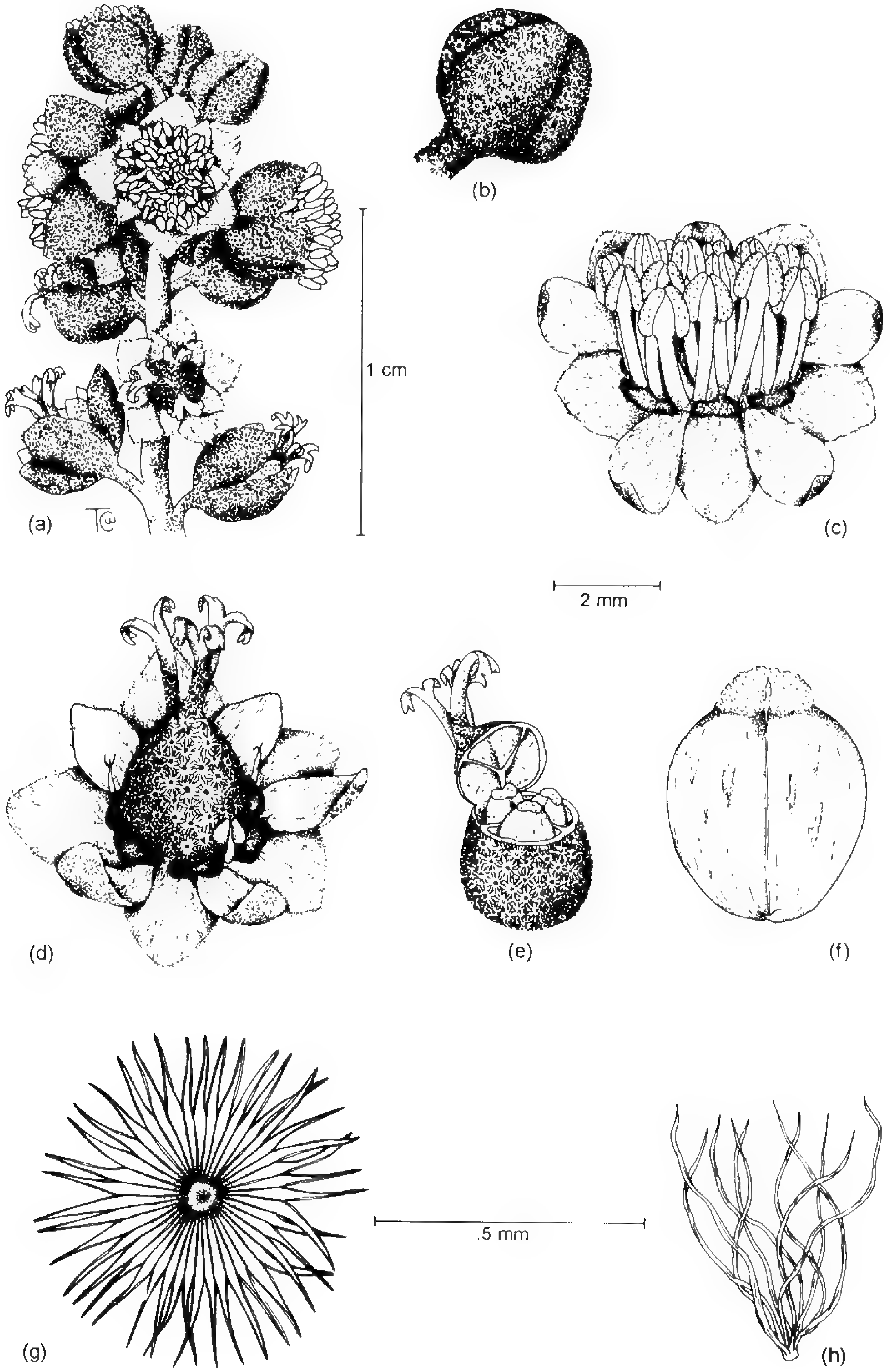

FIG. 2. *Croton alabamensis* var. *texensis*: (a) androgynous raceme inflorescence, (b) maleflower bud, (c) male flower, (d) female flower with rudimentary stamens, (e) 3-celled capsule, (f) seed, (g) stellate trichome common on leaves, buds, and ovary, (h) trichome found on disk lobes of male and female flowers.

Texas and Alabama to assess the status of all populations of this rare and scientifically important species.

STUDY AREA

This study was conducted in several small watersheds of the Owl Creek Mountains, Bell and Coryell counties, in the Hill Country of central Texas (31°N, 97°W). The Owl Creek Mountains (elevation ~300 m) are composed of Mesozoic limestone overlain by clayey and loamy soils (McCaleb 1985). The formation rises to its summit plateau ~65 m above the west-to-east flowing Owl Creek in less than 2 km. Intermittent tributary streams run northward to the creeksuch that virtually all canyon walls have east- and west-facing aspects.

The climate is hot in the summer, and the winters are generally mild, with an occasional cold surge. The average daily temperature during the summer is 28°C, with an average daily maximum of 36°C. Winter daily temperatures average 9°C, with an average low of 3°C. Rainfall is distributed uniformly throughout the year, with a slight peak in the spring and an average annual total of 825 mm (McCaleb 1985). Owl Creek flows to some extent throughout the year, but the tributary streams are dry most of the year.

The vegetation of the area (see Appendix 1 for complete plant species list) is primarily Ashe juniper (*Juniperus ashei* Buchh.) woodland of the appropriate character to meet the habitat needs of two rare birds, the black-capped vireo (*Vireo atricapilla*) and the golden-cheeked warbler (*Dendroica chrysoparia*). The vireo primarily inhabits the shrubby balds of the summit plateau, but the warbler requires the bark of relatively old junipers for nesting materials and mature hardwoods for feeding (J. Cornelius pers. comm.).

Prior to our study, *Croton alabamensis* var. *texensis* had been identified from two of the tributary canyons of Owl Creek. We searched five additional canyons and found only three more plants in the canyon between the original two and several plants along the stretch of Owl Creek between the two tributaries; populations of *Croton* appear to be largely restricted to the two original canyons. Our study involved two phases: a description of the structure and habitat of the two *Croton* populations (canyons 1 and 3) and an attempt to discern why *Croton* is all but absent from the canyon between (canyon 2). Subsequent to the completion of this study, another population consisting of 35 individuals was located in a canyon three km east of the study area. This population is not considered in our analysis.

METHODS

The bed of each of the three canyons was mapped using a tape and a hand-held compass. The slope of the creek was measured using a hand-held clinometer. Three high density stands of *C. alabamensis* var. *texensis* were identified for intensive sampling along the creekbeds in Canyons 1 and 3. At each sample location, two transects were established perpendicular to the creekbed to facilitate sampling of both east- and west-facing aspects. In Canyon 2, which lacked *Croton*, similar pairs of transects were established at distances up the canyon comparable to those identified in Canyons 1 and 3.

Slope topography, overstory and understory cover, *Croton* seedling density, *Croton* adult population structure, and soil depth were determined along each transect. At each site, a tape was stretched upslope beyond the extent of the *Croton* population. In some cases, this was as far as 60 m from the creekbed, but was generally less. Transects in Canyon 2 were 30–40 m long. Slope breaks and important topographic features were noted along the slope, and a cross-section map was prepared for each transect. Soil depths were measured at 10 m intervals and at important topographic features by probing the soil with a 1 m rod.

Along the tape, cover of overstory (>2 m tall) and understory (<2 m but >10 cm tall) vegetation was determined using the line-intercept method (Mueller-Dombois and Ellenberg 1974). The line also served as the center of a 2 m wide *Croton* seedling belt in which individuals <30 cm tall were tallied.

Croton >30 cm tall were sampled using a modified nearest-neighbor method adapted from those described by Mueller-Dombois and Ellenberg (1974). Starting at the beginning of the line (middle of the creekbed), a 180° arc was searched upslope for an individual of *Croton* >30 cm tall. The distance and azimuth to the nearest plant were recorded as were the height of the tallest shoot and the diameter of each live shoot (to the nearest 0.5 cm). From that plant, the process was repeated until no plants could be found within 10 m of the last plant (Fig 3). In only one case, the process was suspended and moved back to the tape when the search led to a plant >10 m from the tape. Thus, all plants were sampled within 10 m of the tape.

Consistent with other nearest-neighbor methods, the distance between plants was assumed to be related to the share of the total area allotted to an individual plant. From these data, population density could be calculated as the total number of plants sampled divided by the sum of areas allotted to individual plants. Additionally, using a simple trigonometric conversion, the density represented by individual plants could be plotted against distance from the creek to assess changes in density related to environmental variables.

Sizes of individual, multi-stemmed *Croton* plants were described using the statistic of equivalent diameter (D_{eq}). Equivalent diameter is the diameter of a single stem that possesses the same cross-sectional area as the sum of all the stems borne by the plant. For example, as the total cross-sectional area of four shoots, each 2 cm in diameter (4×3.14 cm^2) is equal to that of one shoot, 4 cm in diameter (12.56 cm^2), the D_{eq} for the four shoots is 4 cm.

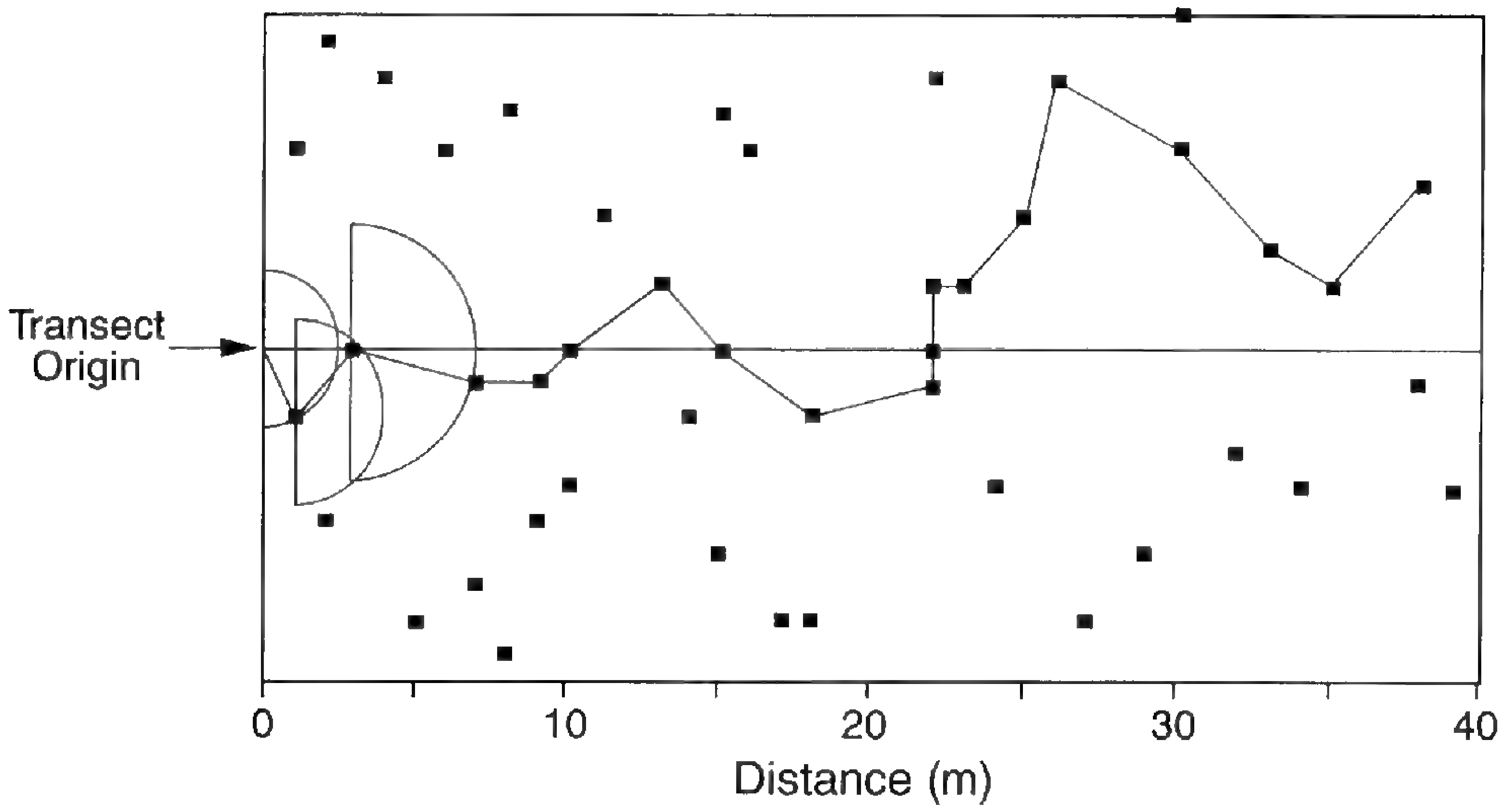

FIG.3. Illustration of the modified nearest neighbor method for sampling *Croton* height, and diameter and calculating density. Solid squares indicate plant locations within a hypothetical transect. Solid squares connected by line indicate sampled plants.

RESULTS

Autecology

The population structures of *Croton alabamensis* var. *texensis* in the two canyons are presented in Figure 4. In both canyons, *Croton* was well represented in the smaller diameter classes, but also occurred as large mature plants. This decreasing monotonic population structure was found in all transects in which *Croton* was relatively dense. Therefore, both canyons appeared to support healthy populations of adults, juveniles, and new recruits.

Croton density was highly variable within Canyons 1 and 3. Each canyon contained places in which scarcely an individual was found. In other places, *Croton* formed dense thickets in which it dominated to the near exclusion of other understory species. The densest stands occurred in Canyon 1 where *Croton* density (adults and seedlings) in two transects exceeded 100 plants/100 m^2, but three transects in Canyon 3 exceeded 50 plants/100 m^2 (Table 1). Overall, we estimate the number of plants occurring in the 1.5 km of creekbed in Canyons 1 and 3 to be ~20,000 individuals.

In general, *Croton* was found only in the canyon bottoms. No individuals were found >60 m from the creek, and of the 12 transects containing *Croton*, only four contained plants >40 m from the creek. *Croton* density fluctuated, but *Croton* did not decline proportionally with distance from the creek.

Canopy gaps along the line intercept showed no correlation with *Croton* occurrence. *Croton* were found in openings and in the deepest shade. The canyons of the Owl Creek Mountains have been subjected to harvesting of juniper trees for fence posts, and some of the gaps may have been anthropogenic.

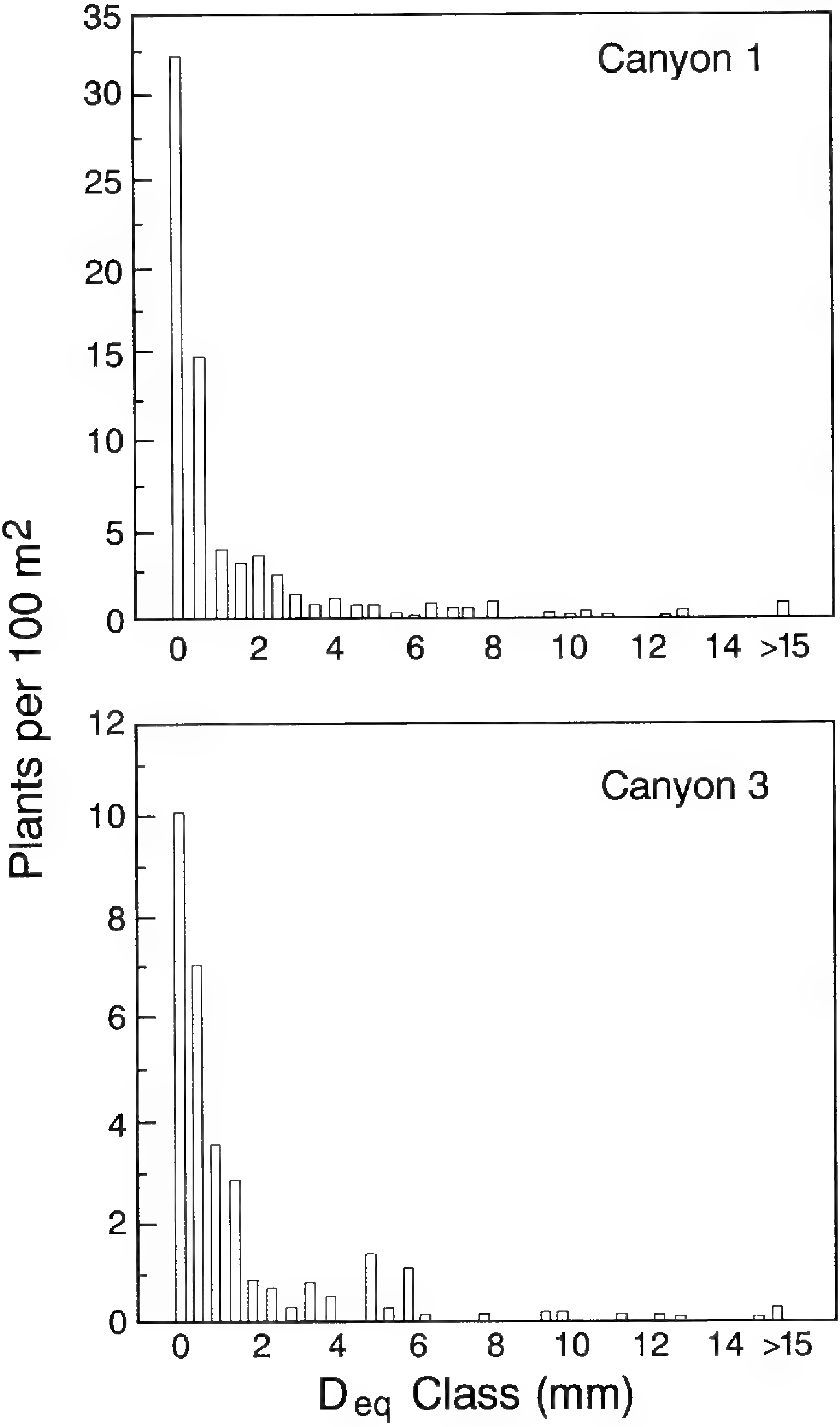

FIG. 4. *Croton* population size structures, indicating number of plants by equivalent diameter (D_{eq}) class. See text for explanation.

TABLE 1. Characteristics of the 18 transects.

		VEGETATION COVE					CROTON	
Canyon	Tran	>2m (%)	<2m (%)	Slope (%)	Aspect	Watershed Size (ha)	Density (#/100m^2)	
1	1	77	21	16.7	E	1400	16.2	23.2
1	2	85	37	30.0	W	1400	46.8	61.2
1	3	69	18	16.7	E	925	5.1	28.2
1	4	50	39	10.0	W	925	13.1	12.6
1	5	75	50	18.3	W	800	98.6	91.0
1	6	94	38	33.3	E	800	13.0	18.2
2	1	74	16	53.3	W	425	0	0
2	2	77	25	16.7	E	425	0	0
2	3	90	37	33.3	E	375	0	0
2	4	52	39	13.3	W	375	0	0
2	5	75	42	53.3	E	325	0	0
2	6	66	37	30.0	W	325	0	0
3	1	89	23	25.0	E	600	2.1	13.4
3	2	84	49	10.0	W	600	2.0	4.4
3	3	96	54	60.0	E	350	9.7	55.8
3	4	99	30	21.7	W	350	23.1	19.9
3	5	99	47	30.0	W	325	23.4	28.6
3	6	77	39	60.0	E	325	0	2.1

In some cases, the loggers incidentally cut adult *Croton* along roads and skid trails, but the plants sprouted and were growing well.

Topographic features also showed no direct correlation with *Croton* density. *Croton* occurred on bank slopes, terraces, and on toeslopes of each canyon. Soil depth, however, explained much of the variability in *Croton* distribution. A comparison of soil depth with the presence of *Croton* along the transect indicated a significant association of adult plants with deep soil ($p<0.05$; Kruskal-Wallis test). Our inability to measure depths in excess of 1 m means that the measured mean soil depth in the presence of *Croton* (0.80 m; $n=64$) was probably considerably less than the true mean. In contrast, soil measurements in the absence of *Croton* averaged only 0.42 m ($n=33$) in Canyons 1 and 3.

Comparison of *Croton* density with overstory species composition suggests an association with mesic sites, as would be expected from the observed restriction of *Croton* to the canyon bottoms. Figure 5 shows the relationship of adult *Croton* density to the combined cover of *Fraxinus texensis* (Gray) Sarg. and *Quercus muhlenbergii* Engelm. and to the combined cover of *Juniperus ashei* and *Quercus texana* Buckl. within 40 m of the creek. These four species dominated the overstory stratum in these canyons; only the woody vine *Vitis mustangensis* Buckl. contributed comparable cover over the study area. Of the

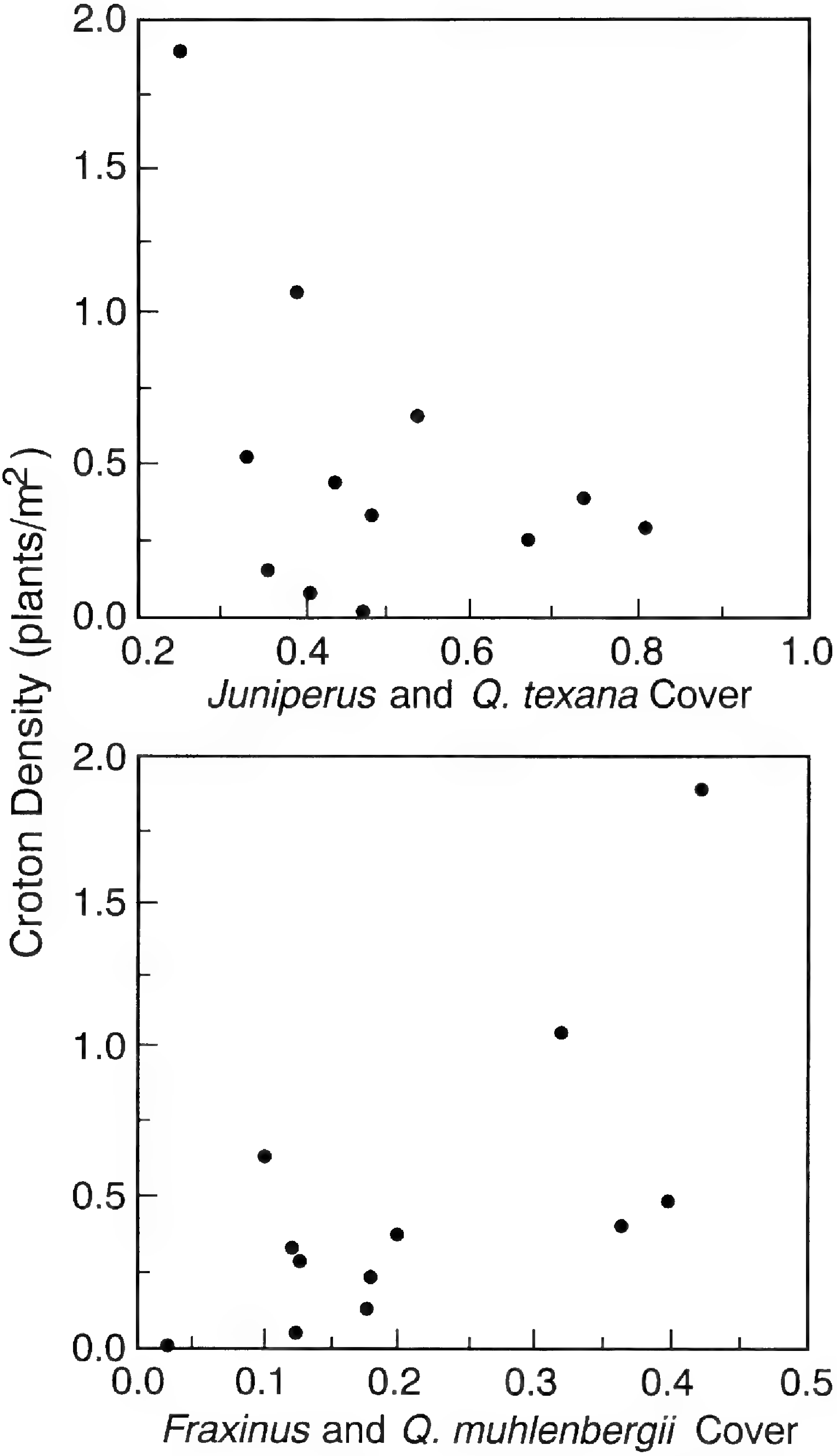

FIG. 5. Relationship of adult *Croton* density to combined cover of *Fraxinus texensis* and *Quercus muhlenbergii* and the combined cover of *Juniperus ashei* and *Quercus texana*.

three species of oak encountered during sampling, *Q. muhlenbergii* is the most mesic (Miller and Lamb 1985), and *Fraxinus* is found primarily in canyons (Correll and Johnston 1970). *Juniperus* is not so restricted, and *Q. texana* is described as occurring on "dry limestone hills and ridges" (Miller and Lamb 1985). In the study area, *Croton* was more abundant on mesic transects in which *Fraxinus* and *Q. muhlenbergii* were common and less abundant on dry transects in which *J. ashei* and *Q. texana* were most common.

Synecology

The four tree species listed above dominated the vegetation of all three canyons. Figure 6 shows the contribution of these species to the overstory cover within 40 m of the creek (40 m was used as the limit of *Croton* habitat). The dominant species in all three canyons was clearly *J. ashei*, which contributed about one-third of the cover. The other three species collectively contributed another third. These four were the only species to contribute >10% relative cover in one of the three canyons, although some species, such as *V. mustangensis*, *Ulmus crassifolia*, Nutt. *Juglans major* (Torr.) Heller., and *Celtis laevigata* Willd. were abundant locally (Appendix 2). All overstory species contributing <10% relative cover are included in Figure 6 as "minor species."

In an attempt to discern differences in habitat characters between the canyons supporting *Croton* populations and Canyon 2, we subjected transect cover data to principal components analysis (PCA) (SAS/STAT User's Guide 1988). If the transects in Canyon 2 differed in overstory composition from the other two canyons, those sites would have segregated as a distinct habitat type. Canyon 2 showed no difference in habitat from the other two as expressed in overstory composition (Fig. 7).

Likewise, understory cover displayed no pattern related to *Croton* occurrence. With the exception of *Croton* itself, all three canyons supported similar understory communities (Appendix 2). In the two canyons in which it occurred, understory *Croton* cover averaged 10.4%. (Again, placement of the transects was biased by the presence of dense populations.) Other relatively abundant understory species included *Fraxinus* species (5.5%), *V. mustangensis* (3.9%), *Rhamnus caroliniana* Walt. (3.4%), *J. ashei* (3.2%), *Rhus toxicodendron* L. (2.6%), various grasses (2.4%), *Q. texana* (2.1%), and *Ilex decidua* Walt. (2.0%).

The three canyons differed very little in both total overstory and understory cover. Overstory cover ranged from 50% in one transect in Canyon 1 to 99% in two transects in Canyon 3, but no significant difference occurred among canyons (Table 1). Similarly, understory cover ranged from 16% in one Canyon 2 transect to 54% in a Canyon 3 transect, but canyon means were similar.

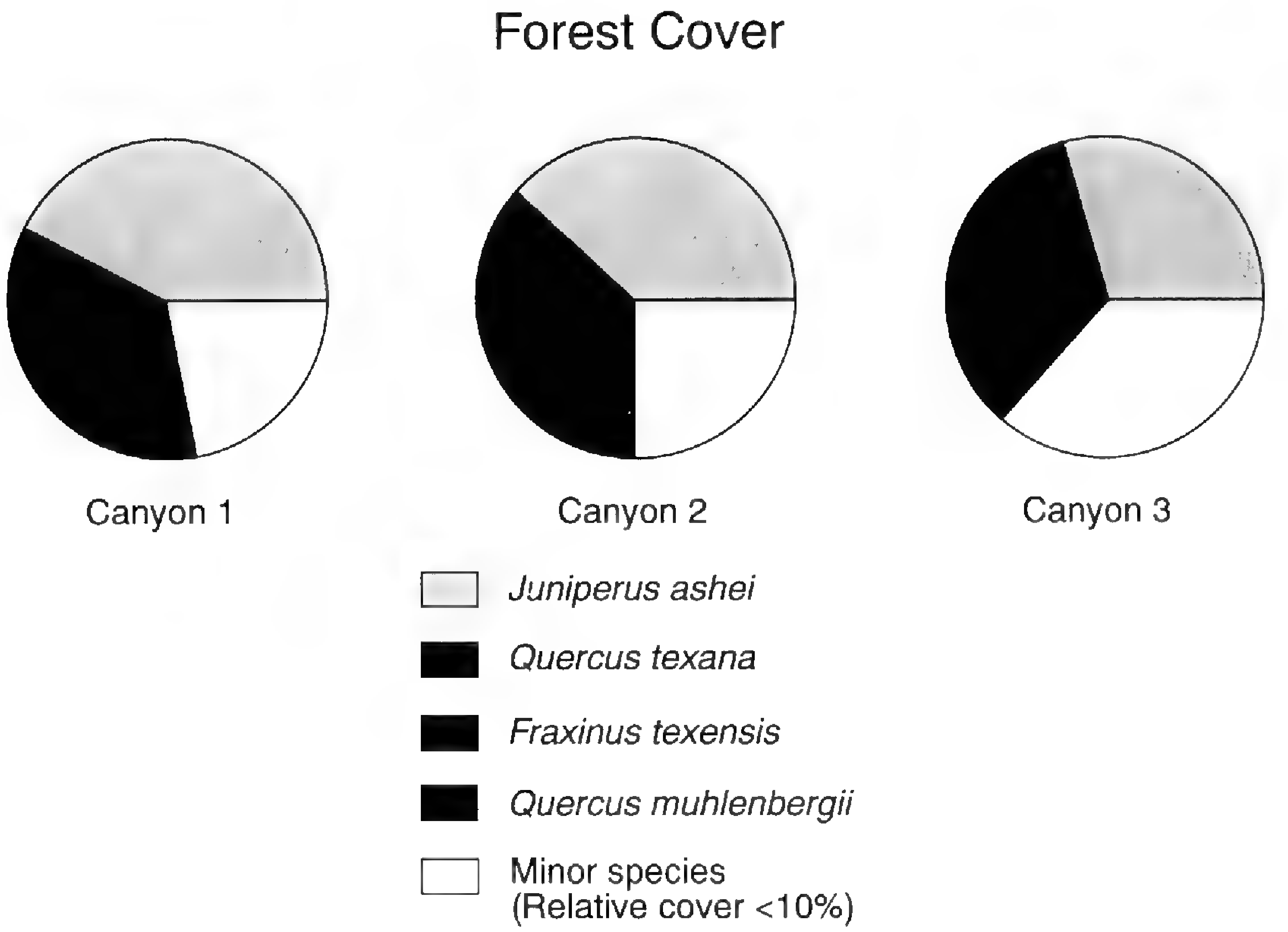

FIG. 6. Relative cover of the four dominant overstory species. All overstory species contributing <10% relative cover are included as "minor species."

Steepness of canyon walls within 40 m of the creek varied widely from site to site (10% to 60%), but means from the three canyons were similar (Table 1). Canyons 1 and 3 were the largest watersheds, but watershed areas above *Croton* populations in Canyon 3 were no larger than those present in Canyon 2. Likewise, soils of a depth that favored *Croton* in Canyons 1 and 3 were abundant in Canyon 2. The only morphological feature distinguishing Canyon 2 from Canyons 1 and 3 was the steepness of the creekbed. Streambed gradient in Canyon 2 (3.81%) was significantly steeper than in Canyons 1 and 3 (1.92% and 2.11%) ($p<0.05$; Kruskall-Wallis test).

DISCUSSION

Croton alabamensis var. *texensis* in the Owl Creek Mountains grows in healthy, self-sustaining populations along the bottoms of tributary canyons and the connecting section of Owl Creek. *Croton* occurrence exhibits no association with overstory gaps, disturbance, or particular fluvial geomorphic features. It appears to be restricted to canyon bottoms characterized only by mesic conditions provided by the presence of overstory cover and deep soils. There is some suggestion that high cover of *F. texensis* and *Q. muhlenbergii* indicates a good site for *Croton*.

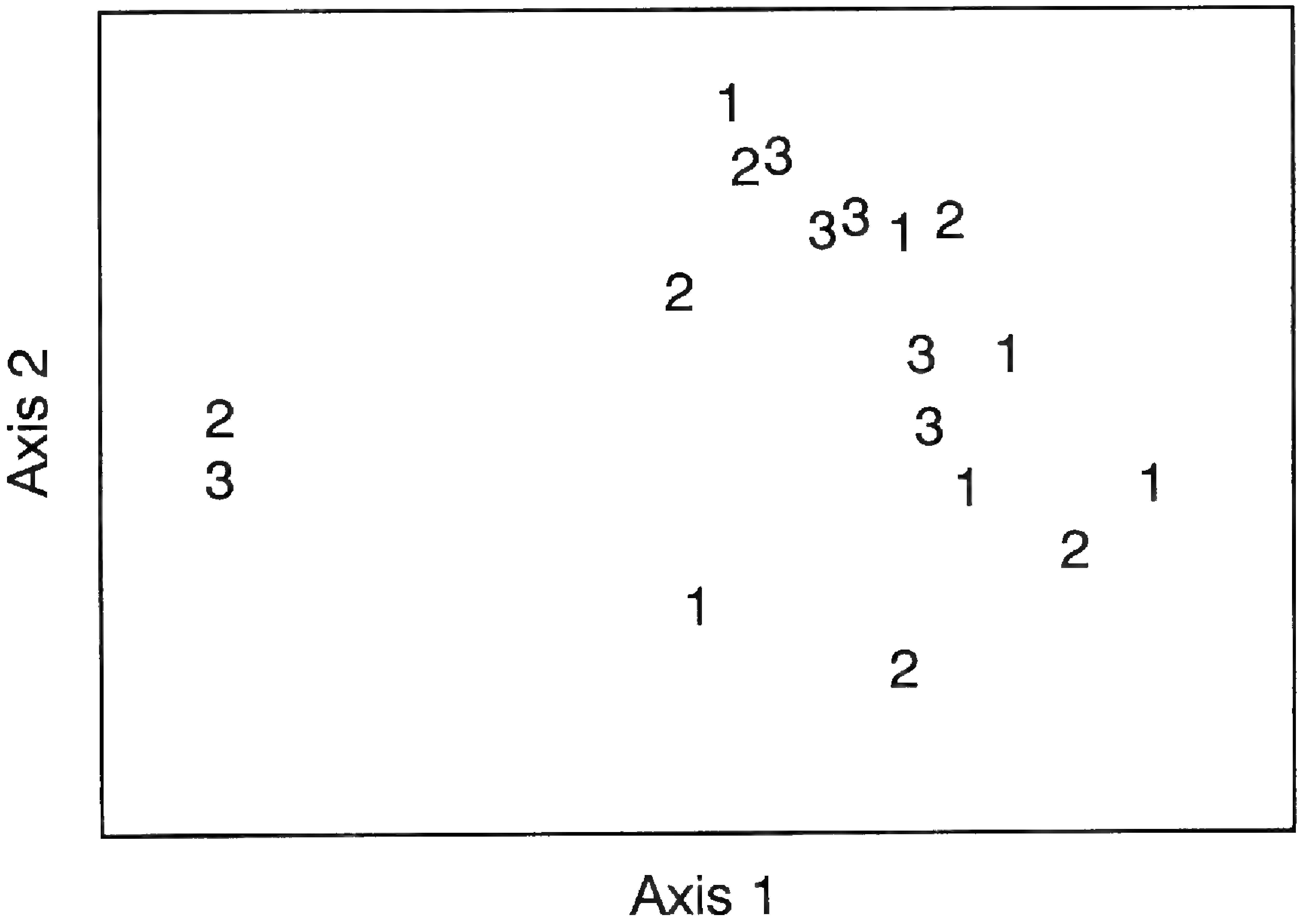

FIG. 7. Results of principal components analysis of cover data for all three canyons. Symbols identify locations of plots by canyon. Lack of segregation indicates that Canyon 2 did not differ in overstory composition from Canyons 1 and 3.

The distribution of *Croton* does not appear to be limited by the availability of sites. Canyon 2, which contained only 3 plants, supported a similar overstory and understory to Canyons 1 and 3. Canyon 2 also contained deep soils and a similar geomorphology to the other two canyons. Likewise, watershed size did not appear to explain *Croton* presence. The only feature that differed among canyons was stream gradient.

Hupp (1988) discusses several ways in which stream channel geomorphology affects vegetation, including fluvial landforms, flood frequency and duration, and stream gradient. It would be consistent with other observations if the steeper gradient of Canyon 2 afforded a less mesic environment that discouraged *Croton* survival. However, fluvial processes in these arid intermittent channels are quite different from those of the eastern floodplain systems that Hupp discusses, and channel gradient is offered only speculatively as a factor explaining *Croton* distribution.

The larger question of how *C. alabamensis* var. *texensis* came to occupy disjunct sites in Alabama and Texas is beyond the scope of this study. Although Ginzbarg (1992) discusses the possibility that the present distribution may be an ice age relict, he suggests that the Texas populations may be more easily explained as the result of relatively recent introduction by long distance seed dispersal by birds. Regardless, it is likely that the disjunct distribution resulted from a prolonged process of migration, colonization, and extinction of many sites. The absence of *Croton* from Canyon 2 may reflect not the lack of available habitat, but the vagaries of colonization and extinction. Perhaps a population once thrived there and has gone extinct, or seeds have, by chance, not recently reached this canyon. More likely, the canyons of the Owl Creek Mountains and similar features of the Edwards Plateau support metapopulations of *Croton alabamensis* var. *texensis*, each subpopulation establishing, thriving, and going extinct only to be replaced somewhere else. Only through repeated observations over long time periods will we understand the process.

Regardless of the limitations on its range within the study area, the behavior of *C. alabamensis* in the Owl Creek Mountains is dramatically different from its behavior in Alabama. Farmer (1962) describes *Croton* as occurring on shallow soils and rock outcrops at mid-slope positions in two counties in Alabama. He describes the habitat as "shallow soil ... on moderately- to steeply-sloping terrain; high temperature of soil and air during summer; intense drought; and freedom from fire." Soil is described as "usually only a few cm thick and seldom more than 1 m thick." In our study site, *Croton* occurs on deep soils on toeslopes and fluvial deposits of canyon bottoms.

The groves in Alabama are "marked by shrub dominance, few or no large trees, and a relative absence of herbs" (Farmer 1962). Occasional plants are found under the forest canopy surrounding the outcrops, but these are considered only "extensions of nearby thickets". This contrasts sharply with *Croton* behavior in Texas. In our study sites, *Croton* occurs as an understory shrub in the company of many large trees and a healthy herb layer.

Farmer considers adaptation to extreme drought to be an important factor in the ecology and distribution of *C. alabamensis* in Alabama (see above). In Texas, however, this species behaves as a drought avoider by remaining in mesic canyon bottoms. Perhaps these differences result only from perceptions relative to annual climate and surrounding vegetation. The 3–5 inches (7–12 cm) of monthly precipitation that Farmer (1962) reports for the "dry" season in Alabama is considerably greater that the 2–3 inches (5–7 cm) recorded for summer months in central Texas (McCaleb 1985). In Texas, where upland vegetation is necessarily drought adapted, a species requiring 7–12 cm of precipitation naturally would be restricted to the most mesic sites.

Another interesting difference between *Croton* behavior in Alabama and Texas regards vegetative reproduction. Farmer (1962) discounts asexual reproduction in *Croton* by stating that "there are no rhizomes or adventitious rootings that result in plant reproduction." In Texas, however, we observed numerous plants that had produced "new" upright shoots through the nodal rooting (layering) of prostrate branches. We did not investigate the degree of connectivity between the layered offspring and the parent plants, but layering appears to be a potential mechanism of asexual reproduction in *C. alabamensis* var. *texensis*.

CONCLUSIONS

The disparate behaviors exhibited by this species over its disjunct range underscore the necessity for site-specific studies prior to making management recommendations. The ecology of *Croton* in Alabama would suggest a conservation strategy that might well be unsuccessful in Texas. The Alabama ecology implies preservation of, and population augmentation into, dry, open, limestone outcrops. This strategy, if adopted in Texas, likely would fail miserably.

We know very little of the disturbance ecology of *C. alabamensis* var. *texensis* in central Texas. The species apparently tolerates some degree of physical disturbance as plants injured or cut off during the pole cutting operation appear to have recovered well. We know nothing, however, of the species' response to fire or soil disturbance. In Alabama, fire is believed to be lethal to *Croton* (Farmer 1962). We saw nothing to indicate a dependence on disturbance for establishment. Conservation efforts, therefore, should focus on maintenance of the undisturbed nature of the mesic forests of the area. Construction of new roads for military training and logging should be discouraged, and old roads should be allowed to fall into disuse. The importance of this plant community has already been recognized for a rare bird; it now appears to be critical to the survival of a rare plant as well.

ACKNOWLEDGMENTS

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APPENDIX 1

Species encountered during line-intercept sampling. Taxonomy follows Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation. Renner, Texas.

ACRONYM	SPECIES	FAMILY	GROWTH FORM[1]
ACLI	*Acalypha lindheimeri*	Euphorbiaceae	H
AMAR	*Ampelopsis arborea*	Vitaceae	V
AQHE	Unidentified aquatic emergent		H
ARSI	*Argythamnia simulans*	Euphorbiaceae	H
BULA	*Bumelia lanuginosa*	Sapotaceae	T
CADR	*Calylophus drummondianus*	Onagraceae	H
CAREX	*Carex* spp.	Cyperaceae	G
CEHE	*Ceanothus herbaceus*	Rhamnaceae	T
CELA	*Celtis laevigata*	Ulmaceae	T
CEOC	*Cephalanthus occidentalis*	Rubiaceae	T
CERE	*Celtis reticulata*	Ulmaceae	T
CLTE	*Clematis texensis*	Ranunculaceae	H
CODR	*Cornus drummondii*	Cornaceae	T
COER	*Commelina erecta*	Commelinaceae	H
CRAL	*Croton alabamensis*	Euphorbiaceae	T
CYBA	*Cynanchum barbigerum* var. *texensis*	Asclepiadaceae	H
CYUN	*Cynanchum unifarium*	Asclepiadaceae	H
DITE	*Diospyros texana*	Ebenaceae	T
FRTE	*Fraxinus texensis*	Oleaceae	T
GARE	*Galactia regularis*	Fabaceae	H
GRASS	Various grasses[2]	Poaceae	G
HESP	*Helianthus* sp.	Asteraceae	H
ILDE	*Ilex decidua*	Aquifoliaceae	T
INMI	*Indigofera miniata*	Fabaceae	H
JUAS	*Juniperus ashei*	Cupressaceae	T
JUMA	*Juglans major*	Juglandaceae	T
LEVI	*Lespedeza violacea*	Fabaceae	H
LOJA	*Lonicera japonica*	Caprifoliaceae	H
MEAL	*Melilotus albus*	Fabaceae	H
MIRE	*Mitchella repens*	Rubiaceae	H
MORU	*Morus rubra*	Moraceae	T
OPPH	*Opuntia phaeacantha*	Cactaceae	H
PALU	*Passiflora lutea*	Passifloraceae	V
PAPE	*Parietaria pensylvanica*	Urticaceae	H
PAQU	*Parthenocissus quinquefolia*	Vitaceae	V
PLOC	*Platanus occidentalis*	Platanaceae	T
PODO	*Polanisia dodecandra*	Capparidaceae	H
PRMU	*Prunus munsoniana*	Rosaceae	T
PRSE	*Prunus serotina*	Rosaceae	T
QUMU	*Quercus muhlenbergii*	Fagaceae	T
QUSI	*Quercus sinuata* var. *breviloba*	Fagaceae	T
QUTE	*Quercus texana*	Fagaceae	T
RHAR	*Rhus aromatica*	Anacardiaceae	T
RHCA	*Rhamnus caroliniana*	Rhamnaceae	T
RHTO	*Rhus toxicodendron*	Anacardiaceae	T/V
RHVI	*Rhus virens*	Anacardiaceae	T

APPENDIX 1 *continued*

ACRONYM	SPECIES	FAMILY	GROWTH FORM[1]
RUBI	*Rubus bifrons*	Rosaceae	T/V
SARO	*Salvia roemeriana*	Lamiaceae	H
SMBO	*Smilax bona-nox*	Smilacaceae	V
SOAF	*Sophora affinis*	Fabaceae	T
SOSE	*Sophora secundiflora*	Fabaceae	T
STPL	*Styrax platanifolia*	Styracaceae	T
ULCR	*Ulmus crassifolia*	Ulmaceae	T
UNHE	Various unidentified herbs		H
UNSP	*Ungnadia speciosa*	Sapindaceae	T
VEVI	*Verbesina virginica*	Asteraceae	H
VIMU	*Vitis mustangensis*	Vitaceae	V
YURU	*Yucca rupicola*	Liliaceae	H

[1] G=Grass or grasslike plants; H=Herbaceous plants; T=Trees or shrubs; V=Vines

[2] Grasses encountered during sampling include *Aristida purpurascens*, *Bothriochloa* sp., *Bromus pubescens*, *Dichanthelium acuminatum* var. *implicatum*, and *Glyceria striata*.

APPENDIX 2

Absolute percent cover and frequency of occurrence (no. of transects) of all species encountered during line-intercept sampling. Percent cover is reported for overstory (> 2m) and understory (< 2m) in each canyon. Species are listed in descending order of dominance over the study area, ALLCOV, where ALLCOV was calculated as (overstory cover + understory cover)/3. Plot placement in canyons 1 and 3 was biased by the presence of *Croton* (see text).

	OVERSTORY COVER				UNDERSTORY COVER				
ACRONYM	CYN 1	CYN 2	CYN 3	FREQ	CYN 1	CYN 2	CYN 3	FREQ	ALLCOV
JUAS	51.60	49.67	49.88	18	1.54	3.37	4.67	14	53.58
FRTE	16.50	13.18	26.21	17	3.88	4.93	7.71	18	24.14
QUTE	15.59	29.09	20.11	17	3.69	2.23	0.42	11	23.71
VIMU	9.87	11.68	14.35	13	3.21	3.26	5.29	15	15.89
QUMU	13.39	6.33	8.65	10	0.69	0.18	0.21	6	9.82
RHCA	4.58	2.92	4.87	10	1.21	1.55	7.00	13	7.37
ILDE	5.60	5.62	4.43	13	1.37	3.40	1.17	11	7.19
CRAL	0.22			1	11.24		9.46	11	6.97
ULCR	2.02	4.14	10.67	7		0.75	0.63	3	6.07
JUMA		2.87	8.74	6	0.58		0.04	2	4.08
CELA			9.11	3					3.04
RHTO					2.28	2.90	2.57	15	2.58
GRASS					2.28	2.96	1.90	13	2.38
PRSE	1.95	2.61		6	1.22	1.10		5	2.29
QUSI	3.17	0.33		3	0.83	1.58	0.04	8	1.99
SMBO	0.22	0.08	2.09	5	0.17	1.33	0.68	10	1.52
STPL			1.94	2	0.08	1.05	0.04	3	1.04
CAREX				0.04	2.13	0.90	9	1.02	
BULA	0.14		2.19	3	0.04	0.14	0.11	3	0.88
MORU		0.06	2.39	3					0.81
RHVI		0.58	0.28	2	0.17	0.33	0.72	3	0.69
PLOC	2.03			2					0.68

APPENDIX 2 *continued*

	OVERSTORY COVER				UNDERSTORY COVER				
ACRONYM	CYN 1	CYN 2	CYN 3	FREQ	CYN 1	CYN 2	CYN 3	FREQ	ALLCOV
SOSE		1.21		1	0.04	0.21	0.47	4	0.64
PAQU			0.63	1	0.25	0.63	0.11	8	0.54
COER							1.36	3	0.45
HESP							1.15	3	0.38
VEVI						0.45	0.39	4	0.28
YURU						0.33	0.50	2	0.28
CEOC						0.83		1	0.28
AMAR			0.67	1	0.08		0.04	2	0.26
LEVI						0.43	0.25	2	0.23
PODO					0.29	0.21	0.13	6	0.21
UNSP						0.57		1	0.19
DITE			0.33	1		0.23		2	0.19
RHAR					0.29		0.17	4	0.15
CERE		0.46		1					0.15
SARO						0.30	0.14	5	0.15
INMI						0.42		1	0.14
AQHE					0.42			2	0.14
UNHE					0.08	0.12	0.17	5	0.13
MEAL						0.29		1	0.10
SOAF						0.25		1	0.08
PRMU						0.23		2	0.08
CODR					0.21			1	0.07
OPPH					0.08	0.10		2	0.06
PALU							0.17	1	0.06
CEHE	0.11			1					0.04
GARE							0.08	1	0.03
LOJA						0.08		1	0.03
RUBI						0.08		1	0.03
MIRE							0.08	1	0.03
CLTE							0.08	1	0.03
CYBA			0.03	1			0.04	1	0.02
ACLI						0.05		1	0.02
ARSI						0.05		1	0.02
CYUN						0.05		1	0.02
PAPE							0.04	1	0.01
CADR							0.04	1	0.01

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BOOK NOTICES

SMITH, NIGEL J.H., J.T. WILLIAMS, DONALD L. PLUCKNETT, and JENNIFER P. TALBOT. 1992. **Tropical Forests and their Crops.** (ISBN 0-8014-2771-1, pbk). Comstock Publishing Associates, a Division of Cornell University Press, Ithaca, NY. $27.95 (pbk), $69.95 (hbk). 568 pp.

"Many cultivated plants important for food and income in developing countries arose in tropical forests." A number of these plants are the subjects of this book, grouped into "Beverage and confectionery crops" (e.g., coffee, cacao); "Major fruits" (e.g., mango, citrus, pineapple); "Regional fruits" (e.g., durian, rambutan); "Rubber, oils, and resins" (e.g., oil palm, tropical pines); "Daily bread" (e.g., bananas, breadfruit); "Fuelwood, fodder, and woody grasses" (leucaena and bamboo); "Spices and natural food colorants" (e.g., clove, cinnamon, annatto); and "Nuts" (cashew, Brazil nut, macadamia). Among the data given for these crops are history, evolution, domestication, spread, genetic resources, gene pools, gene banks, germplasm collection, breeding challenges, conservation—not all of these for each crop. Additional chapters discuss the search for new plants to domesticate and the need for and strategies of conservation. Most entries in the 50-page list of "References" are post-1950 (largely from the 1980s). The book is illustrated with black-and-white photos and a few line drawings and is well indexed.—*John W. Thieret.*

NATIONAL RESEARCH COUNCIL. 1993. **Vetiver Grass. A Thin Green Line against Erosion.** (ISBN 0-309-04269-0, pbk). National Academy Press, Washington, DC. No price given. 171 pp.

Vetiver, *Vetiveria zizanioides*, has long been cultivated as the source of essential oil of vetiver used in perfumes and soaps. That it is also a grass of much promise for controlling soil erosion in warm areas is being increasingly realized. Hedges of this deep-rooted, robust, densely cespitose plant create impressive "botanical dams" strong enough to retard runoff. Although its use as a hedge plant is not new, it has recently come much into the limelight. This book offers an excellent summary on vetiver: biology, past use, current research, and future prospects. Appendix A highlights "some environmental horrors and points to the role that vetiver might play in alleviating them"; Appendix B, "Other potential vetivers," gives data on other grasses and some shrubs and trees that might be useful in erosion control; Appendix C has selected readings; and Appendix D lists worldwide research contacts. This book and the World Bank's practical handbook *Vetiver grass* (noted in *Sida* 15: 558. 1993) are a most valuable pair for anyone wanting information on this grass.—*John W. Thieret.*

NOTES ON *ERIOCHLOA WEBERBAUERI* (POACEAE: PANICEAE)

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ABSTRACT

Recent collections from Ecuador have uncovered the presence of a species, *Eriochloa weberbaueri* Mez, for which little comparative taxonomic information is available. Previously reported only from Peru, this species is characterized by features unique within the genus. A complete morphological description is presented and based on studies of all available specimens. Relationships with other species are discussed and based on the presence of shared taxonomically important characters. Diagnostic features of *E. weberbaueri* include a muticous and smooth upper floret, perennial habit, paired spikelets, spikelets 3.1–3.9 mm long, and the absence of a first glume.

RESUMEN

Recolecciones recientes en Ecuador han descubierto la presencia de una especie, *Eriochloa weberbaueri* Mez, de la que hay disponible muy poca información taxonómica comparativa. Citada previamente sólo de Perú, esta expecie presenta unas características únicas dentro del género. Se presenta una descripción morfológica completa en base a estudios de todos los especímenes disponibles. Se discuten las relaciones con otras especies en base a la presencia de caracteres compartidos taxonómicamente importantes. Los caracteres diagnósticos de *E. weberbaueri* incluyen una flor superior mútica y lisa, hábito perenne, espiguillas pareadas, espiguillas 3.1–3.9 mm de largas y la ausencia de la primera gluma.

INTRODUCTION

The Paniceae is a tribe of grasses characterized by a paniculate inflorescence, spikelets with two florets, the lower floret sterile, the upper floret

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fertile and coarser in texture than the lower floret. *Eriochloa* Kunth, a member of this tribe, consists of about 30 species and occurs throughout the tropical, subtropical, and warm temperate regions of the world. Presence of a cup-like callus at the spikelet base differentiates *Eriochloa* from the other 105 genera of the Paniceae. Additional significant characters used to differentiate *Eriochloa* within the tribe include an indurate upper floret, disarticulation at the spikelet base, inflorescence with racemose primary branches, and the absence of a bristle (Webster & Valdez 1988, Webster et al. 1989). Significant characters used to differentiate the species of *Eriochloa* include spikelet shape, presence of an awn on the upper floret, spikelet length, presence of hairs in the inflorescence, spikelet arrangement, longevity, and the relative length of the florets (Webster 1987, Shaw & Webster 1987).

Recent collections by Peterson and others in Ecuador have revealed the presence of specimens which do not match the morphological characteristics of taxa commonly associated with that area. The characteristics of this taxon were recorded in DELTA format (Dallwitz 1980, Dallwitz et al. 1993) and compared against all other recognized species of *Eriochloa*. This analysis indicated these specimens could not be differentiated from a poorly know Peruvian species, *E. weberbaueri* Mez. Hitchcock (1927) states that this species was known only from the type specimen. Tovar (1993) list only two specimens, the type and Anderson 740, which was collected in the same area of Peru. A survey of collections at the U.S. National Herbarium revealed the presence of three specimens (*Anderson 740, Sanchez Vega 1031, Camp E-2346*) which possess the diagnostic characteristics of *E. weberbaueri*. In addition, G. Davidse has identified two MO collections (*Sanchez et al. 3567 & Smith 6190*) of the same species.

Diagnostic features of *Eriochloa weberbaueri* include a muticous upper floret, a smooth upper floret, paired spikelets on the primary inflorescence branches, perennial habit, spikelet length (3.1–3.9 mm long), first glume absent, and the absence of elongate rhizomes. *Eriochloa distachya, E. michauxii, E. polystacyha, E. sericea*, and *E. weberbaueri* are the only species with a muticous upper floret and perennial habit. Of this subgroup, *E. distachya* and *E. weberbaueri* are the only species with long hairs associated with the pedicel. *Eriochloa michauxii, E. polystacyha*, and *E. weberbaueri* share the presence of paired spikelets. Therefore, the presence of hairs at the pedicel apex and paired spikelets distinguishes *E. weberbaueri* within this subgroup of morphologically related species. Perhaps the most diagnostic characteristic of *E. weberbaueri* is the smooth and relatively shiny upper floret. This characteristic appears to be unique for *E. weberbaueri* within the genus. This species appears to be associated with drier environments at elevations between 1,500 and 3,000 meters.

SPECIES DESCRIPTION

Eriochloa weberbaueri Mez, Bot. Jahrb. Engler 56: Beibl. 125:11. 1921.
TYPE: PERU. Dept. Cajamarca: *A. Weberbauer 4135* (HOLOTYPE: B; photographs and fragments at US!).

Plants perennial; stoloniferous; rhizomatous. Rhizomes with compacted nodes; with glabrous scales. Flowering culms 3–8 dm tall; not caespitose; erect from the base; not rooting at the lower nodes; with a hard knotty base; terminated by a solitary inflorescence; branched from the base; 2–5-noded. Nodes not swollen; pubescent. Internodes hollow; glabrous; smooth; neither viscid nor glaucous. Leaves cauline or basal; green; without auricles. Sheaths 6–13 cm long; overlapping or not overlapping; not inflated; smooth; glabrous; rounded; not keeled; not ciliate; closed. Ligule a fringe of hairs; 0.5–1.2 mm long. Collar not differentiated; pubescent. Leaf blades 7–20 cm long; 1.5–5 mm wide; linear; flat, involute, or convolute; flexuous; spreading; lax; smooth on the lower and upper surfaces; glabrous on the lower surface; glabrous or hairy (minutely pubescent) on the upper surface; with a truncate base; with flat margins; with margins not thickened; with scabrous margins; with glabrous margins; with the midrib not obviously differentiated; lacking obvious transverse veins; acuminate. Prophyllum with scabrous nerves; with pronounced keels. Peduncle 160–300 mm long; glabrous.

Panicle 10–35 mm wide; fully exserted at maturity; oblong. Lowermost inflorescence node not differentiated; hairy. Main axis present; 60–150 mm long; straight; stout; hairy; pubescent; with hairy axils; with quaquaversal primary branches. Primary branches 10–30 mm long; 0.3–0.5 mm wide; appressed to the main axis or spreading; with appressed secondary branches; with secund spikelets; not whorled; 8–13 on the main axis; straight; not winged; smooth; hairy; setose; ciliate; with loosely arranged spikelets. Rachis terminating in a spikelet. Pedicels present; 0.2–0.5 mm long; straight; scabrous; hairy; setose; with hairy apices; discoid at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus differentiated; not prolonged into a stipe; not flared to form a discoid receptacle; not oblique; rounded; smooth; glabrous. Cleistogamous inflorescence absent.

Spikelets 3.1–3.9 mm long; 0.9–1.1 mm wide; paired; densely overlapping; evenly distributed on the rachis; not divergent from the axis; homomorphic; adaxial; green; dorsiventrally compressed; lanceolate. First glume absent. Rachilla pronounced below the second glume; not pronounced between the florets. Second glume 3.0–3.7 mm long; 1 times spikelet length; 1 times the length of the lower floret; lanceolate; membranous; rounded on the back; smooth; 5-nerved; hairy; pubescent; acute to acuminate; muticous. Fertile florets 1. Sterile florets 1. Lower floret lacking

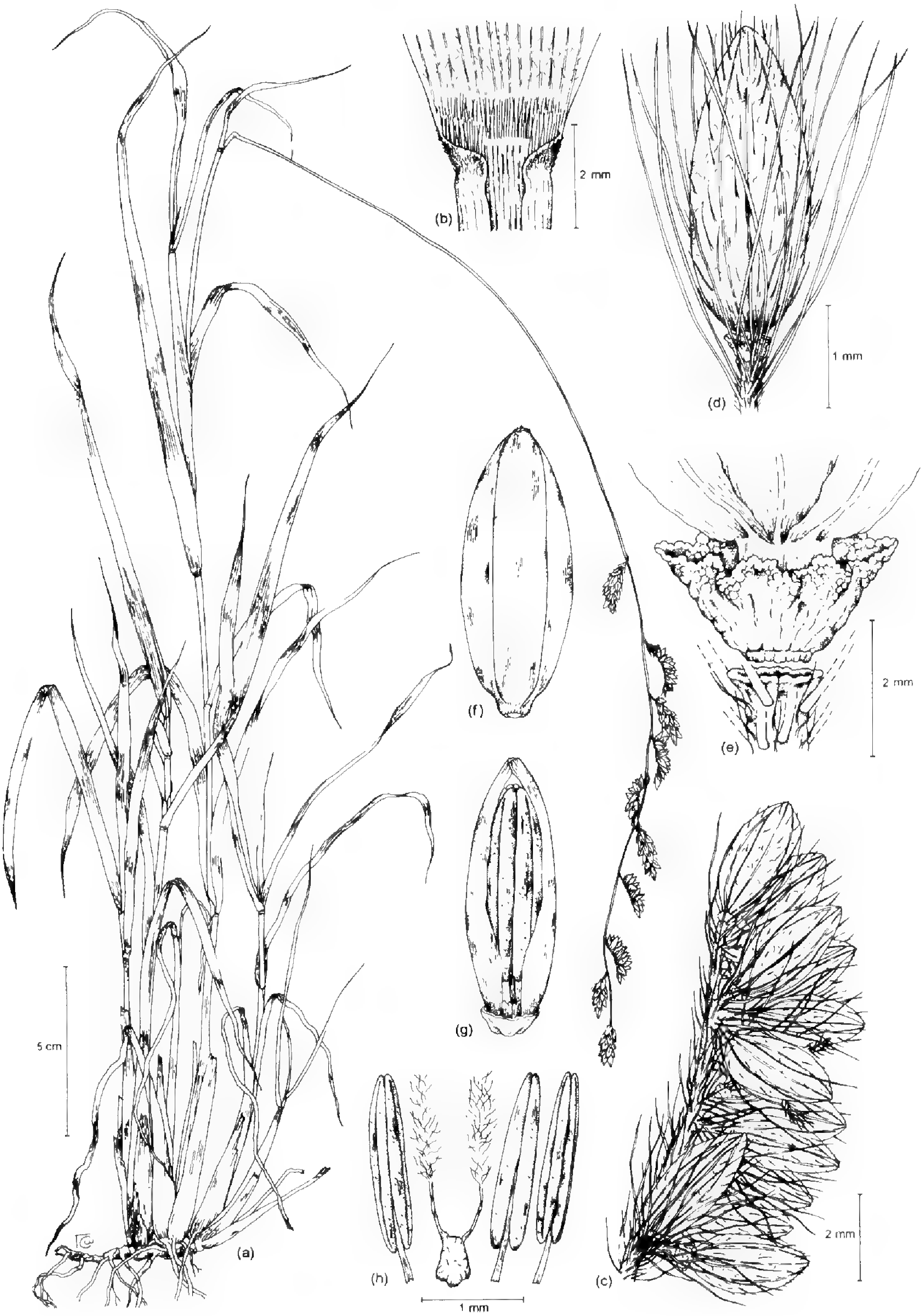

FIG. 1. *Eriochloa weberbaueri*. A. Habit. B. Ligule. C. Primary inflorescence branch. D. Spikelet and pedicel apex. E. Spikelet base and pedicel apex. F. Upper floret. G. Upper lemma enclosing stamens. H. Stamens and stigmas.

stamens. Lemma of lower floret 2.8–3.7 mm long; lanceolate; membranous; smooth; with equal internerve spacing; 3-nerved; the nerves pronounced but not swollen; the nerves smooth; not keeled; with glabrous margins; lacking a central longitudinal groove; acute; muticous; hairy. Lower lemma hairs not forming a distinct horizontal line; shorter than the upper floret; pubescent; smooth and terete; without apical modifications; white. Palea of lower floret absent. Upper floret 0.9 times the length of the lower floret. Lemma of upper floret 2.3–2.8 mm long; lanceolate to ovate; cartilaginous; slightly convex; smooth; yellow; shiny; with involute margins; with margins of the same texture as the body; glabrous; 3-nerved; the nerves not pronounced; with smooth nerves; without basal modifications; not differentiated at the apex; entire; acute; muticous. Germination flap conspicuous. Palea of upper floret well-developed; enclosed at the apex; cartilaginous; smooth; the base neither swollen nor protruding; the nerves pronounced but not winged. Lodicules about 0.15 mm long; the nerves not pronounced. Stamens 3. Anthers 1.5–1.7 mm long; yellow. Stigmas yellow to orange. South America: Ecuador & Peru.

Specimens Examined: SOUTH AMERICA. ECUADOR. **Provincia de Azuay**: 10.2 km N of Ona on the Pan American Hwy at the bridge crossing the Rio Leon, elev. 1880 m, 24 Apr 1990, *P.M. Peterson. C.R. Annable and M.E. Poston 8915* (US!); 83 km S of Cuenca on road to Loja, crossing of Rio Leon, elev. 1800 m, 30 May 1990, *P.M. Peterson and E.J. Judziewicz 9378* (US!); valley of the rio Paute, between Paute and Cuenca, 26 Apr 1945, *Camp E-2346* (US!). PERU. Santa Cruz, *I. Sanchez Vega 1031* (US!); 11 Apr 1948, *Anderson 740* (US!).

ACKNOWLEDGMENTS

Gratitude is extended to Dr. Gerrit Davidse for making valuable suggestions concerning the taxonomy of this group.

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Querol, Daniel. Undated. 1992. **Genetic Resources: A Practical Guide to Their Conservation.** (ISBN 1-85649-203-6, hbk; 1-85649-204-4, pbk). Zed Books Ltd., London, England. $55.00 (hbk); $22.50 (pbk). 252 pp

Daniel Querol originally compiled this book as a manual for his course on genetic resources and genebanks at the Chapingo Autonomous University in Mexico. He later adapted it to guide the development of the Nicaraguan Genetic Resources Program and a Genetic Resources Program in Peru. Those experiences, over a decade, are reflected in the very practical orientation of this book. Translated from Spanish, it offers a perspective from the "South," countries that have been exploited for genetic resources by the "North," with unfair compensation. This book offers the basics on genetics, diversity, crop breeding, and wild species use, then describes the methods necessary for collecting material and establishing, maintaining, and using a genetic resource conservation program.—*Larry Ford.*

ACTA BOTANICA HUNGARICA. Volume 36, numbers 1 4, 1990-91. Twenty papers. El genero Moacroton Croiz. (Euphorbiaceae). A. Borhidi.—Taxonomic revision of genus Leucocroton (Euphorbiaceae) A. Borhidi.—New spontaneous taxa of the genus Clerodendrum Brown ex L. (Verbenaceae) in Cuba. Z. Kereszty.—Xylotomical examination of lignifying shoots and roots for age determination of grasslands—Fumana procumbens and Euphorbia seguieriana. K. Babos.—Xylotomical examinations of some Venezuelan species of tree belonging to the Caesalpiniaceae, Fabaceae and Mimosaceae families—Caesalpiniaceae II. K. Babos, L.J.C. Cumana.—Xylotomical examinations of some Venezuelan species of tree belonging to the families Caesalpiniaceae, Fabaceae and Mimosaceae—Caesalpiniaceae III. K. Babos, L.J.C. Cumana.—Comparison of the pollen of various angiospermous taxa and the sporae of ferns for proline concentration and quality. S. Gulyas, G. Pálfi-Deim.—Cunninghamia R. Br. in the pollen spectra of Central Europe. L. Stuchlik, M. Konzalová.—Light and scanning electron microscope study of Lactuca L. and Cichorium L. pollen (Compositae: Lactuceae). M.Z. Haque, M.B.E. Godward.—Análisis polínico de sedimentos marinos del Occidente de la Isla de la Juventud (Cuba). Milagros Moncada Ferrera, C.E. Hernández Fuentes, M. Cabrera Castellanos.—Botanical identification of Ipomoea tricolor Cav. seed samples from Hungary and thin-layer chromatographic examination of their hallucinogen ergot alkaloids. L. Botz, E. Háhn, L. Gy. Szabó.

Volume 37, numbers 1–4, 1992. Nineteen papers. New names and new species in the Flora of Cuba and Antilles, IV. A. Borhidi.—A new Erythroxylum species in Cuba. R. Oviedo Prieto, A. Borhidi.—A review of Brazilian representatives of the chrysotricha species group in the genus Tabebuia Gomes ex DC. (Bignoniaceae). J. Paclt.—Ekmaniopappus Borhidi gen. novum (Senecioneae: Asteraceae) in Hispaniola. A. Borhidi, E. Gondár, T. Kiss, Zs. Orosz-Kovács.—Is there vegetation continum in mangrove swamps? Imoh Ukpong.—Xylotomical study of some Venezuelan tree species (Minosaceae I–IV). K. Babos, L. J.C. Cumana.

TAXONOMY OF THE *SIDA RHOMBIFOLIA* (MALVACEAE) COMPLEX IN INDIA

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ABSTRACT

The *Sida rhombifolia* complex in India is revised. *Sida rhomboidea* and *S. scabrida* are reinstated as distinct species; *S. retusa*, also reinstated as a distinct species, is treated under the older name *S. alnifolia*. An artificial key for identification, amended synonymy, descriptions, and illustrations are provided.

RESUMEN

Se revisa el complejo *Sida rombifolia* en la India. *S. rhomboidea* y *S. scabrida* son restablecidas como especies diferentes; *S. retusa*, también restablecida como especie diferente, se trata bajo el nombre más antiguo de *S. alnifolia*. Se ofrecen una clave artifical para la identificación, sinonimias corregidas, descripciones e ilustraciones.

The genus *Sida* L. is taxonomically difficult. Among its species, *S. rhombifolia* continues to be the hardest nut of all. There is great diversity of opinion as to its circumscription. Even as a world-wide revision of the genus is still wanting, we have tended to consider this species as a highly polymorphic taxon including widely different elements from different areas. The result is that classifications proposed for one region, say for Malesia (Borssum Waalkes 1966), Nigeria (Ugborogho 1980), Mexico (Fryxell 1988), China (Hu 1955), and Taiwan (Chang 1977), are not applicable to Indian elements. This makes the current taxonomy of the species a little suspect and it seems that the very concept of species needs change. From the treatments of the complex available, it seems that defining the species in this complex into well characterized, easily identifiable units on narrower lines would be of greater service than dumping everything into a vague and hazy *S. rhombifolia*. This is the idea that emerged during a critical and exhaustive study of the Indian elements during a revisionary study of the Malvaceae of the area.

Sida rhombifolia, as it is understood at present, is one of the most variable and widely distributed species of the genus and has been given some 30 binomials by different taxonomists (Ugborogho 1980). Linnaeus (1753, 1763) described three species now included in this complex, namely *S. rhombifolia*, *S. alnifolia*, and *S. retusa*, all from India. Cavanilles (1785) added *S. alba*, *S. canescens*, *S. microphylla*, and *S. orientalis*, and De Candolle (1824) recognized *S. capensis*, *S. philippica*, *S. planicaulis*, and *S. schrankii*. That was

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the time when the species had narrower definitions, but they were soon rejected in favor of a broad concept; consequently most such species were sunk into synonymy of a broad *S. rhombifolia* or were recognized as subspecific taxa under it.

It was Masters (1874) who broadened the definition of the species; he recognized five different varieties of it in India. Schumann (1892) recognized six varieties in Brazil "because he had no clear idea what *S. rhombifolia* sens. str. was" (Fryxell, pers. comm.). A similar course followed by Baker (1892) and, for the African elements, by Hutchinson and Dalziel (1958), who recognized three varieties of this species in Africa. Borssum Waalkes (1966), working on Malesian Malvaceae, elevated var. *rhombifolia* and var. *retusa* into subspecies and reduced all other binomials into synonymy. This is the treatment widely followed at present. Subsequently, Hatusima (1971) recognized another new subspecies (subsp. *insularis*) in the Philippines; this was later reported also from Taiwan (Chang 1977). Ugborogho (1980) kept *S. retusa* and *S. alnifolia* as two different subspecies in Nigeria.

The classification of this complex becomes all the more difficult because taxonomists differ among themselves in its circumscription. For example, *S. orientalis* Cav. has been included in *S. rhombifolia* by some (e.g., Rao 1985), but others treat it as a synonym of *S. acuta* (Borssum Waalkes 1966). The most confusing part of all is that very different elements from different parts of the world have been treated under the same name by different authors. Thus *S. alba* L. is actually *S. spinosa* L., but *S. alba* Cav. is *S. rhombifolia*. To add to the trouble, Paul and Nayar (1988) treated *S. alba* L. and *S. spinosa* L. as two different species. So also, *S. alnifolia* L., widely accepted as conspecific with *S. retusa* L., is kept distinct by Ugborogho (1980), who recognized three subspecies in the *S. rhombifolia* complex in Nigeria, namely, subsp. *rhombifolia,* subsp. *alnifolia,* and subsp. *retusa*. From his descriptions and plates, it is obvious that he treated at least the two latter taxa in a sense different from that of Linnaeus, because both of them seem to belong to subsp. *rhombifolia* (sensu Borssum Waalkes, 1966). It is pertinent to quote here the comments of Marais (1983) on this: "He uses some names in a sense other than that of van Borssum Waalkes and myself ... the photographs of the mericarps of *S. rhombifolia* sens. lat. (p. 83 Fig. 6) are so poorly reproduced that it is impossible to comment on his application of the three Linnaean epithets" (i.e., *rhombifolia, alnifolia,* and *retusa*).

We undertake here a revision of this complex. We have not been able to study it from the entire range because of difficulties in procuring materials and literature. Instead, we have confined ourselves to the Indian elements.

Linnaeus (1753) described *S. rhombifolia* as "Sida foliis lanceolato-rhomboidibus serratis" and *S. alnifolia* as "Sida foliis orbicularis plicatis serratis." Later, he described another species, *S. retusa* (Linnaeus 1763), as

"Sida foliis cuneiformibus retusis, serratis subtus tomentosis." He described all these taxa based on Indian specimens; while describing *S. retusa*, he indicated that it is very close to *S. alnifolia* ("Varietarum *S. alnifoliae* statuit Dillenius, mihi distincta visa est"). These three taxa have now been lectotypified (*S. rhombifolia*: lectotype 2. rhombifolia LINN 866. 3, BM–Fryxell 1988; *S. alnifolia*: lectotype Herb. Herm. III fol. 4. *Linn. 260*. BM–Borssum Waalkes 1966; *S. retusa*: lectotype *Linn. 866.7*, LINN–Borssum Waalkes 1966). We have now studied all these (as photographs) along with Indian specimens and relevant literature and are convinced that *S. alnifolia* L. and *S. retusa* L. are conspecific.

Sida alba, another name often reduced to the synonymy of *S. rhombifolia*, was originally described by Linnaeus (1763) as "Sida foliis cordatis subrotundis, stipulis setaceis, axillis trispinosis" based on Indian material (lectotype H.U. Herb. *Linn. 866.2*). He also indicated its close kinship with *S. spinosa* ("Similissima *S. spinosae*, sed folia rotunda flores albi, stigmatibus purpureis; petiolarum apices purpurascentis tota demum planta major"). Consequently, most authors have reduced it to synonymy of *S. spinosa* (Masters 1874; Borssum Waalkes 1966; Ugborogho 1980; Fryxell 1988). But Paul and Nayar (1988), in their revision of Indian Malvaceae, treated *S. alba* and *S. spinosa* as separate species based on presence or absence of stipular spines. We studied the types of *S. spinosa* (Lectotype: Herb. *Linn. 866.1*, LINN) and that of *S. alba* L. (l.c.). They differ mainly in shape of leaves, probably due to morphological plasticity (as also acknowledged by Ugborogho 1980) and in stipular spines. However, "the subpetiolar spine (better: spur) is quite variable in expression (even from one node to the next of a given plant!) and its presence or absence is of little taxonomic value. Moreover, it sometimes occurs on several other unrelated species, at least in South America" (Fryxell, pers. comm., 6 Sep 1993). Our observations on Indian specimens endorse Fryxell's viewpoint. These spines usually occur on the woody branches of older plants. The Linnaean specimen is, most likely, a young plant where spines have not yet developed. Otherwise, his *S. spinosa* and *S. alba* are identical and hence conspecific.

Cavanilles, however, (1785) seems to have attributed the name *S. alba* to a different Indian plant (type: MA, Photo BM, not seen), which is now widely accepted as conspecific with *S. rhombifolia*.

Sida obovata Wall. and *S. microphylla* Cav. from Bengal are two other names often associated with *S. rhombifolia*. In fact, Masters (1874) recognized them as two different varieties of the same species. We have not been able to study the type of the latter (*Sonnerat s.n.*, P), but Paul and Nayar (1988) studied it, concluding that it is nothing but a smaller form of *S. rhombifolia*. We have, however, been able to study the type of *S. obovata* Wall.(lectotype, Wall. Cat. 1864 from Burma, K). It is a very distinctive plant with obovate-obtuse leaves and long-peduncled, somewhat racemose, axillary inflorescences, which character combination is not known anywhere in the *S. rhombifolia* complex. In the absence of more material, we are not able to comment upon its exact identity, but are almost certain that its place is not in this complex.

In his classification of this complex, Masters (1874) recognized five varieties of *S. rhombifolia* in the Indian subcontinent, i.e., var. *scabrida*, var. *retusa*, var. *rhomboidea*, var. *obovata*, and var. *microphylla*; we have already eliminated the last two from the present consideration. Subsequently Borssum Waalkes (1966) found that Malesian materials of this complex fall under two groups, *S. rhombifolia* and *S. retusa*, distinguishable by habit, leaf shape, flower size, and some other characters, which he has dealt with in detail (Borssum Waalkes 1953). He also observed that, though the taxa are sympatric, they do not interbreed and produce hybrids in nature (Borssum Waalkes 1966). Consequently, he rejected Masters' treatment ("the differences between the groups are several, they cannot merely be regarded as varieties") and gave them the rank of subspecies. But his subsp. *rhombifolia*, still, is very highly polymorphic, including in it *S. scabrida* and *S. rhomboidea*.

After a critical study of living populations and herbarium specimens we are still at a loss to understand why we cannot consider *S. retusa* to be a species distinct from *S. rhombifolia*, in the strict sense of Linnaeus. The differences between the two, Backer (1943), Borssum Waalkes (1953, 1966), listed by Masters (1874), and Ridley (1922), are substantial and adequate for specific separation, notwithstanding the muddling by Ugborogho (1980: 65–75); their reproductive isolation renders them good "biological" species. We reinstate *S. retusa* as a species different from *S. rhombifolia*.

But one of the problems that usually crops up in distinguishing *S. retusa* is that taxonomists often rely too much on leaf characters, especially the retuse leaf apex, but this character is not unique to this taxon; an unambiguous classification would not be possible unless we correlate it with mericarp features. Dr. Fryxell, while commenting on this manuscript (pers. comm.), wrote, "I have six specimens in my herbarium, of which three (from India and Ceylon) have muticous mericarps (in agreement with your description), but the other three have long spines (to 3 mm) on the mericarps. These specimens are from Malaysia and two from the Philippines. All have pubescent fruits." The awns of the mericarps are evident in the Malaysian specimen (*Worthington 13027* UTEP, pf), a photocopy of which Dr. Fryxell kindly sent to us. However, after consulting the type of *S. retusa* and other Indian specimens, we are of the opinion that the Malaysian and the Philippine materials belong elsewhere than to *S. retusa*. But there is a nomenclatural problem involved.

It was already mentioned that *S. alnifolia* and *S. retusa* are conspecific, the epithet "alnifolia" antedating the latter. There is technically nothing wrong with Borssum Waalkes' (1966) adoption of the later epithet "retusa" for the subspecies, because a name does not have priority outside its own rank (ICBN Art. 60), but he has also rightly suggested that "in case this taxon is considered a distinct species, it should be named as *S. alnifolia* L." So, we treat this taxon under the earlier name.

Since the publication of *S. rhombifolia* by Linnaeus (1753), Fleming (1810) described yet another, closely related Indian species under the name *S. rhomboidea*, based on a specimen named by Roxburgh (see Borssum Waalkes 1966: 197; Fryxell 1988: 403). Fleming (1810) and Roxburgh (1832) described it as differing from *S. rhombifolia* "in the arils having no horns." But Wallich, apparently, attributed this name to a different plant (Wall. Cat. 1862 F) and observed that Roxburgh's plant is *S. rhombifolia* (distinguished by the two long awns on the mericarps) (cf. Wight & Arnott 1834). It is probably from this time on that *S. rhomboidea* has been included in synonymy of the latter. However, Wight and Arnott (1834: 58) studied Roxburgh's figures and material cultivated in the Calcutta Garden by Roxburgh and concluded that they are different from Wallich's *S. rhombifolia*. Borssum Waalkes (1966: 197) also made a critical study of these and concluded that "Wallich's specimen is obviously misidentified." He, in turn, designated the two specimens at Brussels (s. loc., s. coll., no. *2228*, photographs seen) as the lectotype of *S. rhomboidea*.

Sida rhomboidea is widely distributed in India, and we had ample opportunities to study it in the field and laboratory and to compare it with *S. rhombifolia* L. (s.s), which is also plentiful. They differ substantially in several respects, of which fruit characters are most striking. In the case of *S. rhombifolia*, the schizocarps are prominently beaked at the apex with the projecting awns of the mericarps. The mericarps, each with two long awns, dehisce at the apex, exposing part of the seed before dispersal and they separate from each other even as the fruits remain on the plants. In the case of *S. rhomboidea*, however, the schizocarps are depressed, somewhat umbilicated at top, as described by Roxburgh (1832), but not beaked. The mericarps are rather indehiscent, with a beak at apex (not 2-awned). They cohere together closely and are shed as a single unit by articulation of the pedicel, the mericarps separating much later. From our observations here, it is obvious that *S. rhomboidea* is a distinct taxon, morphologically and apparently reproductively isolated from *S. rhombifolia* and that it deserves to be treated as a distinct species on its own as has been done by Fleming (1810), Roxburgh (1832), and Wight and Arnott (1834), instead of drowning it in a highly polymorphic *S. rhombifolia*. *Sida rhomboidea* seems to be more akin to *S. unicornis* Marais from Mauritius. It differs in its glabrous mericarps with obtuse or retuse beaks, whereas *S. unicornis* is characterized by pubescent mericarps with sharp-pointed beak.

Sida scabrida was originally described as "whole plants sprinkled with rigid, simple or 2–3 (or more) partite hairs ... leaves rhomboid or oblong, lanceolate ... without tomentum ... pedicels jointed at the very base; carpels 9–11, bicuspidate" (Wight & Arnott 1834:57), based on the peninsular Indian specimen *Wight* 166 (K, CAL). We have collected and studied several specimens that perfectly match the type (photograph seen). Apparently, it is close to *S. rhombifolia*, so much so that Masters (1874) and Paul and Nayar (1988) treated it as a variety of the latter. But it differs from *S. rhombifolia* (s.s.) in a number of characters, notably in the indumentum, coarse pubescence of leaves, calyces etc. Apart from that, the mericarps in *S. scabrida* are stellate-pubescent while those of *S. rhombifolia* are glabrous.

Sida scabrida also closely resembles *S. yunnanensis* Hu, with which it might easily be confused. But the former is characterized by adpressed simple hairs on the upper surface of leaves, pedicels articulated at base or not at all, and 7–10 mericarps in contrast to the stellate hairs on the upper surface of leaves, pedicels articulated above the middle, and 6–7 mericarps, in *S. yunnanensis*.

Now the question arises whether these are sufficient reasons for segregating *S. scabrida* as a distinct species or whether we should retain it as a variety of *S. rhombifolia*. The answer will have to focus on the manner of delimitation of species in the entire genus. With a circumtropical distribution and wide-ranging variability, species delimitation here has been based on a few character differences with, of course, support from apparent reproductive isolation. In this context, *S. scabrida* qualifies well for species status and so we are reinstating it as distinct.

Our studies on vegetative features (from seedling stage to adult plants) and reproductive characters, especially mericarp morphology (Sivarajan et al. 1992),reveal that in India we have at least four distinct species, i.e., *S. rhombifolia* (s.s.), *S. alnifolia*, *S. scabrida*, and *S. rhomboidea*, which have been hitherto included in *S. rhombifolia* (s.l.). Amended descriptions and synonymy of these taxa are given below.

KEY TO SPECIES

1a. Adaxial surface of leaves with appressed simple hairs, abaxial surface coarsely pubescent with simple and 2–3(5)-rayed stellate hairs; pedicels jointed at very base or not jointed .... 4. *S. scabrida*

1b. Adaxial surface of leaves without simple hairs, abaxial surface densely pubescent with many-rayed stellate hairs; pedicels jointed at about middle 2

  2a. Lower leaves always obovate, retuse or truncate at apex; mericarps minutely stellate-pubescent, mucronate at apex, mucros obtuse, retuse, or emarginate at apex. .... 1. *S. alnifolia*

  2b. Lower leaves not obovate, retuse or truncate at apex; mericarps glabrous, 2-awned or beaked 3

3a. Staminal column stellate-pubescent; mericarps beaked with a single, muticous process, indehiscent .... 3. *S. rhomboidea*
3b. Staminal column glabrous; mericarps prominently 2-awned, apically dehiscent .... 2. *S. rhombifolia*

1. Sida alnifolia L., Sp. Pl. 684. 1753. (Fig. 1). TYPE: Herb. Herm. Ill. fol. 4. *Linn. 260* (LECTOTYPE: BM); Wight & Arn., Prodr. Fl. Pen. Ind. Or. 1:58. 1834.

Sida retusa L. Sp. Pl. 961. 1763. TYPE: Herb. *Linn. 866.7*, LINN; Wight & Arn., Prodr. Fl. Pen. Ind. Or. 1:58. 1834.
S. rhombifolia var. *retusa* (L.) Mast. in Hook. f., Fl. Brit. India 1:324. 1874; Trimen, Handb. Fl. Ceylon 1:143. 1893.
S. rhombifolia subsp. *retusa* (L.) Borss., Blumea 14:198. 1966; Mani. & Sivar., Fl. Calicut 44. 1982; Sald. & Ramesh in Sald., Fl. Karnataka 1:260. 1984; Paul & Nayar, in Nayar et al. (eds.), Fasc. Fl. India 19:216. 1988, non Ugborogho 1980.
S. rhombifolia subsp. *alnifolia* Ugborogho, Bol. Soc. Brot. Ser. 54:70. 1980.

Woody herbs or subshrubs to 50 cm, usually low and strongly branched; stems prostate or ascending, terete, green or purplish grey, stellate-tomentose to glabrescent. Leaf blades 0.5–5 × 0.5–4 cm, leaves towards stem base always obovate with retuse or emarginate apex, rarely truncate, upper leaves obovate to elliptic-lanceolate with rounded, subobtuse or acute apex, obtuse or rounded at base, margins irregularly serrate-dentate or crenate distally, entire proximally, upper surface sparsely pubescent with short many-rayed stellate hairs, lower surface densely greyish tomentose with short, many-rayed stellate hairs; petiole 3–5 mm long, stellate-pubescent, shortly pulvinulate below blade; stipules 4.5 mm long, equal, linear to subulate, glabrescent. Flowers axillary, solitary, sometimes in terminal clusters due to reduction of distal leaves; pedicels longer than petioles, 3–4 mm long in flower, to 30 mm in fruit, glabrous, jointed about middle; calyx 6–7 mm diameter, 6 mm long, pubescent with minute stellate hairs, glabrous within, 5-lobed, lobes 2 mm long, ovate-triangular; corolla 12 mm diameter, orange yellow, petals 7.8 × 6.5 cm, obliquely obovate, cuneate at apex, glabrous except for minutely hairy base; staminal column 3 mm long, glabrous or minutely stellate-hairy, antheriferous at apex; ovary 1.5 mm diameter, depressed globose, glabrous; styles 7–10, white; stigmas capitate, creamy-yellow. Mericarps 7–10, 2.5–1.5 mm, included in calyx, reticulate or rugose on sides and back, apex with a pair of short stellate-hairy mucros, mucros obtuse, retuse, or emarginate at apex. Seeds 2 mm long, black, glabrous except for puberulent hilum.

Distribution and Ecology. *Sida alnifolia* is widely distributed in the plains and hills of Southern Peninsular India, and occurs along Ghat roadsides, forest clearings as secondary growth, lateritic hill slopes, and occasionally as a weed in upland cultivation. It flowers from August to April in Kerala. The flowers open at about 0900 am and wither by 1400.

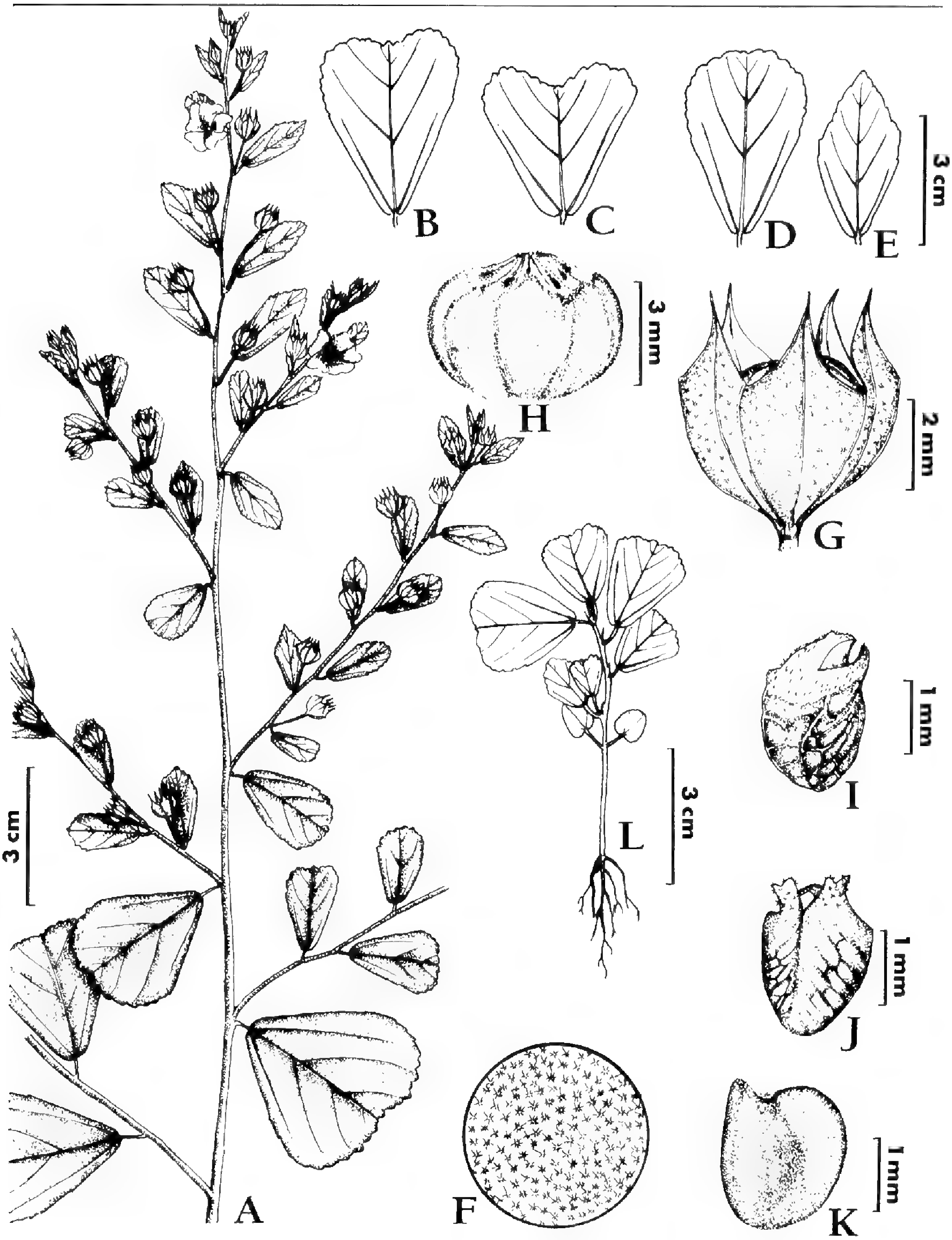

FIG. 1. *Sida alnifolia.* A. Flowering branch; B–E. Range of leaf variation; F. Indumentum; G. Schizocarp with accrescent calyx; H. Schizocarp with calyx removed; I–J. Mericarps, lateral and frontal view; K. Seed; L. Seedling.

Specimens examined: ANDHRA PRADESH: **Cuddapah Dt.**: without precise locality, *Barber 4634* (MH). **Guntur Dt.**: without precise locality, *Barber 4632* (MH). **East Godavari Dt.**: Bison Hill, *Barber 5104* (MH).

KARNATAKA: **Chikmangalur Dt.**: Santaveri, *Pradeep 47732* (CALI). **Dakshin Kannad**

Dt.: Sullia, *Barber 2095* (MH); Uduppi, *Pradeep 5060* (pf); Nalgody-Kutajadri road, *Pradeep 5041* (CALI). **Kodagu Dt.**: Sampaji, *Barber 2209* (MH). **Uttar Kannad Dt.**: Karwar, *Pradeep 5017, 5018;* Shrunkeri, *Pradeep 5025B*; Jogfalls, *Pradeep 5041* (CALI).

KERALA: **Idukki Dt.**: Munnar, *Vivekanandan 48577* (MH). **Kannur Dt.**: Kannoth R.F., *Ramachandran 57700* (MH). **Kottayam Dt.**: Kumaramperoor R.F., *Subramanian 8246* (FRC). **Kozhikode Dt.**: Kadalundi, *Pradeep 5013*; Badagara, *Pradeep 5025* (CALI). **Palakkad Dt.**: Dhony, *Pradeep 5268* (CALI); *Sebastian 21092* (MH); *Venkatasubramanian & Sasidharan 10650* (FRC). **Thrissur Dt.**: Peringalkuth, *Pradeep 5228* (CALI); Peechi, *Subramanian 9322* (FRC). **Wynad Dt.**: Tariodu R.F., *Pradeep 51617* (CALI).

TAMIL NADU. Coimbatore Dt.: Maruthamalai, *Sebastian 721* (MH); *Fischer* 2017 (FRC); *Pradeep 5238, 50429* (CALI). **Kottabomman Dt.**: Tirunelveli, *Barber 535* (MH). **Nilgiri Dt.**: Theppakad, *Vivekanandan 43051* (MH). **Ramanathapuram Dt.**: Srivilliputhur, *Srinivasan 72378* (MH). **Salem Dt.**: Hunasur cattle farm, *Narayanaswami 2925* (MH).

2. **Sida rhombifolia** L., Sp. Pl. 684. 1753. (Fig. 2). TYPE: "*2 rhombifolia*" (LECTOTYPE: LINN - 866.3; ISOLECTOTYPE: S); Roxb., Fl. Ind. ed. Carey 3:176. 1832; Mast. in Hook. f., Fl. Brit. India 1:323. 1874, in part; Trimen, Handb. Fl. Ceylon 1:143. 1893, excl. var. 3 *retusa*; Dunn in Gamble, Fl. Pres. Madras 1:90. 1915; Ramam. in Sald. & Nicolson, Fl. Hassan Dt. 155. 1976; Britto & Matthew in Matthew, Fl. Tam. Carnatic 3:131. 1983, in part; Fryxell, Syst. Bot. Monogr. 25:403. 1988, in part, excl. syn. *S. rhomboidea*; Mani., Fl. Silent Valley 28. 1988, in part., Vajravelu, Fl. Palghat Dt. 84. 1990, in part, excl. syn. vars. *obovata*, *retusa & rhomboidea*.

Sida rhombifolia subsp. *rhombifolia*: Borss., Blumea 14:193. 1966; Mani. & Sivar., Fl. Calicut 44. 1982; Sald. & Ramesh in Sald., Fl. Karnataka 1: 259. 1984 (all in part, excl. syn. *S. rhomboidea*).

S. rhombifolia subsp. *rhombifolia* var. *rhombifolia*: Paul & Nayar in Nayar et al. (eds.), Fasc. Fl. India 19:214. 1988.

S. alba Cav., Diss. I. 22.t. 3.f.8. 1785, non Linn., 1763.

Erect branched undershrubs to 1 m tall; stems terete, green or purplish, cinereous with many-armed short-stellate hairs. Leaf blades 5–6 × 2–2.5 cm, elliptic to rhomboid, rounded to truncate at base, 3-nerved, serrate distally, entire towards base, upper surface green, glabrescent, lower surface densely cinereous with short-stellate hairs, appearing farinaceous; petiole 5–6 mm long, densely pubescent, shortly pulvinulate at both ends; stipules up to 5 mm long, equal linear-lanceolate, 1-nerved, margins simple-hairy. Flowers axillary, solitary, sometimes in apparent racemes due to reduction of upper leaves; pedicels 0.5–1 cm long in flower, to 5 cm in fruit, glabrous, articulated above middle; calyx 5–6 mm diameter, campanulate, 10-ribbed at base, pubescent, 5-lobed, lobes 3 mm long, triangular, apex acute-acuminate, externally pubescent with short-stellate and simple hairs, glabrous within; corolla 1 cm diameter, pale yellow or creamy-white, veins sometimes tinged with red at center; petals 9–10 × 6–7 mm, obliquely obovate, truncate or cuneate at apex, short stellate-hairy or glabrous at base; staminal column 3 mm long, glabrous, antheriferous at apex; ovary 1.5 mm diameter, conical, glabrous; styles 8–10; stigmas capitate, yellow or pale pink. Meri-

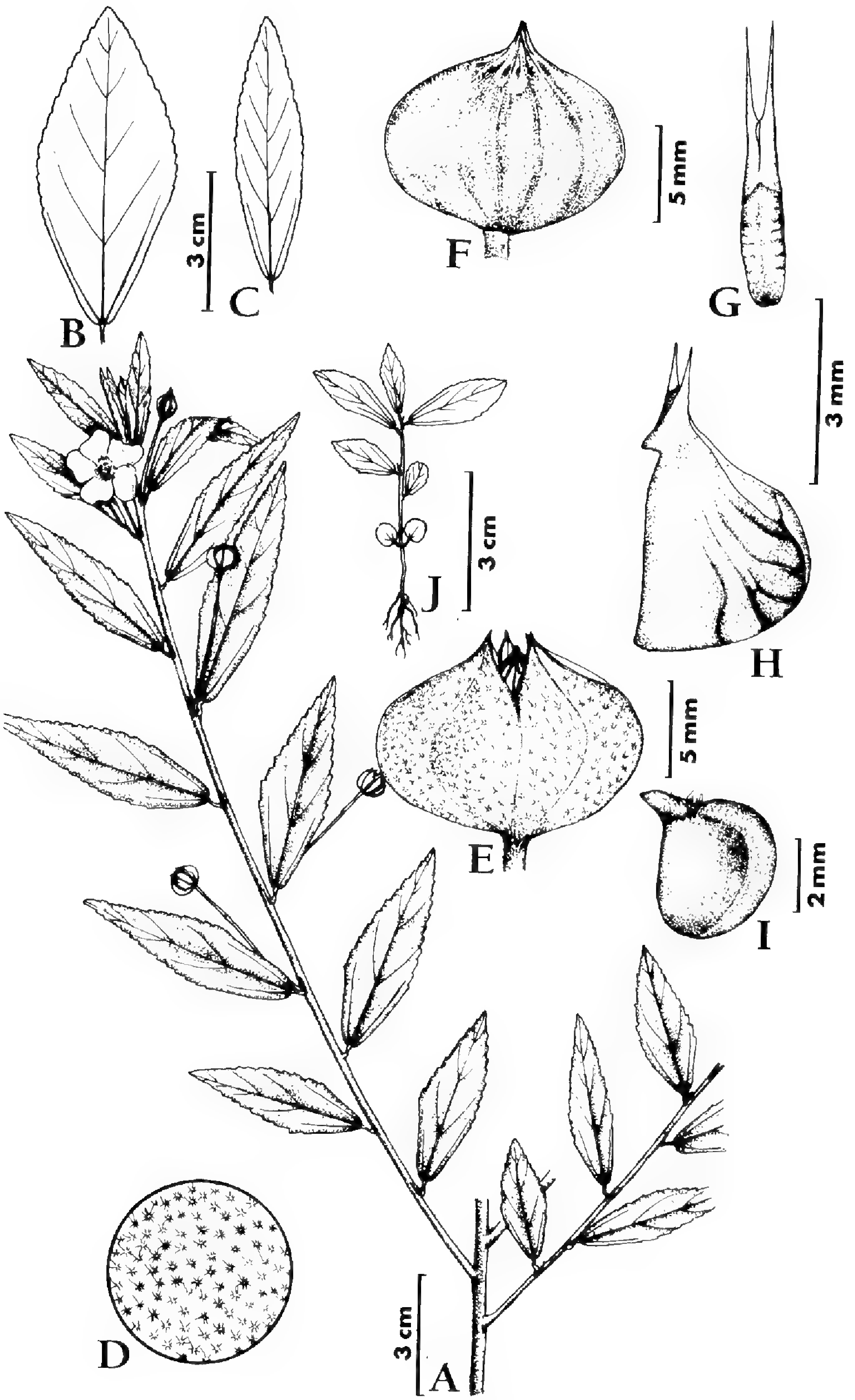

FIG. 2. *Sida rhombifolia.* A. Flowering branch; B–C. Range of leaf variation; D. Indumentum; E. Schizocarp with accrescent calyx; F. Schizocarp with calyx removed; G–H. Mericarps, dorsal and lateral view; I. Seed; J. Seedling.

carps 8–10, 4 × 3 mm, included in calyx, trigonous with acute angles, pale when mature, distinctly and transversely rugose on sides and back; apex with a pair of short, glabrous, divergent awns 1–1.5 mm long (as long or slightly shorter than calyx). Seeds 2 mm long, black, minutely hairy at hilum.

Distribution and Ecology. *Sida rhombifolia* is almost world-wide in distribution, occurring throughout the tropics of both the Old and New worlds and extending into temperate zones (Fryxell 1988). It is common throughout India and occurs along roadsides and wastelands at altitudes from 1000 to 2000 m. It flowers almost throughout the year, the flowers opening late in the morning, usually between 1045 and 1100.

Specimens examined. KERALA: **Kottayam Dt.**: Sabarigiri, *Sivarajan 5211* (CALI). **Thiruvananthapuram Dt.**: Ponmudi, *Pradeep & Sivarajan 50463* (CALI); Bonecaud, *Mohanan 54732* (MH).

TAMIL NADU: **Kanyakumari Dt.**: Kothayar, *Pradeep 44925, 44916* (CALI). **Kattabomman Dt.**: Courtallum, *Pradeep 5105* (CALI).

3. **Sida rhomboidea** Roxb. ex Fleming, Asiat. Res. 11:178. 1810. (Fig. 3). TYPE: s. loc., *s. coll. 2228* (BR); Roxb., Hort. Beng. 50. 1814 & Fl. Ind. ed. Carey 3:176. 1832; Wight & Arn., Prodr. Fl. Pen. Ind. Or. 57. 1834; Dunn in Gamble, Fl. Pres. Madras 1:90. 1915.

Sida rhombifolia var. *rhomboidea* (Roxb. ex Fleming) Mast. in Hook. f., Fl. Brit. India 1:324. 1874.

S. rhombifolia subsp. *rhombifolia* sensu Borss., Blumea 14:193. 1966; Mani. & Sivar., Fl. Calicut 44. 1982; Sald. & Ramesh in Sald., Fl. Karnataka 1:259. 1984; Nair & Nayar, Fl. Courtallum 1:75. 1986; Fryxell, Syst. Bot. Monogr. 25:403. 1988; Mani., Fl. Silent Valley 28. 1988; Paul & Nayar in Nayar et al. (eds.), Fasc. Fl. India 19:214. 1988; Vajravelu, Fl. Palghat Dt. 84. 1990 (all in part).

Erect much branched subshrubs to 2.5 m tall; stems terete, usually purplish, minutely pubescent with small stellate hairs. Leaf blades on younger shoots much larger (7–8 × 5–6 cm), obovate or suborbicular, truncate or rounded at base, subobtuse or acute at apex; those on flowering shoots smaller, 1–5 × 0.5–3 cm, rhomboid to lanceolate, 3-nerved from base, lateral nerves 3–5 pairs, nerves raised on lower surface, margins coarsely serrate to crenate, entire towards base, densely stellate-tomentose beneath, sparsely pubescent above; petiole 1–15 mm long, stellate-pubescent, shortly pulvinulate at both ends; stipules 9 mm long, equal, linear, slightly purplish, caducous. Flowers axillary, solitary; pedicels 6 mm in flower, to 30–40 mm in fruit, filiform, glabrous, articulated at about middle; calyx 9 mm diameter, campanulate, 10-ribbed at base, 5-lobed, lobes 3 mm long, triangular, outer surface densely tomentose with minute stellate hairs, inside nearly glabrous, margins purplish; corolla 1.5 cm diameter, pale yellow; petals 7–8 × 5–6 mm, obliquely obovate, retuse or emarginate at apex, glabrous; staminal column 3 mm long, stellate-pubescent, antheriferous at apex;

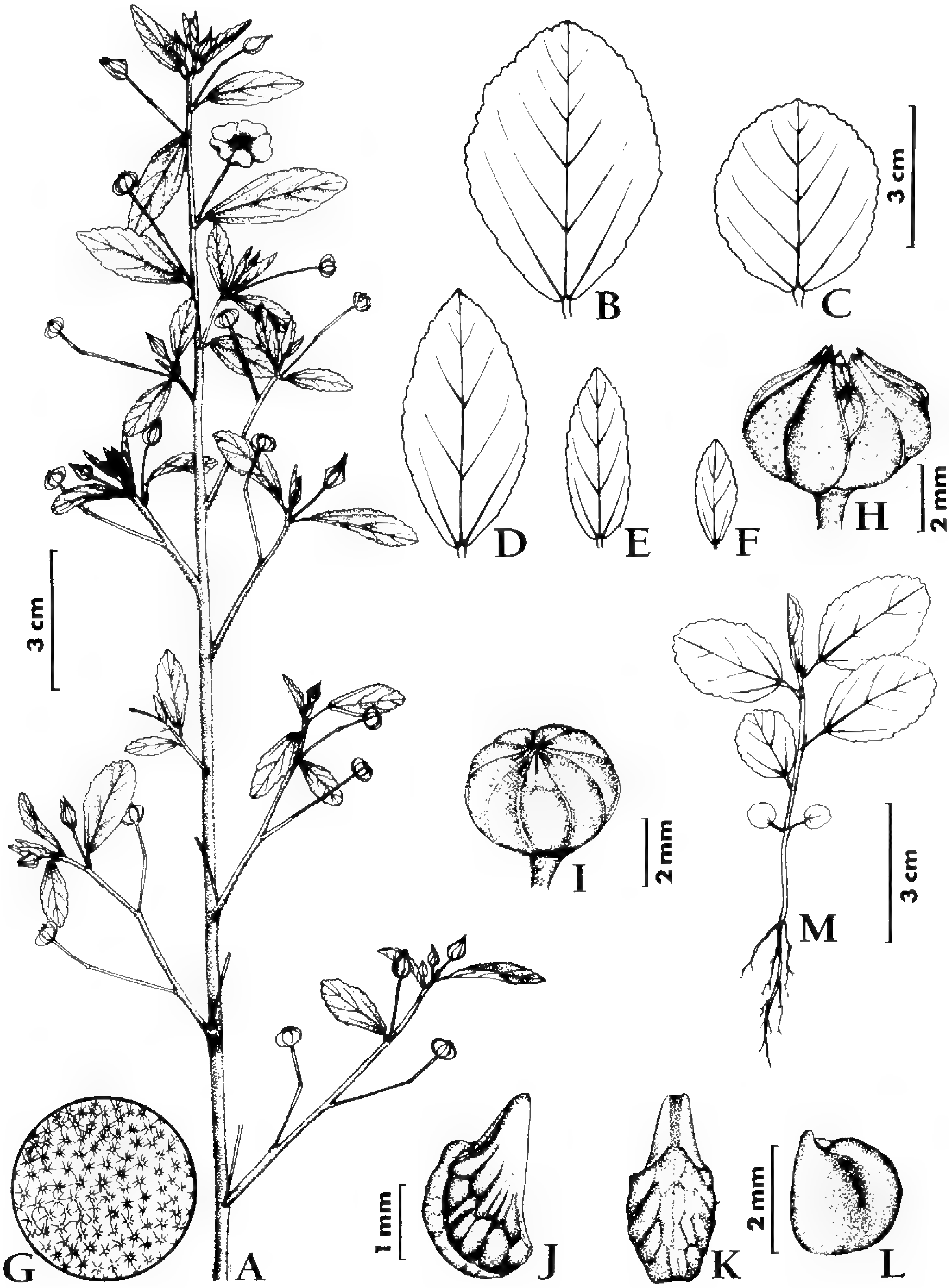

FIG. 3. *Sida rhomboidea.* A. Flowering and fruiting branch; B–F. Range of leaf variation; G. Indumentum; H. Schizocarp with accrescent calyx; I. Schizocarp with calyx remvoed; J–K. Mericarps, lateral and dorsal view; L. Seed; M. Seedling.

ovary 1.5 mm diameter, depressed globose, glabrous; styles 8–10; stigmas capitate, yellow. Mericarps 8–10, completely included in calyx, closely coherent, 3 × 2 mm, indehiscent, trigonous with acute angles, prominently reticulate on sides, reticulate or rugose on back, apex beaked with a single, glabrous muticous process. Seeds 2 mm long, brownish black, glabrous throughout.

Distribution and Ecology. *Sida rhomboidea* is common in the plains of Peninsular India. It occurs along roadsides and waste lands generally at sea level. Because of its frequent confusion with *S. rhombifolia*, it is difficult to draw conclusion on its distribution elsewhere, based on literature. The plant flowers almost throughout the year. The flowers open between 1045 and 1100 and wither by 1415.

Specimens examined. KERALA: **Ernakulam Dt.**: Wellington Island, *Pradeep 5205*; Cochin, *Pradeep 5179* (CALI). **Kannur Dt.**: Tellicherry, Punnol, *Pradeep 5107* (CALI). **Kottayam Dt.**: Changanacherry, *Antony 904* (MH). **Kozhikode Dt.**: West Hill, *Pradeep 5215, 6059*; Devagiri, *Jayakumar 884*; Cheruvannur, *Sivarajan 1482* (CALI). **Malappuram Dt.**: Parappanangadi, *Pradeep & Sivarajan 5002* (CALI). **Thiruvananthapuram Dt.**: Bonecaud, *Mohanan 63246* (MH).

TAMIL NADU: **Ramanathapuram Dt.**: *Vajravelu 33853* (MH).

4. **Sida scabrida** Wight & Arn., Prodr. Fl. Pen. Ind. Or. 57. 1834. (Fig. 4).
TYPE: Peninsular India, *Wight 166* (CAL, K,); Ugborogho, Bol. Soc. Brot., 54:100. 1980.

Sida rhombifolia var. *scabrida* (Wight & Arn.) Mast. in Hook. f., Fl. Brit. India 1:324. 1874.

S. rhombifolia subsp. *rhombifolia* var. *scabrida* (Wight & Arn.) Mast., Paul & Nayar in Nayar et al. (eds.), Fasc. Fl. India 19:216. 1988.

Erect branched subshrubs to 2 m tall; stems terete, green or slightly tinged with purple, pubescent with minute stellate hairs intermingled with scattered, long, simple hairs. Leaf blades 6–8 × 3–4 cm, concolorous, rhomboid or oblong-lanceolate, truncate at base, acuminate at apex, basally 3-nerved, lateral nerves 4–5 pairs, margins serrate-crenate distally, entire towards base, coarsely pubescent on upper surface by appressed simple hairs, on lower surface with few scattered 2–3 armed stellate and simple hairs especially on the nerves, never with tomentum; petiole 0.5–1 cm long, pubescent with minute stellate and long simple hairs; stipules 4–6 mm long, subulate or filiform, ciliate. Flowers axillary, solitary, sometimes in clusters of 3–5 due to reduction of distal leaves. Pedicel up to 1 cm in flower, to 3 cm in fruit, not articulate; calyx 6–7 cm diameter, 10-ribbed at base, campanulate, 5-lobed, lobes 4 × 4 mm, ovate, acuminate at apex; corolla 1.5 cm diameter, yellow; petals 1–12 × 7–8 mm, minutely stellate-hairy at base; staminal column up to 3 mm long, stellate-pubescent; ovary ovoid, 2 mm

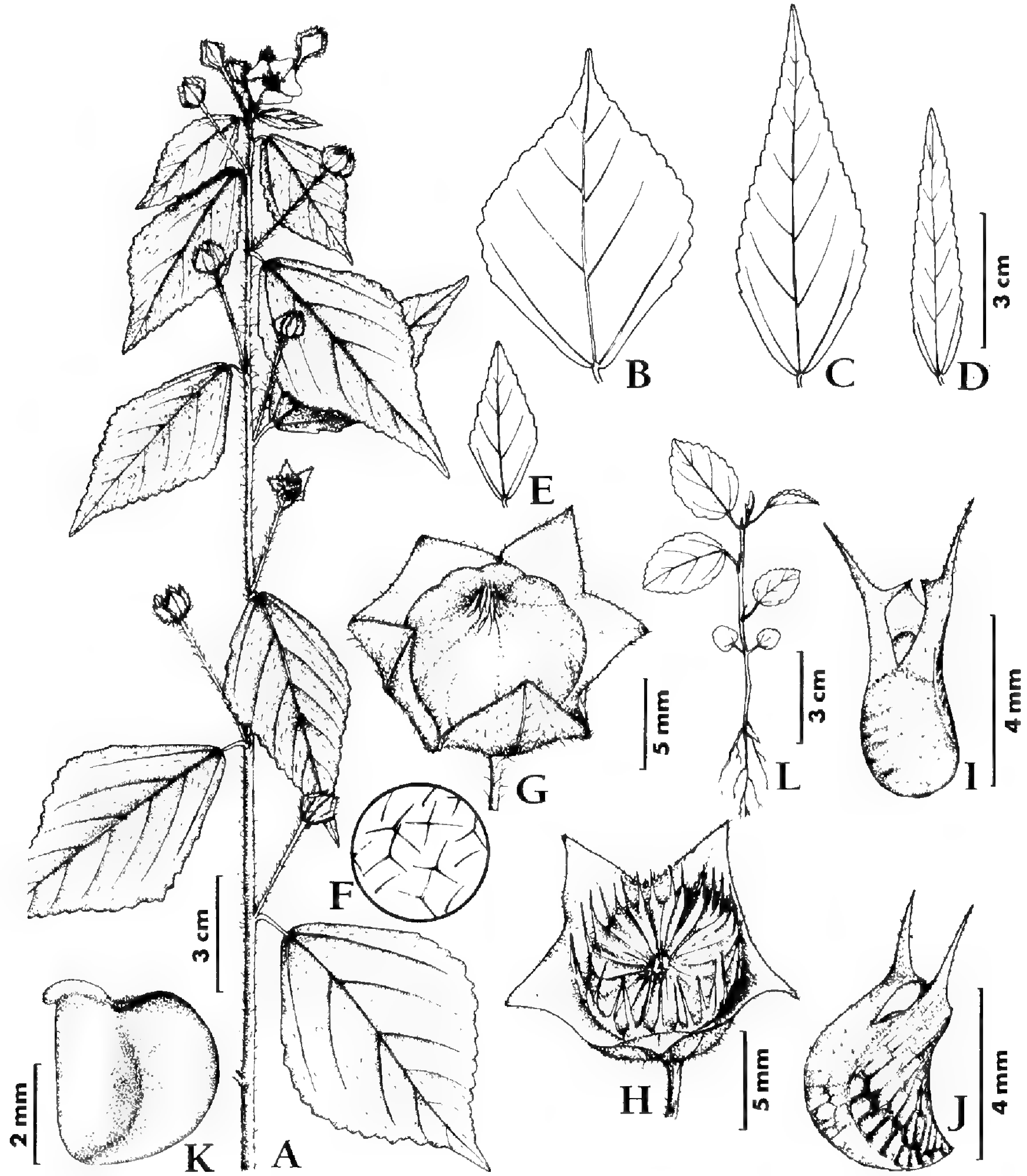

FIG. 4. *Sida scabrida.* A. Flowering and fruiting branch; B–E. Range of leaf variation; F. Indumentum; G. Schizocarp before dehiscence; H. Schizocarp showing dehiscence; I–J. Mericarps, dorsal and lateral view; K. Seed; L. Seedling.

diameter, minutely simple-hairy towards apex; styles 7–10; stigmas subglobose. Mericarps 7–10, 3 × 3 mm, enclosed in calyx, trigonous with acute angles, black when mature, minutely stellate-pubescent on back towards apex, prominently reticulate or transversely rugose on sides and back, apex with a pair of linear divergent simple and stellate-pubescent awns. Seeds 2 mm long, blackish or brown, pubescent at hilum.

Distribution and Ecology. *Sida scabrida* is known from Peninsular India and (disjunctly) from Nigeria in Africa. It occurs in disturbed sites in evergreen, semi-evergreen, and moist deciduous forests. It also grows along roadsides generally at an altitude of 250–2000 m. The plant produces flowers principally from August-April. The flowers open between 1045 and 1100.

Specimens examined. KARNATAKA:. **Chikmagalur Dt.**: Bababudan Hills, *Pradeep & Sivarajan 47726* (CALI). **Kodagu Dt.**: Mercara, Sampaji, *Barber 2315* (MH)

KERALA: **Kottayam Dt.**: Pampa, *Subramanian 9969* (FRC). **Kozhikode Dt.**: Badagara, *Pradeep 5101* (CALI, pf). **Malappuram Dt.**: Nedunkayam, *Pradeep & Sivarajan 5097* (CALI). **Palakkad Dt.**: Silent Valley R.F., *Nair 64374*, *Vajravelu 26103* (MH). **Pathanamthitta Dt.**: Moozhiyar, *Subramanian 9620*; *Mahadevan & party 9193* (FRC); *Anil Kumar 1513* (MH). **Thiruvananthapuram Dt.**: Ponmudi Hills, *Mohanan 52542* (MH). **Thrissur Dt.**: Peringalkuthu, *Pradeep 5227* (CALI). **Wynad Dt.**: Lakidy, *Pradeep 5157, 5154*; near Pookkottu lake, *Pradeep 50457* (CALI); Chandanathode, *Ellis 29438* (MH).

TAMIL NADU: **Coimbatore Dt.**: Attakkati-Valparai road, *Sivarajan Pradeep 47761* (CALI). **Kanyakumari Dt.**: Kothayar, *Pradeep 44929* (CALI). **Nilgiri Dt.**: Devala R.F., *Vajravelu 42831*; Kattaicombai, *Subramanyam 1080*; without precise locality, *Wight s.n.* (MH). **Salem Dt.**: Salem, *Deb 31265* (MH).

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SOME OBSERVATIONS ON LEAF FORM IN *ILEX VOMITORIA* (AQUIFOLIACEAE)

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ABSTRACT

We report a statistical analysis of leaf form for a sample of 481 collected from five yaupon trees at Ponchatoula, Louisiana. Considerable variation exists within these "sun" leaves. Across the 5 trees, surface area varies 24-fold (22.1–533 mm^2), leaf specific mass 22-fold (7.67–167.83 g m^{-2}), leaf length 5-fold (6–31 mm), leaf width 4.5-fold (4–18 mm), and crenations 4.7-fold (7–33 per leaf). Leaf complexity (LC) varies from 1 to 6 Fourier frequencies, and the leaf dissection index (DI) varies from a nearly circular 1.036 to a high of 1.349. Trees in this population are statistically significantly different from each other in average leaf size, leaf mass, leaf specific mass, and in number of crenations per leaf. In logistic regression, the probability that a leaf will develop more crenations, increases with leaf size. As leaf size changes, shape remains relatively constant within this population; amount of leaf dissection does not correlate with other morphological variables. Leaf surface area is strongly related to nodal position on the shoot, middle nodes generally produce the largest leaves.

KEY WORDS: *Ilex vomitoria*, yaupon, leaf form

RESUMEN

Se realiza un análisis estadístico de la forma de la hoja sobre una muestra de 481 hojas colectadas en cinco árboles en Ponchatoula, Louisiana. Existe una variación considerable entre esta hojas de "sol." En cinco árboles, el área de la superficie varía en 24 veces (de 22.1–533 mm^2), la masa específica de la hoja en 22 veces (de 7.67–167.83 g m^{-2}), la longitud foliar en cinco veces (de 6–31 mm), la anchura de la hoja en 4.5 veces (de 4–18 mm), y las crenaciones en 4.7 veces (de 7–33 por hoja). La complejidad de la hoja (LC) varía de 1 a 6 frecuencias de Fourier, y el índice de disección foliar (DI) varía desde casi circular 1.036 hasta 1.349. Los árboles de esta población muestran diferencias significativas estadísticamente en el tamaño foliar medio, masa foliar, la masa foliar específica, y en el número de crenaciones por hoja. En regresión logística, la probabilidad de que una hoja desarrolle más crenaciones aumenta con el tamañ de la hoja. Cuando varía el tamaño de la hoja, su forma permanece relativamente constante en esta población; la disección de la hoja no se correlaciona con otras variable morfológicas. El área de la superficie foliar está fuertemente relacionada con la posición nodal en la rama, los nudos medios producen generalmente las hojas más grandes.

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INTRODUCTION

Advances in computer-assisted image analysis expand the ability of botanists to use large sample sizes in leaf morphometric research (e.g., Kincaid and Schneider 1983, White et al. 1988). Our objective was to quantify leaf variability in a population of yaupon, *Ilex vomitoria* Aiton (Aquifoliaceae) at Ponchatoula, Louisiana. We collected leaves from five trees in order to answer these questions: (1) Are trees homogeneous in leaf size and shape? (2) Is leaf form related to nodal position along the twig? (3) Do predictive relationships exist among leaf specific mass (g dry weight / m^2 surface area), crenation number, mass, area, dissection index, and leaf shape complexity? (4) How do average leaf images per tree, reconstructed by Fourier transform, compare to conventional morphometric statistical analysis?

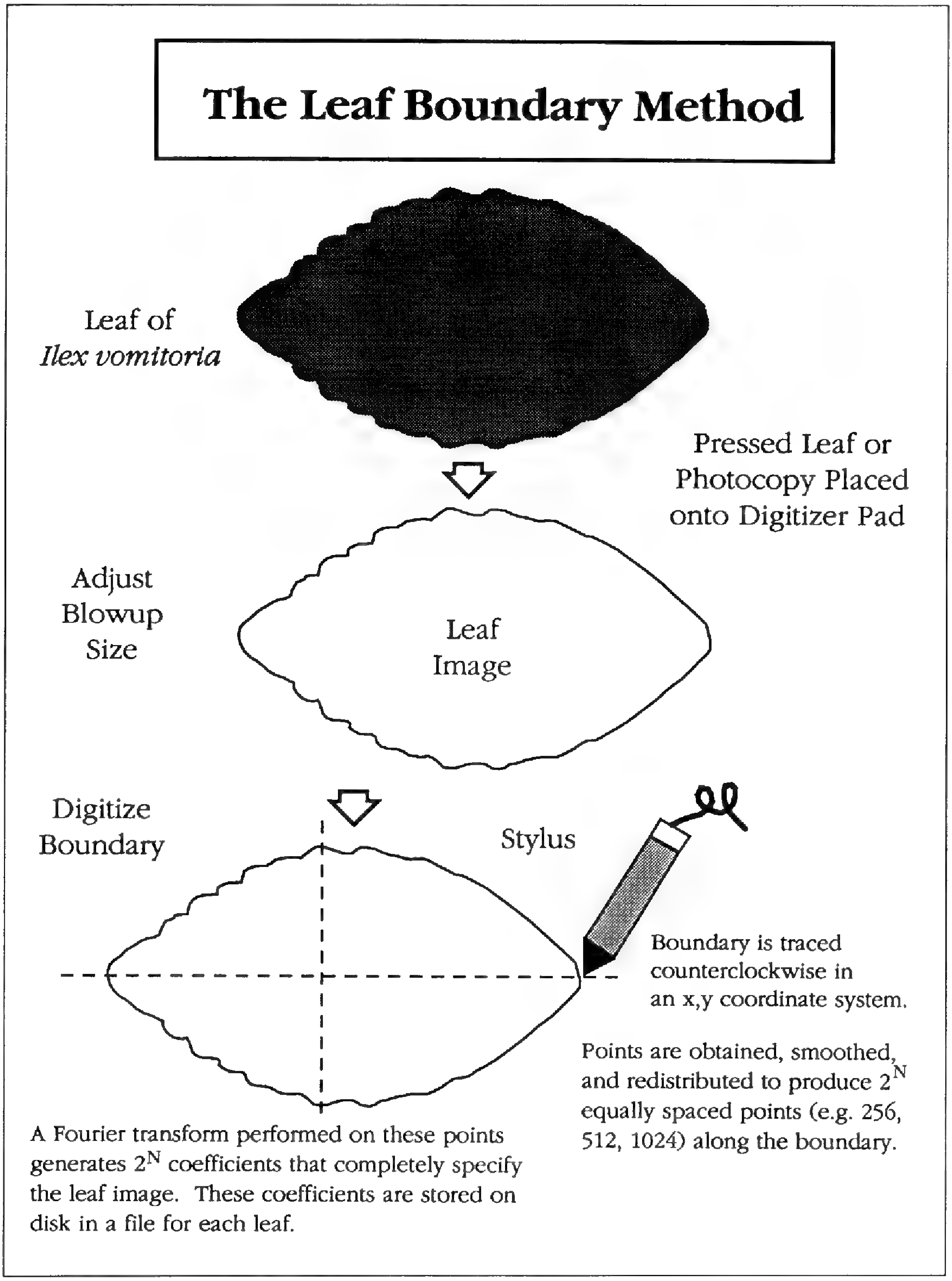
Yaupon is a shrub and small tree common in forests along the Coastal Plain from southern Virginia to Florida, and west to Texas (Elias 1980). The leaves are small, flat, coriaceous, evergreen, elliptical, and have marginal mucronate crenations (Radford et al. 1968).

METHODS

A sample of 481 leaves was collected, on August 12, 1989, from 5 trees growing within 100 meters of each other along a sunlit edge of a pine forest at Ponchatoula, Louisiana. Leaves were individually numbered with a serial number and nodal position on the current year's shoot, the petiole excised, and the blades placed into a plant press. After drying in a convection oven at 70°C, the leaves were weighed to the nearest 0.0001 gram. Crenations were counted using a stereo dissecting microscope. Maximum length and width were recorded for each blade.

In our laboratory, leaf images are analyzed (Fig. 1) using the leaf boundary method of Kincaid and Schneider (1983) which is based on Fourier transform. In an analysis of various computerized leaf morphometric methods, White, et al. (1988) found this method performed well in terms of discriminating power and in the reconstruction of synthetic, average leaf images.

Leaves were photographically enlarged (Fig. 2), and the images boundaries digitized into x, y coordinates using a graphics pad (Model CR1212, Summagraphics Corp., Fairfield, CT) attached to a Macintosh IIci computer (Fig. 1). Other details are in Kincaid and Schneider (1983), and in Figures 1–3. Image information lies in the values of the Fourier coefficients at each frequency (Table 1). Leaves have the same size and shape, if and only if, their Fourier coefficients are identical (Kincaid and Schneider 1983). Using this method, leaf surface area, leaf complexity, and leaf dissection index were computed for 342 out of the 481 leaves. Leaf complexity (LC) is a dimensionless and discrete, ordinal variable providing a mathematical measure of the "complexity" of a leaf's outline. For example, LC = 1 for pure ellipses, and



Boundary is traced counterclockwise in an x,y coordinate system.

Points are obtained, smoothed, and redistributed to produce 2^N equally spaced points (e.g. 256, 512, 1024) along the boundary.

A Fourier transform performed on these points generates 2^N coefficients that completely specify the leaf image. These coefficients are stored on disk in a file for each leaf.

FIG. 1. Leaf boundary method of Kincaid and Schneider (1983).

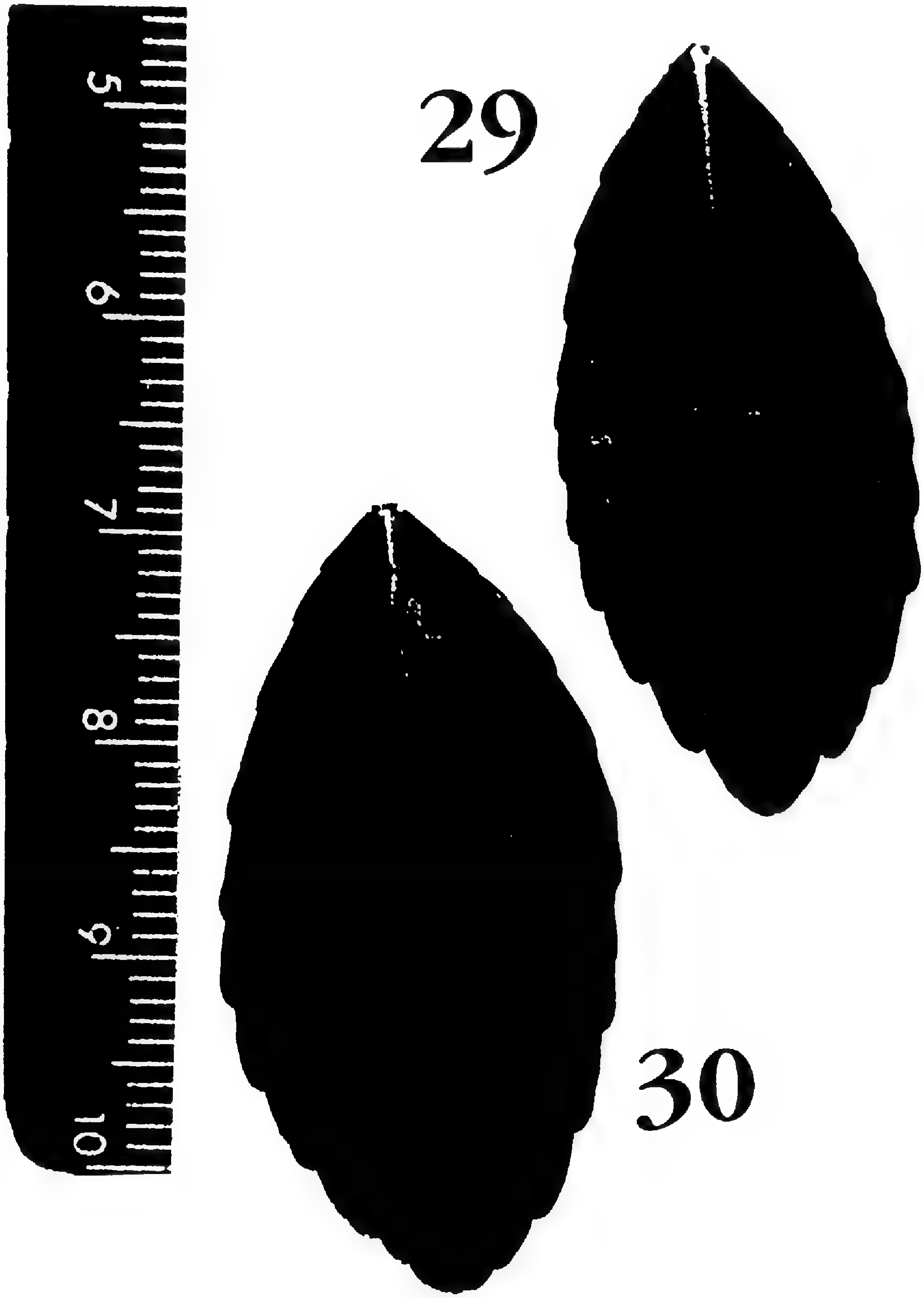


FIG. 2. Enlarged, photographic image of leaf #30 with ruler (small divisions are mm), as digitized. (Flat-bed scanners have now replaced photography as a preferred method of image capture and manipulation prior to digitization of boundary and Fourier Transform.)

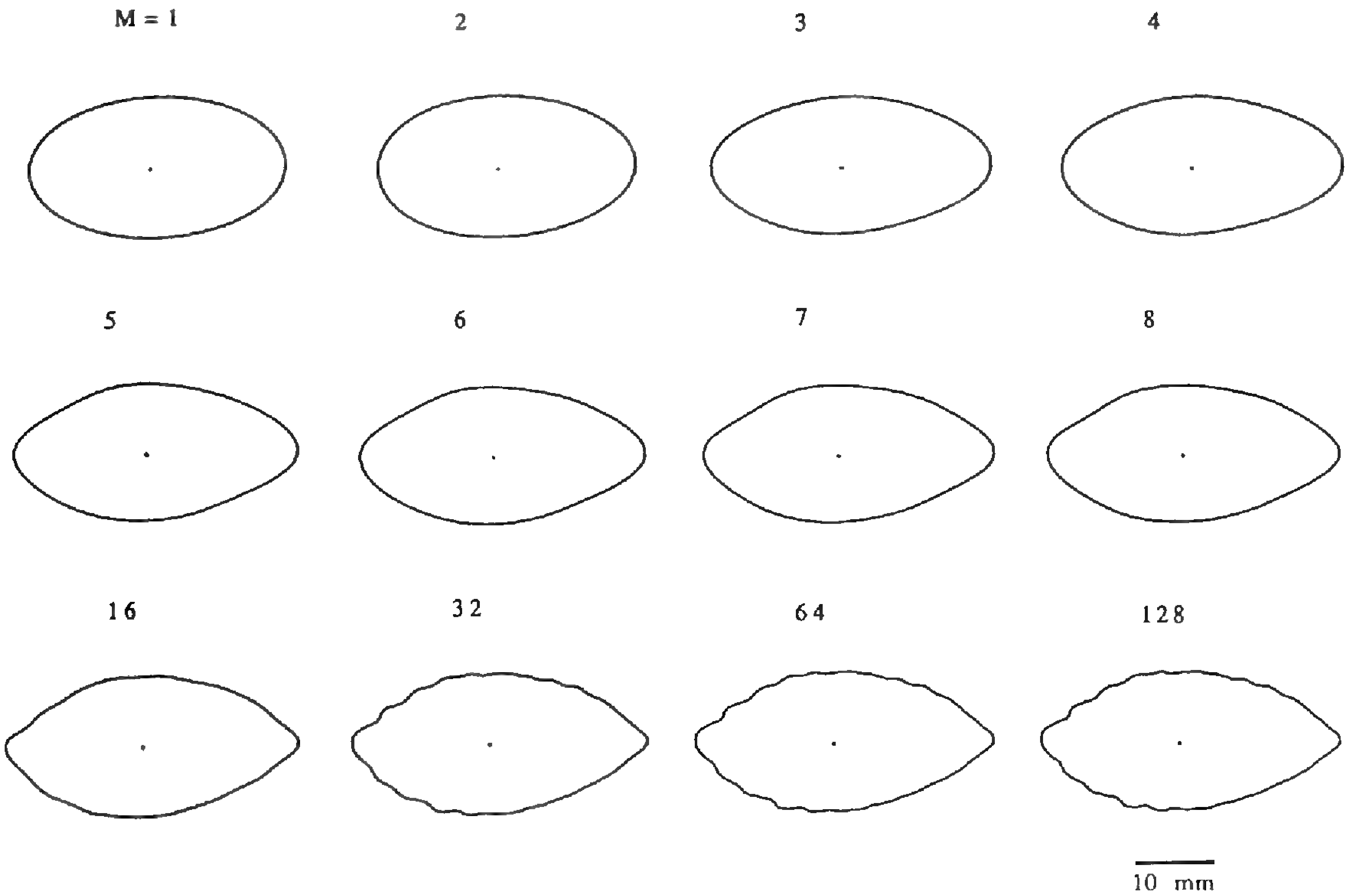


FIG. 3. Images of leaf #30 are reconstructed by reverse Fourier Transform, using various frequencies (M). Reconstruction with M = 1 (the first frequency) yields the "best fit" ellipse. M = 3 reconstructs leaf #30 to within 95% of a full reconstruction (M = 128). The finer details of the leaf margin are encoded by the higher frequencies. Notice the image transition between M = 16 and M = 32, and that frequencies greater than M = 32 add no detectable marginal detail. For leaves of simple shape, and for studies such as this one where detailed image analysis of mucronate crenations is not paramount, one need only deal with coefficients from the lower frequencies.

LC = 1 for most elliptically shaped leaves with relatively smooth margins. The more complicated the leaf shape, relative to the best fit ellipse, the greater the integer value of LC (In terms of reverse Fourier transform, LC is the number of frequencies necessary to reconstruct the leaf image to within 95% of the actual image.).

While LC captures a mathematical aspect of leaf shape, dissection index (DI) is the empirical relationship between leaf perimeter and leaf surface area expressed as a dimensionless, continuous measurement variable, perhaps amenable to biophysical interpretation of convective heat exchange. The minimum value of DI is that of a circle for which DI always equals 1.0. The value of DI for a circularly shaped, entire leaf is slightly larger than 1.0, and the more deeply lobed, dissected or lanceolate a leaf shape, the larger the value [DI = Perimeter / {2*SRQ(Area * pi)}]. These variables, defined by Kincaid and Schneider (1983), are useful in making comparisons of leaf shape among leaves having different surface areas.

TABLE 1. Fourier coefficients in millimeters for an individual leaf (# 30) of yaupon displayed for the first 14 frequencies (out of a total of M = 128 frequencies). M = 3 encodes 95% of this image and M = 8 is sufficient for data analysis for this species. Reconstruction of the image of a leaf using M = 1 (the +1 and -1 freq.) yields the best fit ellipse while reconstructions using more frequencies yield finer and finer marginal details. If the Fourier coefficients are for a circle, the +1 real coefficient is the radius and all other coefficients are zero.

Fourier Frequency	Coefficients	
	Real part	Imaginary part
1	12.34	-.26
-1	3.53	.26
2	.02	0
-2	.19	.02
3	.75	-.11
-3	.48	.01
4	.06	.02
-4	0	-.01
5	.25	-.09
-5	.20	-.02
6	0	.03
-6	.02	.01
7	.12	-.03
-7	.09	0
8	-.01	.01
-8	.02	.02
9	.08	-.01
-9	.07	.01
10	.01	0
-10	-.02	0
11	.06	-.02
-11	.05	.01
12	-.02	0
-12	.01	0
13	.06	-.02
-13	.03	.01
14	0	0
-14	0	.01

We used StatView (Abacus) and JMP (SAS 1989) on Macintosh computers to perform the data analysis. The technique of logistic regression (Pagano and Gauvreau 1993; using JMP) was utilized to search for trends, and to visualize relationships between crenation interval (dependent variable) and leaf surface area, and between classification of leaves by tree (dependent variable) and number of leaf crenations. While logistic regression is a commonly used statistical tool in biomedical fields for analyzing discrete responses, it is rarely used in organismic biology.

RESULTS AND DISCUSSION

Based on our sample of 481 leaves, considerable leaf variation exists within these "sun" leaves. Across the 5 trees, surface area varies 24-fold (22.1–533

mm^2), leaf specific mass 22-fold (7.67–167.83 g m^{-2}), leaf length 5-fold (6–31 mm), leaf width 4.5-fold (4–18 mm), crenations 4.7-fold (7–33 per leaf), and leaf complexity (LC) from 1 to 6 Fourier frequencies. Leaf dissection index (DI) changes from a nearly circular 1.036 to a high of 1.349. Table 2 provides descriptive statistics and results of analysis of variance for these leaves grouped by tree.

We found strong evidence for heterogeneity among the five trees for average leaf area, mass, leaf specific mass, crenation number, and dissection index ($P < 0.00001$ with R-square values for the main effect ranging from 0.153–0.542, Table 2). Interestingly, average LC was homogeneous among the 5 trees ($F = 1.7$; 4,338 df; $P = 0.14$) and homogeneous among shoots within each tree ($P > 0.05$). We predicted that leaf dissection, a variable providing linkage to convective cooling ability, would be positively correlated with leaf surface area. However leaf dissection did not correlate with any variable, indicating that as leaf size changes, shape remains relatively constant within this population.

In these "sun" leaves, leaf weight ($r = 0.91$), leaf specific mass ($r = 0.24$), and crenation number ($r = 0.48$) increased with leaf size ($P < 0.01$ for each correlation coefficient). Figure 4 presents the relationship between leaf mass and leaf area. On an individual tree basis, dry weight of leaf is an excellent predictor of surface area (e.g., in Figure 5 for Tree 5, R-square = 0.976) but less so for all leaves (R-square = 0.826). As a field technique, leaf width provides the simplest predictor of leaf surface area (e.g., for Trees 1 & 4, Area = 25.30 * Width - 60.46, R-sq. = 0.91). Once it is determined that leaf shape changes little with leaf area, regression equations could be used to predict leaf area, as dry weight and/or blade width is easier to measure than leaf area.

Increased leaf specific mass usually confers greater water use efficiency and photosynthetic capacity. Average leaf specific mass ranged from 82.6 in tree 4, to 141.3 g m^{-2} in tree 5. We cannot explain why leaf specific mass varied so much in this study, among 5 trees growing within 100 meters of each other (Table 1). Indeed, trees 4 and 5, with essentially the same average leaf images (Fig. 8), had the most divergent values for leaf specific mass.

Crenation number, grouped into 5 levels (7–10, 11–14, 15–18, 19–22, and 23–33 crenations per blade), was declared a "response" variable, and analyzed by logistic regression against leaf surface area as an explanatory variable (Figure 5). In logistic regression, crenation value is not predicted, rather, probabilities are estimated for each level of crenation "response," given leaf surface area. The resultant graph, partitions the outcome space into mutually exclusive regions. To use the logistic regression graph, one draws a vertical line at any desired surface area dividing the estimated probability into segments for each level of response. For example, as leaf size increases beyond 200 mm^2, the probability that a leaf will have 7–10

TABLE 2. Descriptive statistics (mean and SD) with single classification analysis of variance for leaf morphometric variables for five trees of yaupon collected August 12, 1989, Ponchatoula, LA. Surface area is mm^2 for one side; mass is mg dry weight; leaf specific mass is g dry weight / m^2 surface area; dissection index is a dimensionless number for perimeter relative to surface area with circles having a DI = 1 (Dissection Index = Perimeter / (2 * SQR(Area * pi)); leaf complexity is the number of Fourier frequencies necessary to reconstruct a leaf image to within 95% of a complete reconstruction. R-square is the proportion of the variability (total sum of squares) in each variable accounted for by the main effect (leaves grouped by tree).

VARIABLE	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	ONE-WAY ANOVA F	df	P	R-square
Surface Area	138.2 (53.09)	254.6 (115.50)	130.1 (39.34)	98.5 (33.17)	92.6 (22.33)	71.8	4, 337	<.00001	0.460
Leaf Mass	9.3 (.006)	31.6 (.017)	12.1 (.004)	6.9 (.003)	13.4 (.004)	140.9	4, 476	<.00001	0.542
Leaf Specific Mass	92.8 (27.76)	117.7 (19.74)	92.4 (11.84)	82.6 (29.56)	141.3 (15.74)	55.3	4, 338	<.00001	0.396
Crenation Number	14.5 (2.52)	17.7 (4.49)	13.3 (2.52)	16.2 (2.99)	15.7 (5.48)	21.5	4, 476	<.00001	0.153
Dissection Index	1.13 (.039)	1.14 (.500)	1.24 (.060)	1.16 (.041)	1.15 (.022)	63.5	4, 338	<.00001	0.429
Leaf Complexity	2.95 (.580)	2.97 (.701)	3.16 (.541)	3.07 (.464)	3.09 (.384)	1.7	4, 338	0.14 ns	0.020

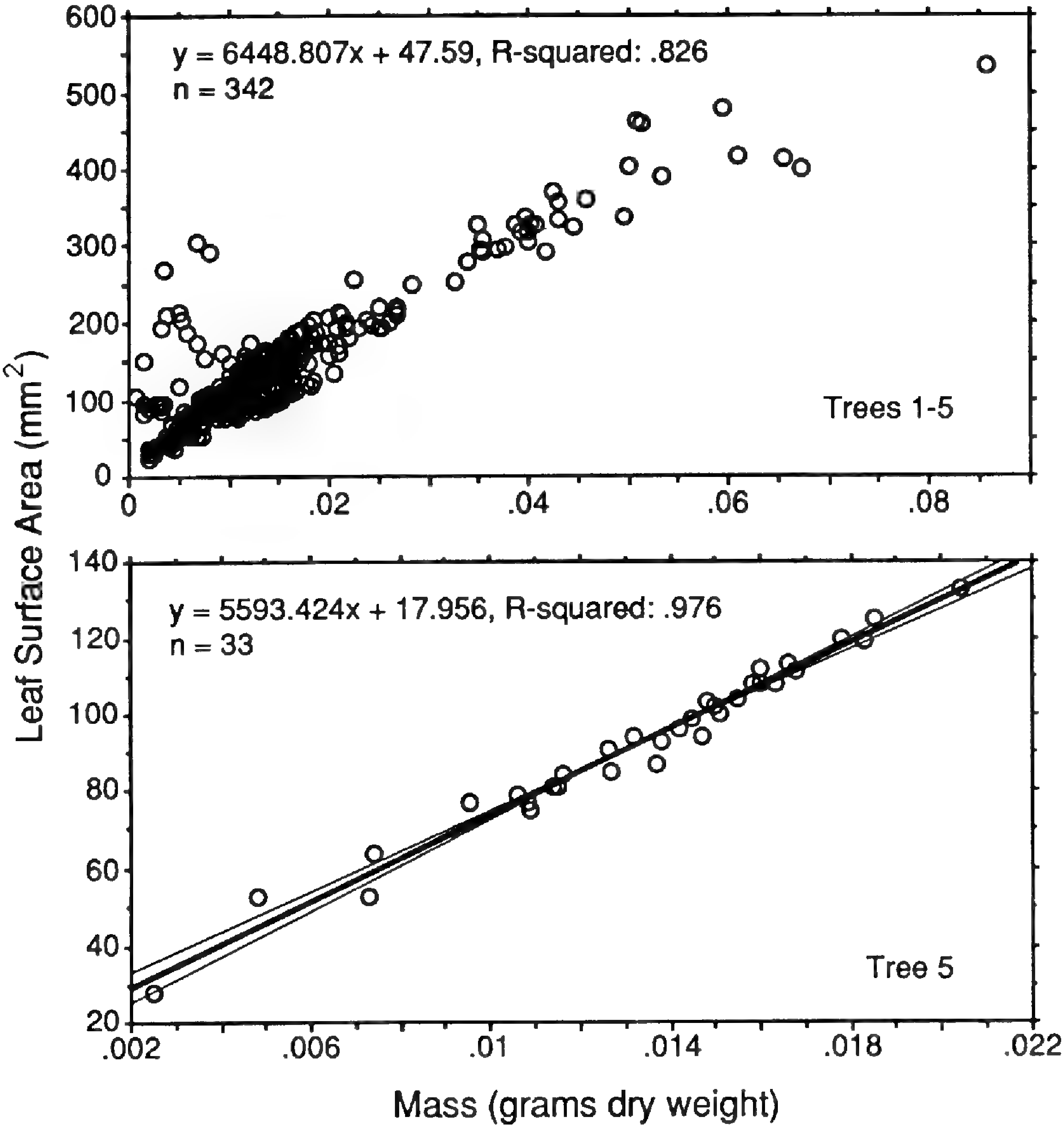


FIG. 4. Relationship between leaf surface area and leaf mass. Upper graph: 5 trees (n = 342); outliers (less than 0.02 g) are immature leaves. Lower graph: Tree 5 (n = 33). Least squares linear regression linear regression ($P < 0.0001$ for both) with 95% confidence intervals for slope given for Tree 5.

crenations becomes extremely low. Large leaves (> 400 mm^2) are much more likely to develop 15–33 crenations than they are likely to develop 7–18 crenations.

In Figure 6, we use logistic regression as a tool to visualize the estimated probability of tree "membership" for a leaf, given the number of crenations on a particular leaf. Trees 1 and 3 have the lowest average number of crenations per leaf; and Trees 2 and 4 have the largest average number (Table 2). The fitted logistic regression curves of Figure 6 provide a display of these trends across the entire range of number of crenations found in this study.

Leaf surface area is strongly related to nodal position, but only when

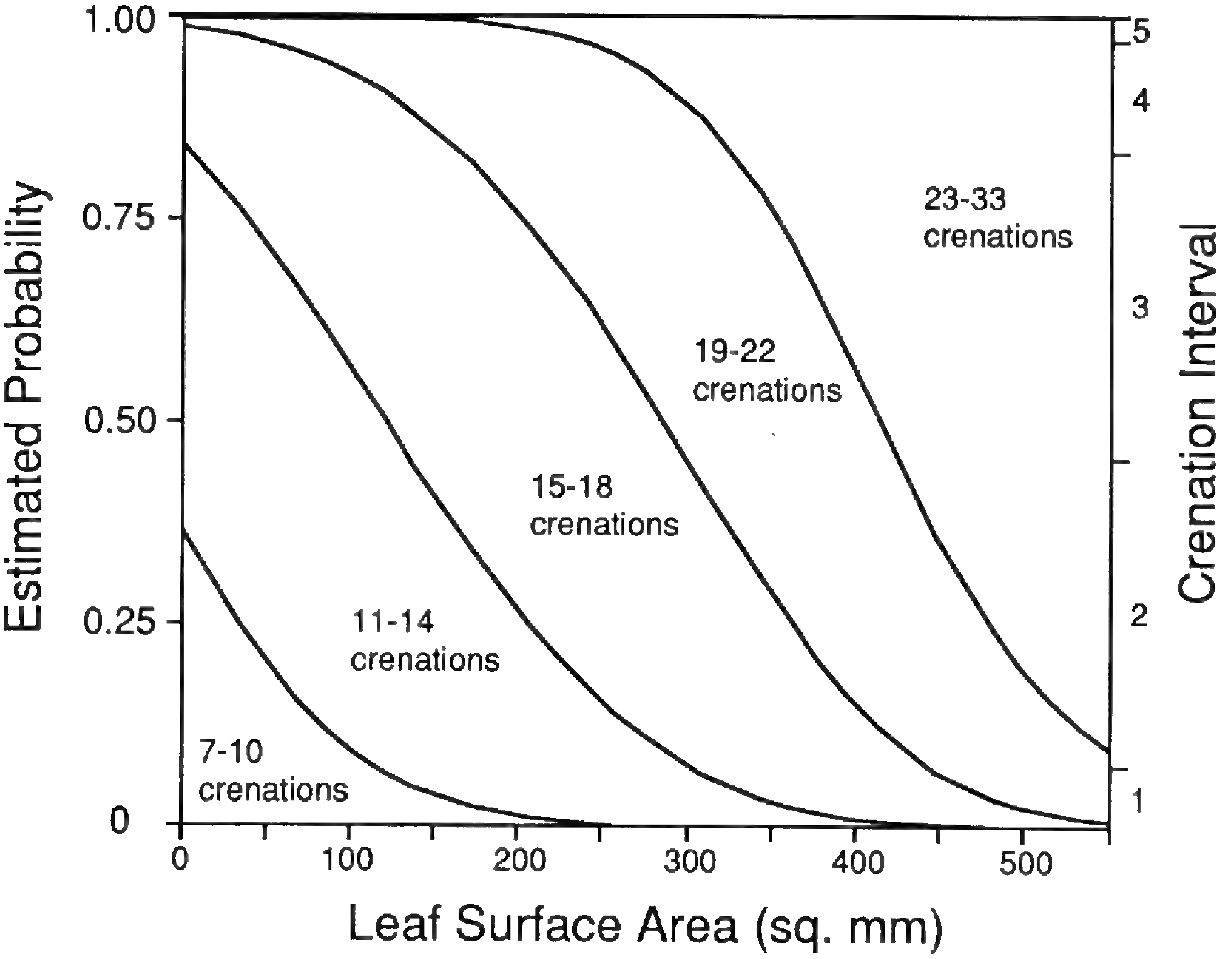


FIG. 5. Logistic regression analysis of number of crenations versus leaf surface area as the explanatory variable. In analysis of loglikelihood, chi-square = 117.4, $P < 0.00001$, $N = 339$.

analyzed on a per shoot basis (Fig. 7). For many shoots, 70–90% (R-square) of total variability in leaf area is accounted for by nodal position. This holds true even for long terminal shoots that have experienced, over the growing season, an episodic growth and/or a developmental switch from preformed to neo-formed (produced and released in current growing season) leaf buds (lower right graph in Fig. 7). Shoots within trees had the same average leaf size in ANOVA.

Average leaf images reconstructed for each tree, as computed from average Fourier coefficients for the first 8 frequencies, are displayed in Figure 8 along with principal component analysis of more conventional morphological variables. The Fourier transform captures only the two-dimensional leaf outline: We see from these average images that Trees 4 and 5 have very similar leaf sizes and shapes, and that Trees 1 and 3 have similar leaf sizes but different shapes. In principal component analysis, leaf area loaded heavily on the first component which accounted for 0.33 of total variance. The shape variables (DI and LC) loaded on the second component, accounting for 0.28 of the variance. Tree number, loaded on the third component, accounting for 0.19 of the variance. As a general rule for biological objects analyzed by

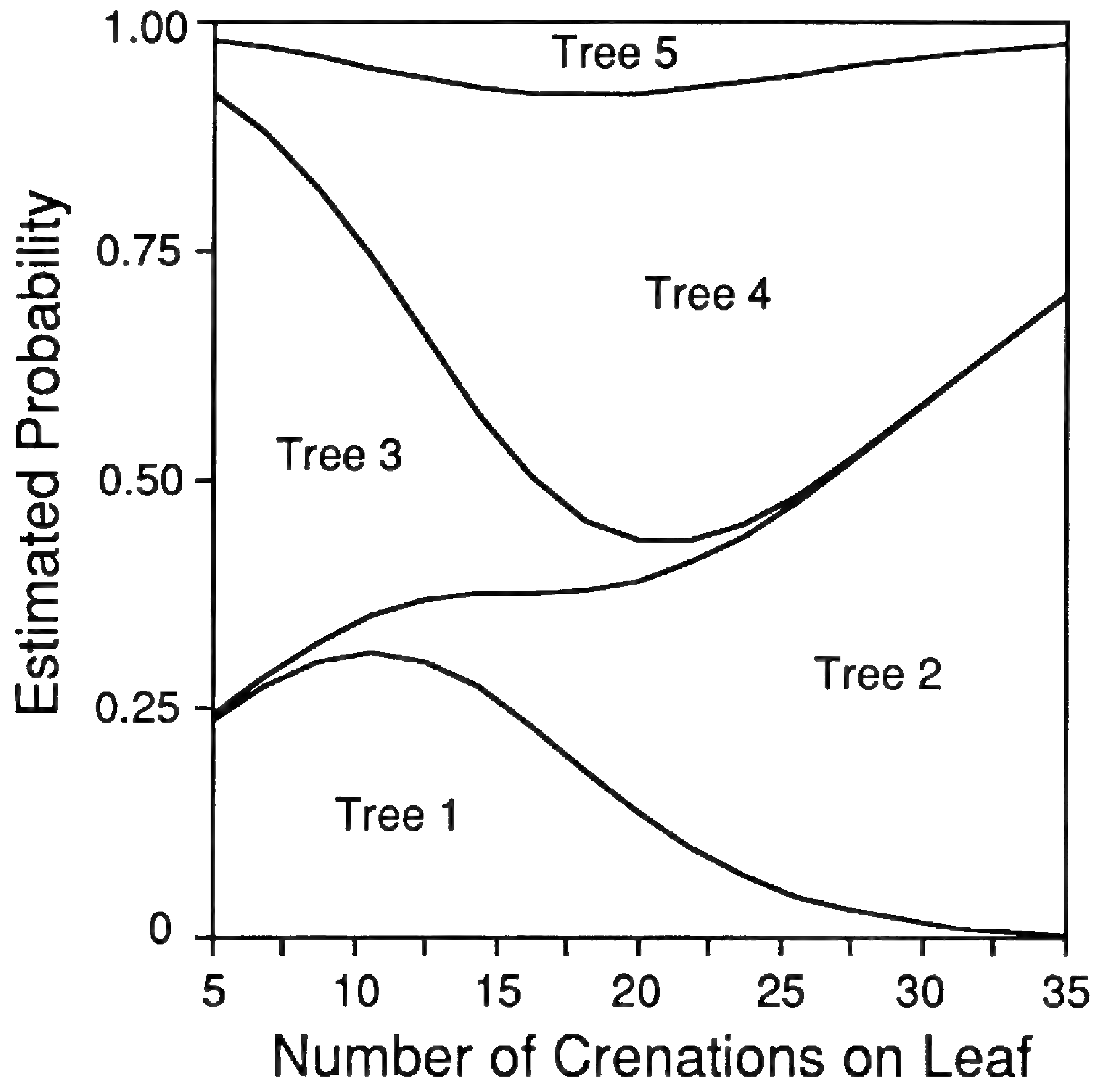


FIG. 6. Visualization of relationship between probability of tree "membership" and number of leaf crenations by logistic regression analysis (analysis of loglikelihood chi-square = 84.2, P < 0.00001, N = 481).

principal components, "size" variables dominate the first component and "shape" variables the second component (Pimentel 1979). The scatterplot of the 342 leaves, graphed in PC space for the first two components, revealed clusters of points corresponding to tree. The 95% confidence ellipses of the bivariate means of each of these clusters are displayed in the lower part of Figure 8. Trees 3, 4 and 5 cluster rather closely together, while Trees 1 and 2 are distinct.

Leaf surface area appears to be functionally related to nodal position, with the middle nodes producing leaves that often are 15 to 20 times larger in surface area than leaves at the early and late nodes (Fig. 7). This range in leaf surface area within single shoots, may transcend average differences from populations across the latitudinal and sun-shade extremes of the species.

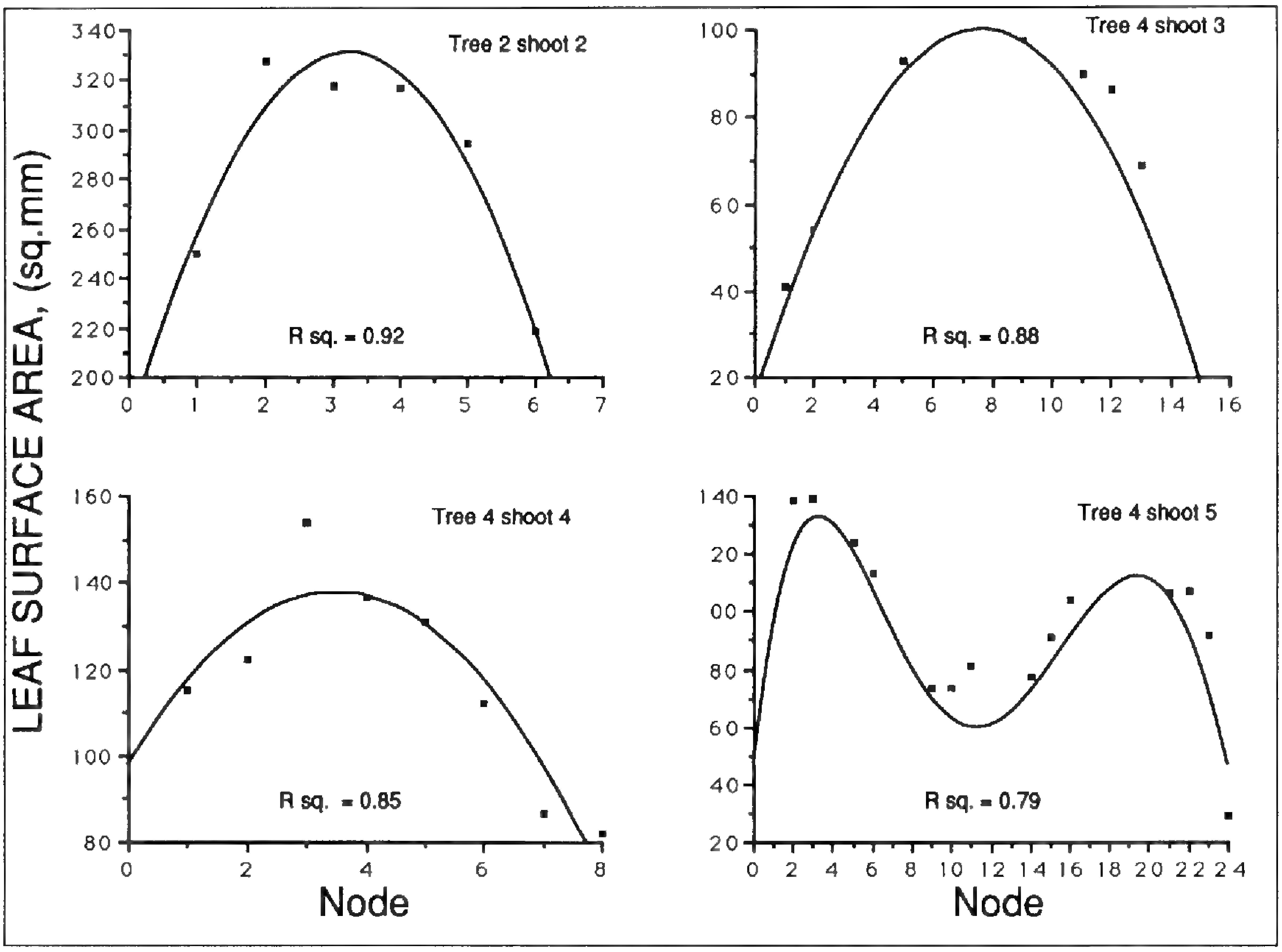


FIG. 7. Leaf surface area is functionally related to nodal position. Seventy to ninety percent (R-square in second order polynomial regression) of the variability in area is accounted for by nodal position. This remains true even for long terminal shoots that have experienced, over the growing season, episodic growth and/or a developmental switch from preformed to neo-formed leaf buds (lower right figure).

We have established nine study populations of yaupon. Three of these are inland stations: Aiken, South Carolina; Homosassa Springs, Florida; and, the subject of this paper, Ponchatula, Louisiana. We have also established six coastal stations from the species northern distributional limit, Virginia Beach, Virginia, to one of its southern limits, New Smyrna Beach, Florida. Exploratory analysis of the modestly sized data set of this paper has helped us plan collection strategies for the other stations. As botanical methods of computer-assisted image analysis advance (White et al. 1988), research designs should be able to accommodate larger sample sizes of leaves, involving more trees per population, and more shoots per tree.

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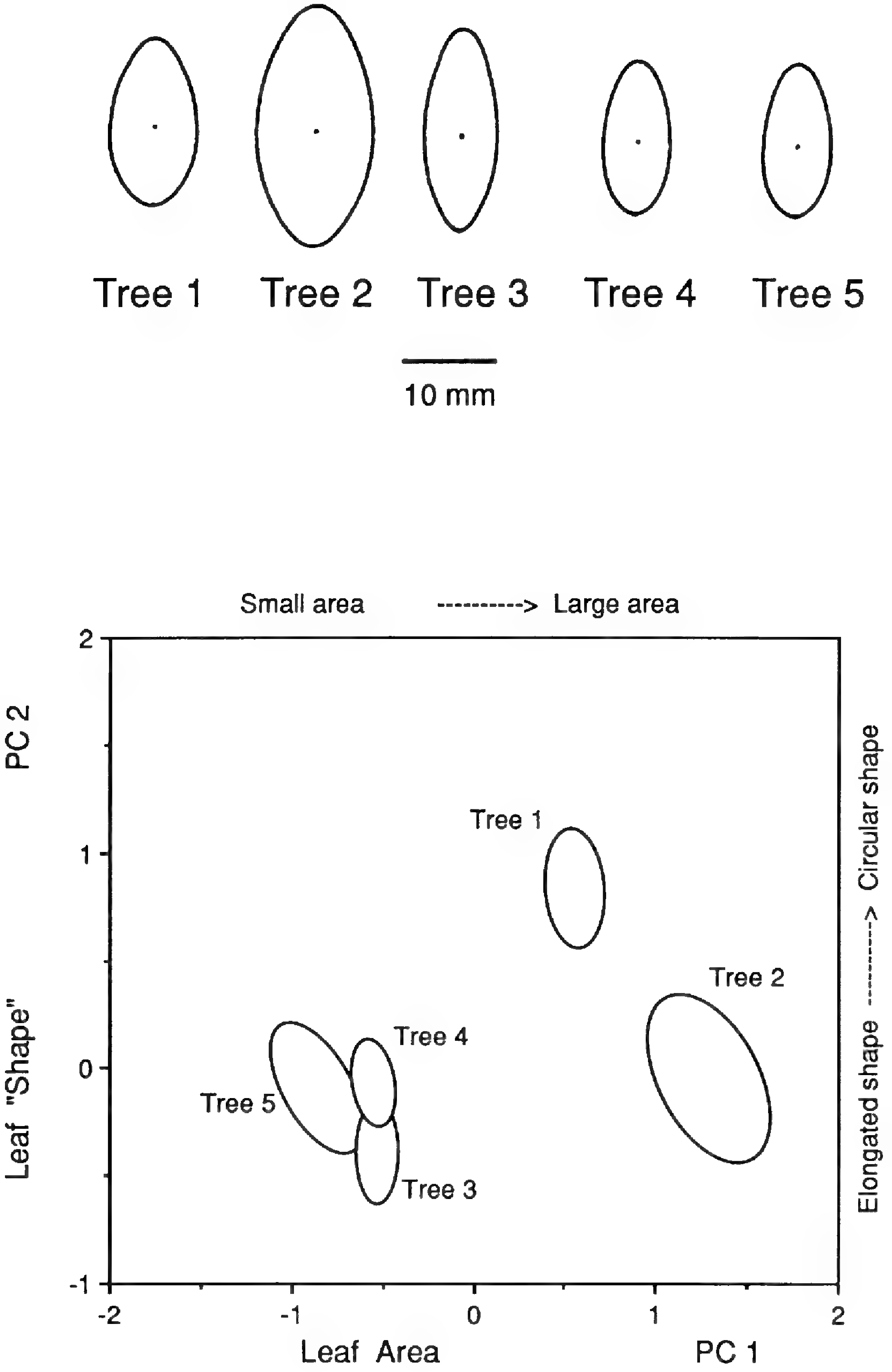

FIG. 8. Upper: Average leaf images per tree reconstructed from average Fourier coefficients. Lower: Principal component analysis with 95% confidence ellipses of the bivariate means for each Tree, N = 342 leaves.

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THE MYRICACEAE OF THE UNITED STATES AND CANADA: GENERA, SUBGENERA, AND SERIES

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ABSTRACT

The compelling case for recognizing three genera of North American Myricaceae (*Comptonia*, *Morella*, and *Myrica*) is presented. Keys and descriptions are provided for the recognized supraspecific taxa. The nomenclatural basis of each of these genera, subgenera, and series is outlined and discussed if at all controversial. *Morella* Lour., the largest genus, is here treated as comprising two subgenera of which subg. *Cerothamnus* (Tidestr.) Wilbur is found in the Americas and Africa and subg. *Morella* is restricted to eastern and southeastern Asia. There are at least four species of *Morella* in the United States and Canada and perhaps as many as six: *M. cerifera* (L.) Small, *M. caroliniensis* (Mill.) Small, *M. inodora* (W. Bartram) Small, and *M. californica* (Cham. & Schltdl.) Wilbur. Those about which there is some question do not have binomials in the genus *Morella* but are known as *Myrica pensylvanica* Mirbel (= *Cerothamnus pensylvanicus* (Mirbel) Moldenke) and *Myrica pusilla* Raf. (= *Cerothamnus pusilla* (Raf.) Small). *Myrica* L. is represented by the circumboreal *M. gale* L. and the Californian *M. hartweqii* S. Watson. *Comptonia* L'Hér. ex Aiton with its only species, *C. peregrina* (L.) J.M. Coulter, is restricted largely to the northeastern United States and adjacent Canada. New combinations and/or rankings are provided for the following taxa: *Morella* subg. *Cerothamnus* (Tidestr.) Wilbur and series *Faya* (Webb & Berthel.) Wilbur, *Morella californica* (Cham. & Schltdl.) Wilbur, and for the Azorean *M. faya* (Aiton) Wilbur.

RESUMEN

Se presenta un estudio convincente para reconocer tres géneros de *Myricaceae* de Norte América *(Comptonia, Morella, y Myrica)*. Se ofrecen claves y descripciones de los taxa supraspecíficos reconocidos. Se bosqueja y discute la base nomenclatural de todos los géneros, subgéneros y series, aunque sea controvertida. *Morella* Lour., el género más amplio, se trata aquí dividido en dos subgéneros de los cuales *Cerothamnus* (Tidestr.) Wilbur se encuentra tanto en América del Norte como del Sur y en Africa, y *Morella* que está restringido al este y sureste de Asia. Hay al menos cuatro especies de *Morella* en los Estados Unidos y Canadá, que quizás puedan llegar a seis: *M. cerifera* (L.) Small, *M. caroliniensis* (Mill.) Small, *M. inodora* (W. Bartam) Small, y *M. californica* (Cham. & Schltdl.) Wilbur. Las especies sobre las que hay dudas, no tienen ningún binomen en el género *Morella,* pero se conocen como *Myrica pensylvanica* Mirbel (= *Cerothamnus pensylvanicus* (Mirbel) Moldenke) y *Myrica pusilla* Raf. (= *Cerothamnus pusilla* (Raf.) Small). *Myrica* L. está representado por *M. gale* L., circumboreal, y *M. hartwegii* S. Watson, de California. *Comptonia* L'Hér. ex Aiton con su única especie *C. peregrina* (L.) J. M. Coulter está restringida al noreste de los Estados Unidos y zonas adyacentes de Canadá. Se dan nuevas combinaciones y/o rangos para los siguientes taxa: *Morella* subgen. *Certhamnus* (Tidestr.) Wilbur y serie *Faya* (Webb & Berthel.) Wilbur, *Morella californica* (Cham. & Schltdl.) Wilbur y para *M. faya* (Aiton) Wilbur, de las Isla Azores.

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For one whose formative years were spent in a section of the country where Small's (1933) *Manual of the southeastern Flora* was the basic reference, numerous adjustments had to be made to relate to the prevailing, more conservative generic concept then dominating most of American botany. Small's "microgenera" were viewed as a provincial aberration. For one's work to be understood by most of the botanical community, one had to convert the generic names employed by Small and other prolific practitioners of the so-called "New York School" such as Britton, Rydberg, and Barnhart into the broader generic concepts employed by more conservative botanists. For example, how many of us know which common genera are intended when one encounters such generic names as *Wallia, Cerothamnus, Tulipastrum,* or *Phenianthus?* Brandegee (1901) argued vehemently against the generic splitting characteristic of the New York Botanical Garden under the leadership of Nathaniel Lord Britton. She suggested that genera should be so broadly delineated that all reasonably bright 10 year olds could be expected to know the principal genera of plants and animals in their neighborhood. Clearly Brandegee would be disappointed today for not only would most school boys and girls fail her test but so would most university biology professors. In fact, in the past 2 decades the pendulum has swung back strongly towards the generic standards of Britton, Rydberg, and Small. Who could have predicted 2 or 3 decades ago that the well-known genus *Cassia* would disappear from the flora of the Carolinas and be replaced by the segregates *Chamaecrista* and *Senna*; or that *Psoralea* would be confined to southern Africa and that those generic names that Rydberg and Small were castigated for using instead (*Orbexilum, Pediomelum*, and *Rhytidomene*) would now be very widely adopted for different elements formerly included in *Psoralea* s.l.?

Turning to Myricaceae, we find that Small (1933) recognized three genera in the area of the southeastern United States: *Myrica* L. (1753), *Comptonia* L'Hér. ex Aiton (1789) and *Cerothamnus* Tidestr. (1910). Radford et al. (1968) also recognized three myricaceous genera in the Carolinas, differing however in the generic names accepted and the groups to which the names applied: *Gale* Adans. (1763), *Comptonia* L'Hér. ex Aiton (1789), and *Myrica* L. (1753). More conservative treatments of Myricaceae recognize, in addition to the controversial and relatively little-known, monotypic, New Caledonian *Canacomyrica* Guillaumin, two genera sometimes combined as subgenera or sections within the broad concept of *Myrica*. Under such a conservative scheme, the genus *Myrica* would consist of three major taxa of very unequal size. The New Caledonian *Canacomyrica* will not be considered in this paper, but it should be noted that considerable doubt has been expressed as to its relationship with Myricaceae (Thorne 1973). The nomenclature of the three North American myricaceous genera is in part controversial as is discussed below.

The morphological evidence summarized in Table 1 argues strongly that there are at least three major groups within non New Caledonian Myricaceae. These three groupings are so fundamentally different that, in my opinion, generic rank should be accorded to each of them. With flowers as greatly reduced as those of Myricaceae, it is not surprising that the most striking differences are found elsewhere—especially in characteristics of fruit and vegetative features. These same groups were treated as three subgenera of *Myrica* by Engler (1894). Gleason (1952) and Gleason & Cronquist (1963) treated all species as *Myrica* with no indication given of infrageneric, supraspecific classification. Many authors including Rehder (1949), Fernald (1950), Hutchinson (1964-), Elias (1971), and Gleason & Cronquist (1991) in the past 5 decades have recognized two genera: *Comptonia* and *Myrica* (sometimes the latter with the two commonly accepted subgenera, *Gale* and *Morella*). Among previous authors recognizing three genera are Chevalier (1901), Rendle (1903), Small (1933), Radford et al. (1968), and Baird (1968).

That there are three major groupings within Myricaceae seems generally agreed upon by most students of the family; the only question is the rank or ranks to be accorded to these seemingly natural, monophyletic taxa. Perhaps a comparable case is *Quercus*, since that genus is traditionally divided into three subgenera by most botanists although Schwarz (1936) treated the subgenera as genera and Oersted (1867) had originally treated those Asian species with connate cupular scales forming concentric rings as the genus *Cyclobalanopsis*. A table or chart comparing the differences between these three fagaceous taxa is both lengthy and impressive, but evaluation of the differences suggests that they are variations on the same theme as opposed to rather dramatic innovations and new themes expressed in the phyletic development of the three lines of Myricaceae.

Although in Table 2 Baird has been outvoted 3 to 1, the preponderance of evidence suggests that he was nomenclaturally correct in the names he employed and the groups to which he applied the names. Small (1903) recognized both *Comptonia* and *Morella* in the southeastern United States but was unaware of the presence of *Myrica gale* there. It is unfortunate that Baird's detailed investigation was never published. I here acknowledge my indebtedness to Baird (1968) for information summarized in his unpublished dissertation that strengthened the case made for the recognition of three genera. It must be admitted that in such matters one can not be dogmatic for the state of our science does not totally exclude individual taste. As long as the groups recognized are seemingly monophyletic (in the precladistical sense) and perhaps reasonably equivalent in morphological differentiation, whether such groups are treated as three genera or three sections or subgenera of one genus is a matter of individual taste doubtlessly tempered by both tradition and the prevailing philosophy of the period.

TABLE 1. Comparing the three genera of the Myricaceae.

	MORELLA	MYRICA	COMPTONIA
Terminal buds	Present	Lacking	Lacking
Leaves	Thick, usually persistent, entire, toothed, or rarely incised	Thin, deciduous, entire or weakly serrate distally	Thin, deciduous, roundedly pinnatifid
Stipules	Lacking	Lacking	Present
Aments	Inserted on old wood mainly below the leaves	Inserted at the summit of the branchlets of preceding year	Inserted in the axils on deciduous branchlets
Stamen number	3-22	Usually 4 but ranging from 3-6 (-9)	Usually 4 but ranging from 3-7
Ovary	Covered with waxy or fleshy emergences; bracteoles none or, if present, non-adnate	Smooth, flanked by 2 entire bracteoles which develop in fruit into wings, strongly adnate	Smooth, flanked by 2 laciniate bracteoles emerging from the base and developing into a loose cupule
Fruits	In very loose clusters; spherical to subspherical nutlet covered by wax-secreting papillae	In dense, subcylindrical spikes; flattened, keeled nutlet made buoyant by two adnate, enlarged and inflated bracteoles	In spherical spikes; conic to cylindric nutlet enveloped by the elongating and persistent bracteoles and scales forming a bur-like fruiting structure
Adnation of bracteoles with fruit wall	None	Strongly adnate	None
Ectocarp:			
Relative thickness	Thick	Thin	Thin
Cell type	Parenchyma	Parenchyma	Sclerenchyma
Papillae presence	Present	Absent	Absent
Trichomes presence	Absent to dense	Absent	Absent
Surface	Non-sclerified, waxy	Neither hard nor waxy	Sclerified and not enveloped by wax
Cell type of mesocarp	Sclerenchyma	Parenchyma	Parenchyma
Wood	Diffuse porous	Ring porous	Diffuse porous
Chromosome number	n=8	n=24, 48	n=16

TABLE 2.

CHEVALIER (1901)	RENDLE (1903)	RADFORD ET AL. (1968)	BAIRD (1968)
Myrica	Myrica	Myrica	Morella
Gale	Gale	Gale	Myrica
Comptonia	Comptonia	Comptonia	Comptonia

In recognizing genera, botanists would perhaps find that by placing greater emphasis on the currently minimized morphological adaptations between plants and their environment, the disparity between botanical and zoological practice would be less striking than now is the case. The importance of the genus as an indicator of discrete evolutionary lines would be enhanced if the obvious correlation between functional morphology and broadly conceived environmental integration were emphasized (Inger 1958). In the case of Myricaceae, it should be pointed out that these morphological adaptations to differing means of fruit dispersal have not been ignored by botanists even if they have not emphasized the functional role. These characteristics of the fruit have been recognized by even the most conservative botanists in their formal classification but usually at the subgeneric level. My account merely advocates recognition at the generic level.

A principal reason for the widely divergent generic treatments of Myricaceae is not because of differences in interpretations of biological or morphological facts or even in the weight given to these facts; it is simply a disagreement as to the lectotypification of the generic name *Myrica* L. Chevalier (1901), Rendle (1903), and Radford et al. (1968) in effect all treated *Myrica cerifera* L. as the lectotype of the generic name *Myrica*; Baird (1968) accepted *Myrica gale* L. as the lectotype. This confusion exists whether we accept one genus with three equivalently ranked subgroups or recognize three independent genera, but the differences are obviously much more dramatic under the binomial system of nomenclature if three genera are recognized rather than one genus.

Unfortunately the International Code of Botanical Nomenclature (ICBN 1988) still provides remarkably little guidance in the matter of choosing a lectotype. In the absence of clear directions from ICBN, botanists will of necessity flounder along with their divergent conclusions as to what the lectotype of such Linnean genera as *Myrica* should be. A special Committee on Lectotypification was established by the Nomenclature Section of the Sydney Congress to resolve problems such as those pointed out by Stirton et al. (1981). This Committee recommended to the Berlin Congress that Art. 8.1 be amended to read "The author who, on or after 1 January 1935, first designates a lectotype or a neotype must be followed. ..." It was hoped that this stipulation would eliminate the uncertainty connected with use of the term "type" by such early authors as Rafinesque whose concept of type surely was different than that of a present-day investigator and also the uncertainty of the lectotypes designated under both the American Code and the Type Basis Code. Under this suggested requirement, the genus *Myrica* would have been typified by *M. gale* as that was the choice of Hitchcock and Green and published as an unofficial supplement to the ICBN (1935, p. 116). However, the International Botanical Congress meeting in Berlin in 1988 found itself unable to resolve the problems of lectotypification and, since one committee failed to solve the problem to everyone's satisfaction, three committees were appointed to study and to report their recommendations to the 1993 Congress (Tokyo). As might be expected the complicated problems of lectotypification have been largely passed on to the next Congress.

Both *Myrica gale* and *M. cerifera* have been designated as the lectotype for the generic name *Myrica*. The species best known to Linnaeus as the only member of the genus occurring in Sweden, where it is abundant, is *Myrica gale*. Britton, operating under the American Code, designated this species as the type (= lectotype) of the genus. Hitchcock & Green (1929) made the same choice; their conclusions as to the "standard species" (= lectotype) were listed in the International Rules (1935) in a semi-official way. However, the desirability of *Myrica gale* as a lectotype was challenged by Hylander (1945) since that species with a very few close allies had been segregated as a small, independent genus. If the much larger clade, represented by *Myrica cerifera*, were to be segregated from *Myrica* this larger portion of the genus, a group of ca. 50 species, would belong to this segregate almost all requiring new combinations. Rehder (1949) also accepted *Myrica cerifera* as the lectotype of the genus *Myrica*. In spite of this consideration, it seems certain that *Myrica gale*, the historically best or at least the scientifically longest known species of *Myrica*, will be confirmed as the lectotype of the genus. Preliminary reports of the subcommittee dealing with lectotypification of Linnaean generic names strongly suggest that *Myrica gale* will be recognized as the lectotype of *Myrica* L.

KEY TO THE AMERICAN GENERA OF MYRICACEAE

1. Terminal buds present; distal axillary buds vegetative; mature fruit both papillose and wax-covered; anthers forming in the spring shortly prior to flowering; fruit a spherical or subspherical nutlet covered by wax- secreting papillae .... 1. *Morella*

1. Terminal buds absent; distal axillary buds floral; mature fruit lacking papillae, somewhat resinous but never bearing a waxy coating; anthers formed in the fall preceding flowering; fruit either flattened and keeled or conical to cylindric, neither wax-coated nor papillate.

   2. Leaves stipulate; leaf margin entire or serrate; bracteoles of pistillate flowers 2, unlobed, adnate to the fruit; fruit a flattened, keeled nutlet rendered buoyant by the two adnate, enlarged, unlobed inflated bracteoles .... 2. *Myrica*

2. Leaves stipulate; leaf margins deeply pinnatifid with broadly rounded lobes; bracteoles of pistillate flowers 2, deeply lobed into linear segments, not adnate to the conic to cylindric fruit; fruit a conic to cylindric nutlet enveloped at maturity in a bur-like involucre formed from the lobed bracteoles and the accompanying bracteal scale .... 3. *Comptonia*

1. *MORELLA* Lour.

Morella Lour., Fl. Cochinch. 548. 1790. TYPE: *Morella rubra* Lour.

KEY TO THE SUBGENERA OF *MORELLA*

1. Aments branched; pistillate bracts subtending several ovaries of which only one develops; fruit 6–8 mm in diameter, covered at maturity by imbricate, fleshy, succulent papillae .... subg. 1. *Morella*
1. Aments simple; pistillate bracts usually solitary, simple, and 1-flowered; fruit 1–5 mm in diameter, covered at maturity usually by wax-secreting, neither fleshy nor succulent papillae .... subg. 2. *Cerothamnus*

MORELLA subgenus *MORELLA*

Morella Lour., Fl. Cochinch. 548. 1790. TYPE: *Morella rubra* Lour. *Myrica* sect. *Morella* (Lour.) Benth. & Hook.f., Gen. Pl. 3:401. 1880. *Myrica* subg. *Morella* (Lour.) Engler, Nat. Pflanzenfam. II. 1:27. 1893.

Subgenus *Morella* apparently contains fewer than 10 species of eastern Asia, the Philippines, and Malaysia. The differences between the species of subg. *Morella* and subg. *Cerothamnus* from both the Americas and central and southern Africa are so striking as to have elicited expressions of consternation from Greene (1910) that Small (1903) would transfer our southeastern species to *Morella*; this dismay was shared by Nieuwland (1910). Greene could not believe that plants whose fruits were so palatable and wholesome as to be eaten both uncooked and cooked and so succulent and juicy as to be made into a flavorful wine could belong to the same genus as the hard, waxy-fruited plants of the southeastern United States or the western coastal region from Vancouver Island throughout much of California. Perhaps Greene was correct in his assessment, but for the present, based largely upon the findings but not the conclusions of MacDonald (1978) and Abbe (1972), the Asiatic plants are here treated as merely subgenerically differentiated from their American and African congeners.

Morella Subgenus **Cerothamnus** (Tidestr.) Wilbur, comb. & stat. nov.

Cerothamnus Tidestr., Elys. Marian., Ferns. 41. 1910. LECTOTYPE: *Cerothamnus arborescens* (Castigl.) Tidestr. (= *Myrica cerifera* L.) [herein designated].

Usually aromatic, dioecious or polygamo-monoecious shrubs to small trees with terminal buds. Leaves alternate, pinnately veined, deciduous or evergreen, entire or serrate, estipulate. Inflorescences borne proximally below or axillary to the lower leaves, the staminate erect or nearly so, at anthesis thick-cylindric to broadly ellipsoid, bracts broadly to narrowly ovate and at anthesis shorter than the 1–22 stamens, the stamens yellow or becoming yellow, filaments simple or branching and arising from the staminal column at different levels, the secondary, tertiary and even quarternary bracts often present; pistillate inflorescences simple or basally branched, at anthesis ovoid to cylindrical, the rachis sometimes glandular and the bracts usually persistent, the pistillate flower subtended by secondary, tertiary, or even quarternary bracts forming a calyculus, the ovary either glabrous or pilose and almost completely covered by persistent, more or less globular, wax-secreting papillae. Fruit a nutlet, ± spherical and mostly covered by a layer of wax, the ovary wall glabrous to densely pilose, the papillae glabrous to puberulent, the associated secondary, tertiary, and even quarternary bracts, if all present, persisting until after fruit maturation and never enlarging.

Cerothamnus, the largest subgenus in Myricaceae, contains the waxy-fruited species of *Morella* native to the Americas and Africa and their neighboring islands—i.e. the West Indies and the Atlantic islands lying off the northwestern coast of Africa.

KEY TO THE SERIES OF SUBGENUS *CEROTHAMNUS*

1. Staminate flowers with 3–7 stamens; staminal column branches each with only 1 anther; bracteoles 0–3; pistils solitary in axil of a bract; fruit wall glabrous or, if pubescent, then the papillae also pubescent .... Ser. 1. *Cerothamnus*
1. Staminate flowers with (6-)8–18(-22) stamens; staminal column branches often with 2 anthers; bracteoles 2–6; pistils 1–3 in axil of each bract; fruit wall but not the papillae densely pubescent .... Ser. 2. *Faya*

Morella series **Cerothamnus** (Tidestr.) Wilbur, comb. & stat. nov.

Cerophora subg. *Cerocarpa* Raf., Alsogr. Amer. 11. 1838. LECTOTYPE: *Cerophora lanceolata* Raf., herein designated [= *Myrica cerifera* L.]

Myrica sect. *Cerophora* (Raf.) A. Chev., Mém. Soc. Sci. Nat. Cherbourg 32:223 (= Monogr. Myric. p.139) 1901.

Cerothamnus Tidestr., Elys. Marian., Ferns. 41. 1910. LECTOTYPE: *Cerothamnus arborescens* (Castigl.) Tidestrom (= *Myrica cerifera* L.)

Aments simple; pistillate usually solitary, simple, and 1-flowered. Fruit 1–5 mm in diameter. Papillae wax-producing, neither juicily succulent nor fleshy.

In spite of the few species in *Morella* series *Cerothamnus* present in eastern North America, there currently exists a surprising amount of uncertainty as to just how few or how many species can be recognized in that well-collected area. The number of species are in any event few: perhaps no more than two and certainly no more than four.

1. **Morella cerifera** (L.) Small, Fl. SE U.S. 337 & 1329. 1903. *Myrica cerifera* L., Sp. Pl. 1024. 1753. *Cerothamnus ceriferus* (L.) Small, Fl. Miami 61 & 200. (26 Apr) 1913.

2. A second taxon has been proposed whose distinctness from *Morella cerifera* is denied by several of our more experienced students of the southeastern flora. The questioned taxon is usually a low bushy, rhizomatose plant with strikingly smaller leaves. It was treated by Michaux (1803) and Radford et al. (1968) as a variety (*Myrica cerifera* var. *pumila* Michx.) but as a species by Rafinesque (1838) and Small (1903 and 1933) (*Myrica pusilla* Raf., *Morella pumila* (Michx.) Small, and *Cerothamnus pumilus* (Michx.) Small).

Many field observers and collectors of bayberries, are at least partly convinced that *Myrica pusilla* merits taxonomic recognition for these dwarf plants seem strikingly unlike the much more abundant and luxuriant *M. cerifera* that often grow in close proximity. In the herbarium on the other hand the claim to specific or even varietal status of *M. pusilla* seems much less certain perhaps because most specimens are not accompanied by notes as to either the height or habit of the plant; those two features together with the much smaller size of the leaves are what makes these plants in the field so strikingly unlike the ubiquitous *M. cerifera*. In spite of the apparent distinctiveness noted in the field, it seems impossible to maintain as distinct *cerifera* and *pusilla* even in a group as plastic or as bereft of taxonomically useful characters as are the bayberries. Sufficient dissatisfaction with this conclusion exists, however, that I intend and would urge all other botanists with the opportunity to study and collect the plants in the field to do so and to record carefully notes on the height, habit and habitat of the plants—something that surprising has been largely neglected by most collectors even in recent decades.

Thieret (1966), who has had extensive field experience with both species in Louisiana, noted that "from a clump that is otherwise typically *M. pusilla*, there will arise one main stem to ten or twelve feet tall and six inches in diameter—a *M. cerifera* stem. Examination reveals that all the stems of the clump comprise a clone. ... Plants intermediate in habitat between the two extremes are usually found in the vicinity." Thieret concluded that "the habit differences ... are not reliable criteria but are simply responses to habitat differences" and "that the habit extremes pass insensibly into each other." I too have often observed in North Carolina both *pusilla* and *cerifera* growing in close proximity but have not yet noted the blurring of growth form and leaf size that Thieret has noted nor am I convinced that there is always a correlation of habitat and growth form. I have regrettably never tried to excavate the underground connection perhaps implied by Thieret and which, if proven, would provide convincing support for the treatment tentatively accepted here of non-recognition (unless root grafting occurred). Godfrey (1988), whose field experience with our southeastern plants is surely unrivalled, does not accept the dwarf plants as a taxon deserving a name either. Additional study is certainly needed, especially investigations centered in the field.

3. **Morella caroliniensis** (Mill.) Small, Fl. SE U.S. 337 & 1329. 1903 [as *Carolinensis*]. *Cerothamnus caroliniensis* (Mill.) Tidestr., Elys. Marian., Ferns. 41. 1910.

Myrica heterophylla Raf., Alsogr. Amer. 9. 1838 [as "heterophyla"]: TYPE LOCALITY: "Carolina to Florida." *Cerothamnus heterophylla* (Raf.) Moldenke, Phytologia 29:386. 1975.

4. **Myrica pensylvanica** Mirbel, Traité Arbr. Arbust. 2:190. 1804, [not Loisel. as usually cited!]. *Cerothamnus pensylvanicus* (Mirbel) Moldenke, Rev. Sudam. Bot. 4:16. 1937.

Although my study is not completed, I am doubtful that the above two species can be maintained as distinct. The alleged principal difference between the two is apparently to be found in the fruits: fruit of more northern species (*Myrica pensylvanica*) possess puberulence on both the papillae and ovary wall; fruit of the southern species (usually referred to as *Myrica heterophylla* Raf.) have glabrous papillae and glabrous walls. Due to the dense covering of wax, detection of the puberulence is often difficult and the amount varies from a dense covering to very few trichomes. The other alleged differences of fruit size, twig pubescence, leaf persistence, etc. seem even less consistently diagnostic. If only one species is to be recognized, the correct binomial is *Morella caroliniensis* (Mill.) Small, a binomial that has been applied to the combined species in the past and to both of the species at different times when they were treated as distinct species. Miller's name should be applied to the species with the more southern distribution if two species are represented as most authors have accepted for the past 75 years.

5. **Morella inodora** (W. Bartram) Small, Fl. SE U.S. 337 & 1329. 1903. *Myrica inodora* W. Bartram, Travels Carolina, 405. 1791. *Cerothamnus inodorus* (W. Bartram) Small, Florida Trees 12 & 102. 1913.

In striking contrast to most other Myricaceae, but as indicated by its specific epithet, the crushed foliage of *Morella inodora* is not aromatic. The species ranges from southern Georgia westward into southeastern Louisiana.

6. **Morella californica** (Cham. & Schltdl.) Wilbur, comb. nov. *Myrica californica* Cham. & Schltdl., Linnaea 6:535. 1835. *Gale californica* (Cham. & Schltdl.) Greene, Man. Bot. San Francisco. 298. 1894.

The natural range of this species apparently extends from central coastal Washington south into Los Angeles County, California at elevation of 150 m or less.

MORELLA series **FAYA** (P. Webb & Berthel.) Wilbur, comb. & stat. nov.

Fayana Raf., Alsogr. Amer. 12. 1838. TYPE: *Fayana azorica* Raf. (= *Myrica faya* Aiton). *Faya* P. Webb & Berthel., Hist. Nat. Iles Canaries 3:272, t. 216. 1847. TYPE: *Faya fragifera* P. Webb & Berthel. (= *Myrica faya* Aiton). *Myrica* sect. *Faya* (P. Webb & Berthel.) C. DC., Prodr. 16(2):151. 1864.

Aments simple or branched; pistillate bracts subtending several ovaries of which only some usually develop. Fruits usually 4–6 mm in diameter, often forming a syncarpium. Papillae often producing wax but never fleshy.

Series *Faya* is a small taxon of three geographically widely separated species. Besides the two North American representatives treated below, the section is composed of the type species of the section, *Morella faya*[1] of the Canaries, Madeira, and the Azores and possibly also of Portugal where it occurs but perhaps only as a naturalized introduction Burges (1964). MacDonald (1977, p. 2638), who has presented a series of papers on the morphology of the inflorescence of many myricaceous taxa, is of the opinion that "section *Faya* could easily be incorporated in section *Cerophora*" of the genus *Myrica*. This genus in his opinion would then consist of the fleshy-fruited section *Morella* of eastern Asia and Indonesia and section *Cerophora*, the largest taxon in the family, with both American and southern African representatives. The suspicion lingers that series *Faya* is not a proven monophyletic group not only because MacDonald questioned its morphological distinctiveness but also because its distribution pattern is not one readily explained or matched by other examples.

In contrast to the uncertainty existing in both the identities and names of the taxa comprising *Morella* series *Cerothamnus*, the taxa forming series *Faya* are morphologially most distinct and geographically widely separated.

2. MYRICA L.

Myrica L., Sp. Pl. 1024. 1753; Gen. Pl. ed. 5.449. 1754. LECTOTYPE: *Myrica gale* L.

Gale Dumort., Fl. Belg. 12. 1827. [Neither *Gale* Duhamel, (Traité Arbr. Arbust. 1:253. 1755) nor *Gale* Adanson., (Fam. Pl. 1763.) Both Duhamel's and Adanson's reintroduction of *Gale* were illegitimate names as substitutions for *Myrica* L. and hence nomenclaturally superfluous (Art. 63 ICBN)].

Myrica "b" *Gale* [Tourn.] Endl., Gen. Pl. 272.1837. [Employed in the sense of the Myricaceae less *Comptonia*.]

Cerophora subg. *Galestis* Raf., Alsogr. Amer. 11. 1838. LECTOTYPE: *Cerophora* (*Galestis*) *angustifolia* Raf. (= *Myrica gale* L.)

Angeia Tidestr., Elys. Marian., Ferns 37. 1910. TYPE: *Angeia palustris* (Lam.) Tidestr. (= *Myrica palustris* Lam., = *Myrica gale* L.)

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[1] *Morella faya* (Aiton) Wilbur, comb. nov. BASIONYM: *Myrica faya* Aiton, Hort. Kew. 3:397. 1789.

Aromatic, usually dioecious shrubs lacking terminal buds. Leaves alternate, pinnately veined, serrate to entire, deciduous, estipulate. Inflorescences borne distally, the staminate suberect to recurved, in bud ovoid to elliptical and at anthesis cylindrical, the bracts broadly ovate to triangular, at anthesis longer than the 3–6 stamens, secondary bracts absent; pistillate inflorescences simple, broadly cylindric at anthesis, the bracts persistent, the pistillate flowers each subtended by 2 secondary bracts partially adnate to the ovary wall, the ovary glabrous and lacking papillae. Nutlet flattened, keeled, not covered with wax but with few to many glandular trichomes, the bracteoles persistent, becoming greatly enlarged and inflated, strongly adherent to the flattened fruit, inflated and forming a buoyant float.

Myrica is represented in the Americas by two species that are morphologically readily distinguished from one another and whose geographical ranges do not overlap.

1. **Myrica gale** L.

This species has a broken circumboreal distribution pattern extending across Canada and Alaska and south to northern New Jersey, Pennsylvania, eastern Ohio, and about the Great Lakes from as far west as eastern Minnesota and in the west to the mountains of Oregon. Morphological variation apparently correlated with distribution occurs within the extensive range of this species but its taxonomic merit requires additional study. Hultén (1944 and 1968) presented a brief overview of the problem.

2. **Myrica hartwegii** S. Watson.

This species is found along stream banks in yellow pine forests in the Californian Sierra between 300–1500 m and consequently not sharing any part of its range with any other member of the Myricaceae.

3. COMPTONIA L'Hér. ex Aiton

Comptonia L'Hér. ex Aiton, Hort. Kew. 3:334. 1789. TYPE: *Comptonia asplenifolia* (L.) L'Hér. ex Aiton (= *Comptonia peregrina* (L.) J.M. Coulter).

Myrica "c" *Comptonia* (L'Hér. ex Aiton) Endl., Gen. Pl. 272. 1837.
Myrica sect. *Comptonia* (L'Hér. ex Aiton) Endl. ex C.DC., Prodr. 16(2):151. 1864.
Myrica subg. *Comptonia* (L'Hér. ex Aiton) Engler, Nat. Pflanzenfam. III. 1:28. 1893.

Aromatic, usually dioecious, colonial shrubs 1.5 m tall or less and lacking terminal buds. Leaves alternate, pinnately veined and lobed, deciduous, conspicuously semi-cordately stipulate. Inflorescences borne distally, the staminate suberect to strongly recurved, cylindrical, the primary bracts persistent, broadly ovate to quadrangular, at anthesis longer than the 3–7 stamens, adaxally bearing numerous glandular trichomes, secondary bracts absent; pistillate inflorescences simple, broadly ovoid at anthesis, the rachis pubescent and glandular, the bracts persistent but in fruit obscured by the greatly enlarged lobes of the secondary bracts, the pistillate flower subtended by the 2 greatly enlarged and deeply lobed secondary bracts, the ovary glabrous and lacking papillae. Nutlet conical to cylindrical, nonceriferous, 2.2–5.5 mm long, glabrous, surrounded by the enlarged lobes of the secondary bracts, which form a bur-like structure in fruit.

The genus *Comptonia* is both monotypic and endemic to eastern North America.

1. **Comptonia peregrina** (L.) J.M. Coulter, Mem. Torrey Bot. Club 5:127. 1894. *Liquidambar peregrina* L., Sp. Pl. 999. 1753. *Myrica peregrina* (L.) Kuntze, Revis. Gen. Pl. 2: 638. 1891.

Myrica asplenifolia L., Sp. Pl. 1024. 1753. *Liquidambar asplenifolia* (L.) C.F. Ludwig, Neuere Wilde Baumz. 27. 1783. *Comptonia asplenifolia* (L.) L'Hér. ex Aiton, Hort. Kew. 3:334. 1789. *Comptonia peregrina* var. *asplenifolia* (L.) Fernald, Rhodora 40:410. 1938.

The variation in vegetative pubescence suggested by Fernald as a diagnostic feature distinguishing var. *peregrina* from var. *asplenifolia* (L.) Fernald does not delimit populations as sharply as Fernald's account implied. There seems to be more continuous variation in pubescence than Fernald reported and the geographic range of the two pubescence types is less discrete than suggested. Well-collected areas of the mid-Atlantic States have many examples of both pubescence types within their borders. Examples of different pubescence types on different branches of the same shrub are not unusual. It surely can be concluded that varietal status within the monotypic genus *Comptonia* based on pubescence has not been convincingly proven. My rapid survey of hundreds of specimens does not suggest that a detailed, careful analysis of pubescence would likely demonstrate the presence of geographically based varieties.

As shown by the above synonymy, Linnaeus treated this species twice in *Species Plantarum*. The species was these first included (p. 999) as *Liquidambar peregrina* and again (p. 1024) as *Myrica asplenifolia*. For nearly a century and a half the name most frequently adopted was *Myrica asplenifolia* or its derivative *Comptonia asplenifolia*. For the past century (except for Gleason (1952), Gleason & Cronquist (1963), and Wagner et al. (1990), the accepted name has been almost universally that based upon *Liquidambar peregrina*. The latter choice is mandated by the International Code not because of the American Code's favoring of the name appearing first in a volume ("page priority") but because Linnaeus, upon discovering the conspecificity of the two binomials, was the first to unite them (Syst. Nat. ed. 10. 2: 1273. 1759.) by placing *Myrica asplenifolia* in the synonym of *Liquidambar peregrina*.

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BOOK REVIEW

RAMAMOORTHY, T.P., R. BYE, A. LOTT and J. FA (Eds). 1993. **Biological Diversity of Mexico: Origins and Distribution.** (ISBN 0-19-506674-X, hbk) Oxford University Press, New York. $79.95. 812 pp.

As stated by the editors in this impressive volume's introduction, the primary objective of this contribution is to assemble data pertaining to a wide variety of Mexican taxa and to make it available to Mexicans and the world community alike. In achieving this admirable and ambitious objective, the book is by and large successful. While many researchers are likely to find points to disagree with in the chapters relevant to their particular area of expertise, they are at the same time likely to rely on the volume as an invaluable source of data and bibliographic references on the subject of Mexican biodiversity.

And the subject is an extremely important one. Although Mexico is the fourteenth largest country in the world, it is usually ranked within the top three or four countries in the world in terms of the richness of its biological diversity. This volume does a very good job at explaining, in general and taxon by taxon, how biogeography, geology, and evolutionary history have combined to bring about Mexico's fantastic species richness. If the book does nothing more than draw well-deserved conservation attention to Mexico's arid and montane habitats, it will have performed a great service.

The book's 26 chapters are organized into six sections. The first section's three chapters focus on historical background, with chapters on geology and the origins and diversity of Mexico's flowering plant flora. The second section reviews six selected faunistic groups including: bees, butterflies, fishes, herps, birds, and mammals. A chapter on ecological diversity in scrub jays, which is included in this section, seems out of place. The third section reviews 11 floristic groups including pteridophytes, bryophytes, grasses, and legumes. The two chapters covering the genus *Pinus* and *Quercus* are particularly outstanding. The fourth section contains two chapters analyzing phytogeographical patterns in contrasting ecosystems: tropical rainforests and alpine habitats. The fifth section contains two chapters dealing with ethnobotanical themes, which although unlikely to contain much information that is new to those familiar with the field, provide a compilation of bibliographic references that is very useful. The sixth and final section contains an overview of Mexican biodiversity in terrestrial habitats.

Some of the chapters are quite noticeably dated; the symposium which was the inspiration for the present volume was held in 1988. Other chapters have been recently updated, and, in general, the lack of bibliographic references from the early '90s is a minor drawback, and one that is probably unavoidable in a volume of this scope. There are translation problems in several of the chapters that result in occasionally unintelligible or odd turns of phrase. One chapter in which the translation seems particularly weak is that by Hernandez-X. on plant domestication in Mexico.

Many of the chapters contain conservation recommendations at the end which although skeletal, do in some cases (e.g., the chapter on *Pinus*) make specific important recommendations. However, it is not this volume's place or role to produce comprehensive conservation recommendations, but hopefully to provoke the development of these by others. Indeed, the book's dedication is to all the scholars of biodiversity, in hopes that this volume will assist in the "endeavor to provide a world-wide conservation agenda." I think that it will.—*Margaret M. Syminton, Biodiversity Support Program, c/o World Wildlife Fund, Washington, D.C. 20037.*

FLORA VASCULAR DE LA SIERRA DE LA PAILA, COAHUILA, MÉXICO

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RESUMEN

La Sierra de la Paila, ubicada en el sureste del estado mexicano de Coahuila, es parte de la continuación interrumpida de la Sierra Madre Oriental hacia en norte del estado. El clima es seco. Se eleva desde los 1200 m hasta los 2350 m. Las rocas que la forman son fundamentalmente calizas y los suelos litosoles. No presenta escurrimentos permanentes de agua. La vegetación es clasificada en cuatro tipos: El Matorral Desértico Chihuahuense, Matorral Submontano, Bosque de Encino-pino y Zacatal.

La flora esta compuesta por aproximadamente 87 familias con 387 géneros, 703 especies, con 712 taxa incluyendo a los taxa infraespecíficos. Las familias más diversas son Asteraceae, Poaceae y Fabaceae, los géneros *Muhlenbergia*, *Dalea*, *Notholaena* y *Polygala* presentan el mayor número de especies. Es la localidad tipo de 21 especies y 9 de ellas son endémicas.

ABSTRACT

The Sierra de la Paila located in the southern portion of the mexican state of Coahuila, is an element of the discontinuous part of the Sierra Madre Oriental. The sierra ranges from the 1200 m to 2350 m in elevation, and the climate is dry. Limestones are the principal substrate and lithosoles the principal soils. There are no permanent water flows on the sierra. The vegetation is divided in four types: Chihuahuan Desert Scrub, Submontane Scrub, Oak–pine Woodland and Grassland. The flora comprises approximately 87 families with 387 genera, 703 species, 712 taxa with the inclusion of the infraspecific taxa. The most diverse families are Asteraceae, Poaceae and Fabaceae. The genera *Muhlenbergia*, *Dalea*, *Notholaena* and *Polygala* are the higher in number of species. It is the type locality of 21 species and about 9 of them are endemic.

INTRODUCCION

La sierra de la Paila es una formación montañosa aislada que forma parte del complejo de la Sierra Madre Oriental. Se localiza en el límite este del Desierto Chiuahuense y es un mosaico de asociaciones vegetales que cambian en cada uno de sus flancos.

Por ser un área poco estudiada botanicamente y con el proposito de contribuir al conocimiento de la flora del noreste de México se presenta el siguente trabajo que aunque exhaustivo no pretende ser completo.

SIDA 16(1): 109 – 138. 1994

DESCRIPCION GENERAL DEL AREA

La Sierra de la Paila es una formación montañosa dómica aislada, ubicada en el sureste del estado de Coahuila (Fig. 1). El área ocupada por la sierra tiene una forma rombica que se localiza entre los 101°25' y 101°49'W y los 25°45' y 26°16'N. Tiene aproximadamente unos 60 km de extensión en su eje mayor (norte-sur) y unos 35 km en su eje menor, con una superficie de unos 1700 km2. Se eleva desde los 1200 m alcanzando las partes más altas los 2350 m de altura. Esta surcada por una serie de cañones que van del centro a la periferia. En la parte central se localizan valles altos y pequeños.

Varias vías de comunicación bordean la sierra totalmente. Por el sur pasa la carretera 40 y la línea de ferrocarril Saltillo-Torreón. Por el noreste pasa la carretera 57 y el resto de la circunferencia los forman caminos de terracería. El poblado de Hipólito, ubicado en el extremo sur, es el más importante y próximo a la sierra. El ejido Las Coloradas se localiza en los valles cercanos al extremo norte. Los ejidos de El Cedral y Parreños se encuentran dentro de la sierra (Fig. 2).

De acuerdo a lo presentado por el INEGI (1983), los climas seco y semiseco (BS°,BSî) dominan en el área. Estos climas se caracterizan por presentar lluvias predominantes en el verano y temperaturas altas. La precipitación promedio es de 400 mm anuales, y la temperatura media anual es de 20°C.

Las rocas dominantes en el área son las calizas, en su mayoría del Cretácico. Los suelos predominantes son litosoles, arcillosos y ricos en materia orgánica, de color pardo oscuro o negro. Los valles intermontanos de la sierra presentan xerosoles, y las partes bajas y valles que rodean la sierra presentan suelos aluviales tipo castañozem y ferozem (INEGI 1983).

En la sierra no se presentan correientes permanentes ni depositos de agua, solo arroyos en los cañones que drenan el agua durante la epoca de lluvias.

VEGETACION

Aunque la colecta de muestras vegetales en la Sierra de la Paila se realizaron desde principios de siglo (Sousa 1969), la información sobre la vegetación del área es escasa. En trabajos tradicionales como los de Muller (1947), pasa desapercibida. Solo recientemente se ha aportado información por Cano y Marroquin (1967) y Wehbe (1985).

La vegetación en el área de la Sierra de la Paila puede ser clasificada en cuatro tipos prnicipales, que de acuerdo con la revisión sobre vegetación de Coahuila hecha por Villarreal y Vladés (1992-1993) correspeonden a: Matorral Desértico Chihuahuense, Matorral Submontano, Bosque de Encino-pino y Zacatal.

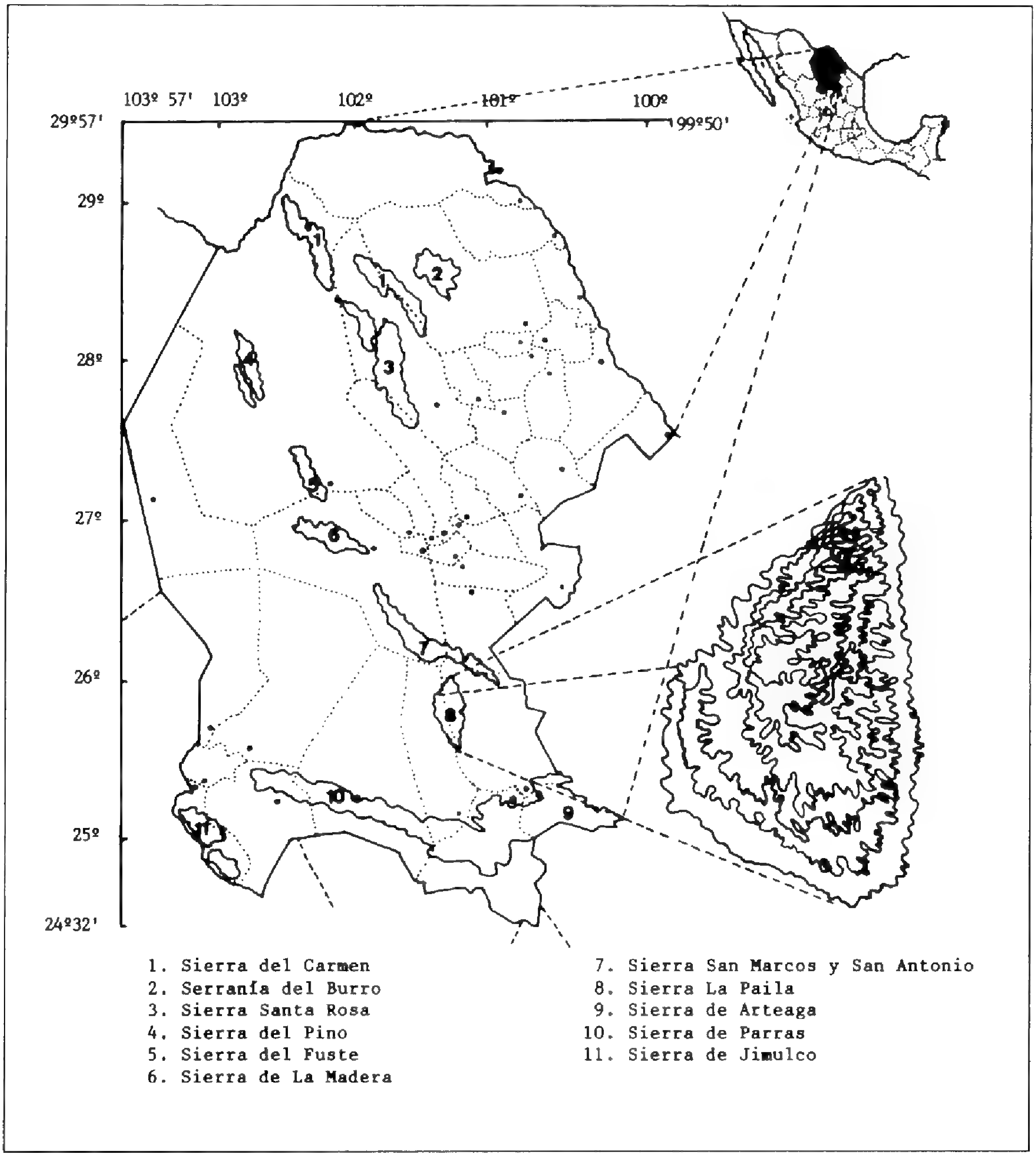

FIG. 1. Localización de la Sierra de la Paila y otros sierras en al Estado de Coahuila.

Matorral Desertico Chihuahuense. Es el tipo de vegetación más común en toda el área, circundando toda la sierra. Los valles que bordean la sierra y lomeríos con suelos algo profundos y poco pedregosos son ocupados por matorrales micrófilos de arbustos de 30–150 cm de alto. La especie más frecuente es *Larrea tridentata*, asociada con *Flourensia cernua*, *Fouquieria splendens*, *Parthenium incanum*, *Yucca filifera*, *Y. treculeana*, *Opuntia imbricata* y *Prosopis glandulosa*. En algunos sitios de la porción oeste *Sericodes greggii* es frecuente y *Grusonia bradtiana* abunda en las porciones norte.

Las laderas de las pociones más externas de la sierra, así como los lados más expuestos de muchos cañones con suelos pedregosos y someros se desarrollan

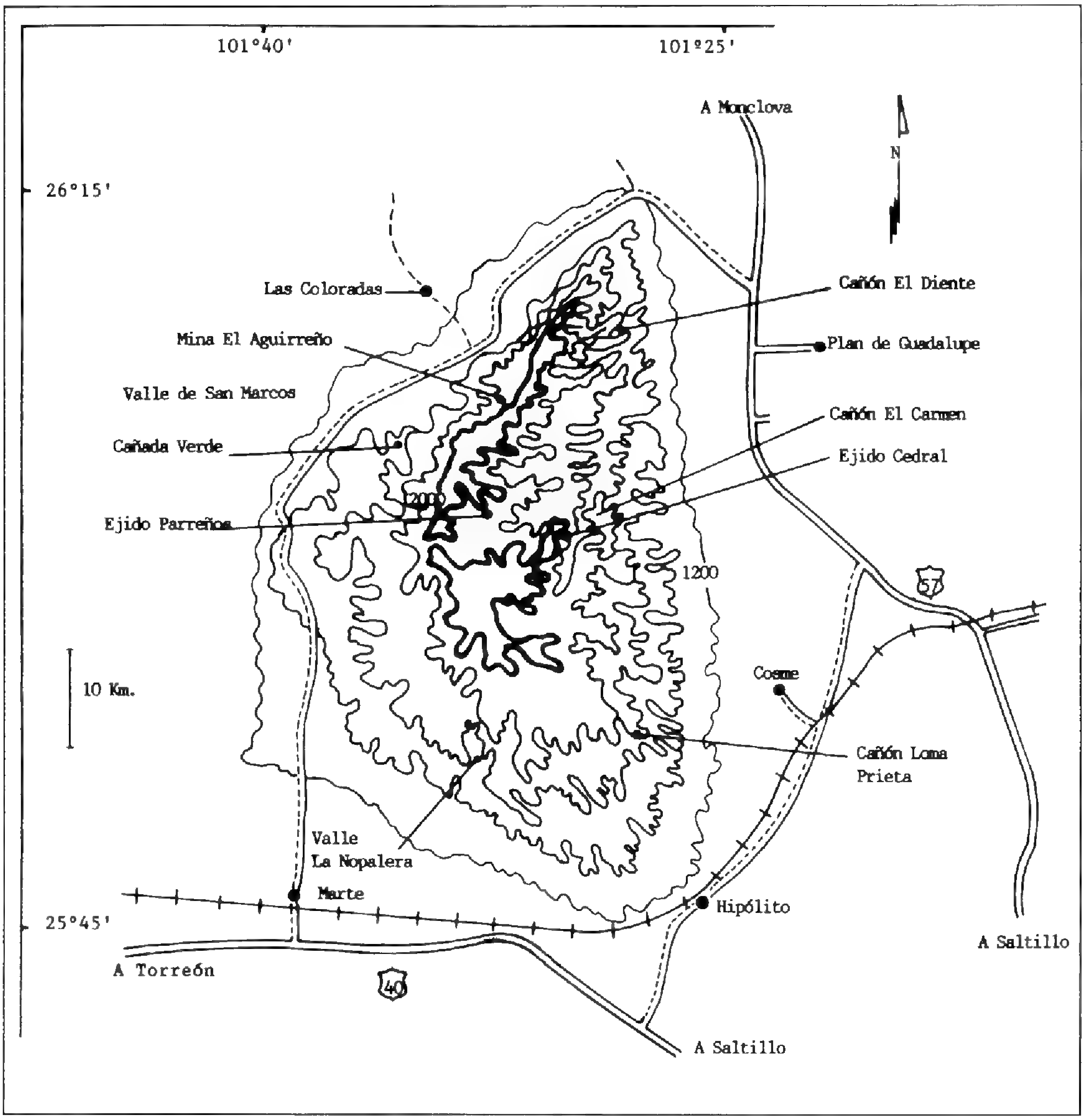

FIG. 2. Mapa de la Sierra de la Paila, ubicación y algunas localidades.

matorrales bajos con comunidades de *Agave lechuguilla*, asociada frecuentemente con *Parthenium argentatum*, *Euphorbia antisyphilitica* y con presencia de *Agave striata*, *Dasylirion palmeri*, *Hechtia texensis*, *Opuntia microdasys*, *O. phaeacantha*, *Yucca carnerosana* y *Gochnatia hypoleuca*.

Matorral Submontano. Este tipo de vegetación tiene distribución irregular, se localiza en los cañones y usualmente se mezcla con porciones de bosque en el centro de la sierra. Esta formado por arbustos y pequeños arboles de 2–5 m que se desarrollan en comunidades densas en los lechos de los arroyos y áreas protegidas con suelos profundos y algo de humedad. Se presentan frecuentemente *Quercus invaginata*, *Q. intricata*, *Fraxinus greggii*, *Vauquelinia corymbosa*, *Cercocarpus mojadensis*, *Pistacia texana*, *Acacia berland-*

ieri, *Rhus virens*, *Flourensia retinophylla*, *Berberis trifoliolata*, *Ptelea trifoliata* y *Leucaena greggii*. *Brahea berlandieri* crece en las laderas de los cañones. En los lechos de los arroyos es frecuente *Dodonaea viscosa*.

Bosque de Encino-Pino. Se localiza en la porción central de la sierra, ocupa valles y cañones amplios con comunidades arboreas poco densas dominadas por *Quercus gravesii*, *Q. laceyi*, *Juniperus flaccida*, con elementos esparcidos de *Pinus arizonica* o *P. cembroides*. Otras especies frecuentes incluyen a *Juniperus erythrocarpa*, *Arbutus xalapensis*, *Garrya ovata*, *Ungnadia speciosa*, *Fraxinus cuspidata* y elementos de matorral submontano. Próximo al bosque es frecuente encontrar vegetación arbustiva de tipo chaparral, que usualmente se mezcla con las especies arboreas del bosque. En estas comunidades esta presente *Quercus intricata*, *Q. invaginata*, *Q. grisea* y *Rhus virens*. En los arroyos es frecuente *Juglans microcarpa*. Las especies arboreas usualmente presentan especies de *Tillandsia* y *Phoradendron*.

Zacatal. En áreas reducidas de los valles centrales elevados de la sierra con suelos profundos se propicia el desarrollo de comunidades de gramíneas. En dichos zacatales sobresalen *Sporobolus airoides*, *Nassela tenuissima*, *Stipa eminens* y en otras áreas *Bouteloua gracilis* y *B. curtipendula*, frecuentemente mezcaldas con elementos de bosque.

FLORA

La flora vascular documentada de la Sierra de la Paila comprende 703 especies (712 taxa incluyendo a los taxa infrespecíficos) distribuidas en unos 387 géneros y unas 87 familias. Es la localidad tipo de unas 21 especies, de las cuales 9 son endémicas (ver tablas 1 y 3). Las familias y géneros con mayor diversidad se muestran en la tabla 2.

Las primeras colectas parecen haber sido hechas por Endlich en 1905 y C. A. Purpus en 1910 y 1911, cuyo material sirvió para la descripción de nuevas especies. En los últimos años una docena de colectores ha trabajado en la sierra, como se presenta en la lista de abreviaciones. Los herbarios revisados para la elaboración de la lista florística fueron el de la Universidad Atomóma Agraria Antonio Narro (ANSM) y el de la Universidad de Texas (TEX-LL).

El arreglo que se sigue para la lista de plantas vasculares en los grupos principales es el de Cronquist (1981) para angiospermas y el de Crabbe et al. (1975) para helechos y grupos afines a helechos. Las categorías de familia, género y especie se presentan en secuencia alfabética. Cada nombre científico va seguido por el tipo de vegetación donde frecuentemente se encuentra, luego los datos sobre el habitat y frecuencia. Al final la abreaviación de los colectores es seguida de los números de colecta.

TABLA 1. Principales grupos componentes de la flora vascular.

Division	Familias	Géneros	Especies	Taxa infraespecíficos adicionales
Lycopodiophyta	1	1	3	0
Polypodiophyta	2	4	14	0
Pinophyta	3	3	6	0
Magnoliophyta				
Clase Magnoliopsida	71	315	556	8
Clase Liliopsida	10	64	124	1
Totales	87	387	703	9

TABLA 2. Familias y géneros con mayor diversidad.

Familia	Géneros	Especies	**Géneros**	Especies
Asteraceae	75	125	Muhlenbergia	12
Poaceae	41	91	Dalea	11
Fabaceae	26	54	Notholaena y Polygala	9

TABLA 3. Lista de especies tipo y endémicas de la Sierra de la Paila.

ACANTHACEAE
- *Carlowrightia parvifolia* Brandg.

AGAVACEAE
- *Yucca endlichiana* Trel.

ASTERACEAE
- **Haploesthes fruticosa* Turner
- *Flourensia retinophylla* Blake
- *Stevia salicifolia* Cav. var *integra* (Blake) Rob.
- *Xylothamnia pseudobaccharis* (Blake) Nesom

CACTACEAE
- **Coryphantha laui* Bremer
- **Echinocereus delaetii* (Güerke) Güerke
- **Gymnocactus aguirreanus* Glass & Foster

CONVOLVULACEAE
- **Ipomea zimmermanii* McDonald

FABACEAE
- *Senna monozyx* (Irwin & Barneby) Irwin & Barneby.

FAGACEAE
- *Quercus invaginata* Trel.

LAMIACEAE
- *Hedeoma montanum* Brandg.

LILIACEAE
- **Muilla purpusii* Brandg.

MALPIGHIACEAE
- *Echinopteris setosa* Brandg.

POACEAE
- *Bouteloua johnstonii* Swallen

POLYGALACEAE
- *Polygala nudata* Brandg.

RHAMNACEAE
- *Rhamnus standleyana* C. B. Wolf

RUBIACEAE
- **Coutaportla pailensis* Villarreal

RUTACEAE
- **Thamnosma pailensis* M. C. Johnst.

SCROPHULARIACEAE
- **Penstemon punctatus* Brandg.

*Especies endémicas

ABREVIACIONES EN LA LISTA FLORISTICA

Tipos de vegetación: **MD**, Matorral desértico chihuahuense. **MS**, Matorral submontano. **B**, Bosque de encino-pino. **P**, Zacatal. Principales colectores y herbarios donde estan depositados sus colecciones: **C**, M. A. Carranza P., (ANSM). **Ca**, G. Cano y J. S. Marroquín (UNL). **CQ**, D. Castillo Q., (ANSM). **Endlich**, R. Endlich (MO). **H**, J. Henrickson (UC, TEX-LL). **Hin**, G. B. Hinton (TEX-LL). **JM**, J. S. Marroquín (ANSM). **JW**, J. Wehbe (ANSM). **MCJ**, M. C. Johnston, F. Chiang y T. Wendt (TEX-LL). **Purp**, F. A. Purpus (UC,F,US). **R**, A. Rodriguez G. (ANSM). **VR**, J. Valdés Reyna (ANSM) y **V**, J. A. Villarreal Q. (ANSM).

CATALOGO DE LAS PLANTAS VASCULARES DE LA SIERRA DE LA PAILA, COAHUILA, MÉXICO

LYCOPODIOPHYTA (Selaginelas)

SELAGINELLACEAE

Selaginella lepidophylla (Hook. & Grev.) Spring. MS. Paredes rocosas. Común. V3103, 3558.
Selaginella pilifera A.Br. MS, MD. Paredes rocosas. Escasa. V3094, 3559, 5312.
Selaginella wrightii Hieron. MD, MS. Laderas rocosas. Común. V3095, 3533, 4481, 4783.

POLYPODIOPHYTA (Helechos)

ADIANTACEAE

Cheilanthes alabamensis (Buckl.) Kuntze. B. Cañones y arroyos. Escasa. **V**3524, 4729.
Cheilanthes notholaenoides (Desv.) Maxon. B, MS. Cañones y arroyos. Común. V3101, 3978, 4479, 4730, 5288, **VR**2233.
Cheilanthes pinkavae Reeves. MD. Laderas rocosas. Escasa. V3096, 4813.
Notholaena aschenborniana Kl. MS, MD, B. Laderas rocosas. Común. **MCJ**10521a, **CQ**875, **V**3543, 4728.
Notholaena bryopoda Maxon. MD, MS. Laderas y arroyos. Común. H16543, **MCJ**10099, 10109, 10511, **R**1486.
Notholaena cochisensis Goodd. MD. Laderas rocosas. Común. H16512, **CQ**783, V4727.
Notholaena greggii (Mett.) Maxon. MD. Laderas rocosas. Rara. **MCJ**10520, V5562.
Notholaena integerrima (Hook.) Hevly. MD. Laderas rocosas. Escasa. CQ782, 787, **R**1481.
Notholaena neglecta Maxon. MD. Laderas rocosas. Escasa. **MCJ**11711e, **R**794, V5201, 5259, 6659.
Notholaena parvifolia Tryon. MD, MS, B. Cañones y arroyos. Común. **MCJ**10109b, **CQ**660, V3098, 3542, 4472.
Notholaena sinuata (Lag.) Kaulf. MD, MS. Laderas rocosas. Común. V3097, 3591.
Notholaena standleyi Maxon. MS. Laderas rocosas. Escasa. V4480.
Pellaea atropurpurea (L.) Link. B, MS. Cañones y arroyos. Escasa. V3523, 5277, 6660, **VR**2197.

ASPLENIACEAE

Asplenium resiliens Kuntze. MS, B. Laderas rocosas. Rara. **MCJ**11697a.

PINOPHYTA (Gimnospermas)

CUPRESSACEAE

Juniperus erythrocarpa Cory. B. Valles y laderas. Común. **V**3937, 3956, 4176, 5830, **VR**2216.
Juniperus flaccida Schlecht. var. *flaccida*. B, MS. Valles y laderas. Común. V3561.

EPHEDRACEAE

Ephedra antisyphilitica Mey. MD. Laderas. Escasa. **JM**2327, **MCJ**10512, 10519, **V**2892, 4135, 6353.
Ephedra aspera Wats. MD. Laderas. Escasa. **JM**320, **C**462, **V**3873, 5572.

PINACEAE

Pinus arizonica Engelm. B, MS. Valles y laderas. Común. **V**3620a, 3983.
Pinus cembroides Zucc. B, P. Valles y laderas. Escasa. **V**3082

MAGNOLIOPHYTA (Angiospermas)

MAGNOLIOPSIDA (Dicotiledoneas)

ACANTHACEAE

Anisacanthus linearis (Hagen) Henrick. & Lott. MS, MD. Arroyos y cañones. Común. **JM**2220, **MCJ**10095, **V**3312, 3540, 4686.
Carlowrightia mexicana Henrick. & Daniel. MS. Areas protegidas. Escasa. **V**4642.
Carlowrightia parvifolia Brandg. MD. Arroyos. Común. **Purp**4751, **V**5436.
Carlowrightia serpillifolia (Torr.) Gray. MD. Arroyos y laderas. Escasa. **V**4541, 5564.
Dyschoriste linearis (T.& G.) Kuntze. MS, B, MD, P. Común. **CQ**710, **V**3904, 5252.
Ruellia parryi Gray. MD. Arroyos y laderas. Muy común. **CQ**635, **MCJ**11690a, **H**16183, **V**4498.
Siphonoglossa pilosella (nes) Torr. MD, MS. Valles y laderas. Escasa. **V**1501.

ACERACEAE

Acer grandidentatum Nutt. B, MS. Cañones, muy localizado. Escasa. **R**1328, **V**3550, 3886, 5262.

AMARANTHACEAE

Alternanthera repens (L.) Kuntze. B. Valles. Común. **V**5829, **VR**2206.
Amaranthus hybridus L. B. Valles y areas perurbadas.
Dicraurus leptocaudus Hook. MD. Valles. Escasa. **CQ**806.
Iresine heterophylla Standl. B, P. Valles. Escasa. **VR** 2243.
Froelichia arizonica Thornb. MS, MD. Arroyos. Común. **H**16187, **V**3902, 4531.
Froelichia interrupta (L.) Moq. MD. Arroyos. Rara. **V**5305.
Tidestromia lanuginosa (Nutt.) Standl. MD, P. Areas perturbadas. Rara.
Tidestromia suffruticosa (Torr.) Standl. var. *coahuilensis* I.M.Johnst. MD. Laderas. Muy común. **Purp**4927, **H**16195, **V**2886, 4179, 4550, 6683.

ANACARDIACEAE

Pistacia texana Swingle. MS, B. Arroyos y cañadas. Muy común. **JM**2222, **MCJ**11718, **V**3069, 6684.
Rhus microphylla Engelm. MD, MS. Valles y lomeríos. Común. **JM**316, 997, **V**3562, 5218.
Rhus muelleri Standl & Barkl. MS, B. Arroyos. Escasa. **MCJ**11683, **V**3942, 4787, 5263, **VR**2213.
Rhus trilobata Nutt. var. *trilobata*. MS, B. Araeas protegidas. Común. **CQ**849, **MCJ**11692a, **V**3261, 3949.

Rhus virens Lind. var. *virens*. B, MS. Arroyos y cañones. Muy común. C466, **JM**757, 2235, **MCJ**11702b, V3545, 3970.

APOCYNACEAE

Amsonia grandiflora Alex. MS, B. Arroyos y orilla de caminos. Común. R1338, V3520, 4761, 5232, **VR**2212.

Macrosiphonia macrosiphon (Torr.) Heller. MD. Valles y lomeríos. Escasa. **JM**957.

Mandevilla karwinskii (Muell. Arg.) Hemsl. MS. Laderas. Común. **MCJ**11680, V3593, 4768, 5268.

ASCLEPIADACEAE

Asclepias brachystephana Torr. MD, MS. Maleza de áreas perturbadas. Escasa. V5607.

Asclepias linaria Cav. MS, B. Arroyos. Común. CQ665, HI6174, V4148.

Asclepias texana Heller. MS, B. Común. V3895, 5254, **VR**2200.

Asclepias sp. B, MS. Laderas. Escasa. V5254a.

Cynanchum kunthii (Dcne.) Standl. MD. Sobre arbustos bajos. Común. **MCJ**11718a, V3538, 4661.

Cynanchum pringlei (Gray) Henrick. MD. Sobre arbustos bajos. Común. V3115, 4175, 4489, 5213.

Matelea reticulata (Gray) Woods. MS. Valles y cañones. Escasa. V6675.

Sarcostema cynanchoides Dcne. MD. Arroyos, rastrera. Escasa. V6678

ASTERACEAE (COMPOSITAE)

Acourtia nana (Gray) Reveal & King. MR, P. Valles. Escasa. V4181.

Acourtia parryi (Gray) Reveal & King. MD. Valles y lomerios. Escasa. **JM**2998, V4163.

Acourtia runcinata (D.Don) Turner. MD. Laderas pedregosas. Escasa. **JM**1537, 3004, V2887.

Acourtia wrightii (Gray) Reveal & King. MS, B. Valles y laderas. Común. V5350.

Ageratina callophylla (Blake) King & Rob. MS, MD. Laderas. Común. V4165, 4779.

Ageratina havanensis (H.B.K.) King & Rob. MS, B. Laderas. Común. V3092, 3587, 4523, 4633, 4637, 4765.

Ageratina wrightii (Gray) King & Rob. MS, B. Laderas. Común. V4794, 5440.

Ageratum corymbosum Zucc. B. Valles y laderas. Común. V3622, 3948, 4795, 5370.

Aphanostephus ramosissimus DC. var. *ramosissimus*. MD, B. Valles. Escasa. **R**803, V3916, 6663, **VR**2241.

Artemisia glauca Pall. B. Arroyos. Escasa. V3063a.

Artemisia ludoviciana Nutt. MS, B. Valles. Común. V3109, 3931, 4160.

Aster spinosus Benth. MD. Valles, en represas y arroyos. Escasa. **JM**303, 781.

Baccharis havardii Gray. MS, B. Laderas y paredes rocosas. Común. V3945, 4140.

Bahia absinthifolia Benth. var. *absinthifolia*. MD, P. Valles. Común. **JM**466, 771, 1034, V4151.

Baileya multiradiata Harv. & Gray. MD. Valles al SW. Común. V6341.

Barroetea subuligera (Schaver) Gray. MS, B. Valles y arroyos. Muy común. V3100, 3613, 4517, **H**16193.

Bidens bigelovii Gray. MS, B. Areas perturbadas. Escasa. V3624, 5289.

Bidens ferulifolia (Jacq.) DC. MS, B. Arroyos. Escasa. V4487.

Brickellia chlorolepis (Woot. & Standl.) Shinners. MS, P. Arroyos. Común. V3073, 4164.

Brickellia cylindracea Gray. & Engelm. MS. Arroyos. Escasa. **Purp**4725, 4728, V4658.

Brickellia laciniata Gray. MS, B. Arroyos y áreas perturbadas. Escasa. V5465.

Brickellia lemmonii Gray. var. *conduplicata* (Rob.) Turner. MS. Laderas pedregosas. Común. **Purp**4717, V3521, 4167, 5372. *Brickellia lemmonii* Gray. var. *nelsonii* (Rob.) Turner. B. Escasa. V4805.

Brickellia urolepis Blake. B. Común. V4786, 5290.
Brickellia veronicaefolia (H.B.K.) Gray. MS, MD. Escasa. V4166, 4781.
Calyptocarpus vialis Less. MS, B. Areas perturbadas. Escasa. V5294.
Centaurea americana Nutt. MS. Areas perturbadas. Escasa. V3951, VR2198.
Chaetopappa bellioides (Gray) Shinners. MD, P. Valles. Común. V3900, 4725, CQ683, 728.
Chaetopappa parryi Gray. MS, B. Laderas y paredes rocosas. Común. V5253, 5302, 5304.
Chaptalia hololeuca Greenm. MD. Valles y laderas. Rara. V3527.
Chaptalia texana Greenm. MS, B. Valles. Muy común. CQ1057, V3527a, 3977, 5375.
Chrysactinia mexicana Gray. MD, MS. Valles y laderas. Muy común. JM617, R1336, V5377.
Chrysactinia pinnata Wats. MS, B. Laderas rocosas. Escasa. V4656, 5234.
Cirsium undulatum (Nutt.) Spreng. MS. Arroyos y áreas perturbadas. Escasa. MCJ11695a, V3889.
Conoclinium greggii Gray. MM, MS, P. Areas protegidas. Común. V3079.
Conyza coulteri Gray. MS, P. Areas perturbadas. Escasa. V4142.
Coreopsis tintoria Nutt. var. *tintoria*. B, MS. Areas perturbadas. Escasa. V3544.
Dichaetophora campestris Gray. MS. Areas perturbadas. Rara. CQ691.
Dyssodia papposa (Vent.) Hitchc. MS, B, P. Maleza de áreas perturbadas. Común. V4767, 5250.
Engelmannia pinnatifida Nutt. MS. Areas perturbadas. Escasa. V3570.
Erigeron bigelovii Gray. MS. Valles y laderas. Común. V3588, 4757.
Erigeron chiangii Nesom. MS, B. Arroyos, laderas rocosas. Común. MCJ11700, V4662, 5308.
Erigeron modestus Gray. MS, B. Lugares húmedos. Común CQ735, 1053, V4726, R1327, VR2196.
Erigeron pubescens H.B.K. MS, B, MD, P. Muy común. JM4503, CQ734, V4518, 5374.
Fleischmannia pynocephala (Less) King & Rob.. B. Valles y laderas. Común. V3577, 4780.
Flourensia cernua DC. MD. Valles. Escasa. JM335.
Flourensia retinophylla Blake. MS, MD. Valles y laderas. Común. Purp4728, MCJ10110a, 10509a, 11702e, V3555, 4154, 5456.
Gaillardia gypsophila Turner. MD. Lomerios. Escasa. V5590.
Gnaphalium roseum H.B.K. B, MS. Laderas y valles. Escasa. VR2239.
Gnaphalium semiamplexicaule DC. MS, B. Arroyos y áreas protegidas. Escasa. V4672, 4754.
Gnaphalopsis micropoides DC. MD, P, MS. Valles. Común. JM1018, V2894, 4494, 4742.
Grindelia grandiflora Hook. B, MS. Arroyos y áreas protegidas. Escasa. C475, V3932, 5291, VR2232.
Gochnatia hypoleuca (DC.) Gray. MS, MD, B. Arroyos. Muy común. JM767, 2253, V3067.
Gutierrezia microcephala (DC.) Gray. MD, MS. Areas perturbadas. Común. V3111, 3899, 4143, 4737.
Gutierrezia sarothrae (Pursh.) B. & Rusby. MD. Areas perturbadas. Escasa. C477, V4157.
Gutierrezia sphaerocephala Gray. MS, MD, P. Areas perturbadas. Común. JM1411, V3915, 4155.
Gymnosperma glutinosum (Spreng.) Less. MS, MD, B, P. Areas perturbadas. Común JM1070, V5361.
Haploesthes fruticosa Turner. MD. Partes bajas, N de la sierra. Común. Hin16555, Purp4708, MCJ10110, 10125, V5567.
Helenium quadridentatum Labil. MD. Areas inundadas. Común localmente. JM1022.
Helianthella mexicana Gray. B. Areas protegidas. Común. V3950, 4774, 5275.
Helianthus annuus L. MD, MS, P. Maleza de areas perturbadas, C1125
Heliopsis parvifolia Gray. MS, B. Valles. Común. V3556, 3872, 5365, VR2223.

Heterotheca villosa (Pursh.) Shinners. MS, B. Arroyos y paredes rocosas. Común. V3963, 5300, 5341, **VR**2221.

Hymenoxys linearifolia Hook. P, B. Areas perturbadas. Escasa. V4153.

Hymenoxys scaposa (DC.) Parker. var. *scaposa*. B, MS, P. Valles. Común. **CQ**670, **MCJ**11688, V3602, 4762, **R**1326.

Iva ambrosiaefolia Gray. Areas perturbadas. Muy común. V3911, 4691.

Jefea brevifolia (Gray) Strother. MD. Laderas. Común. **Hin**16572, **JM**958, 997, V4512, 4699.

Jefea gnaphaloides (Gray) Strother. MD. Lado N. Rara. **MCJ** 11714a.

Koanophyllum solidaginifolium (Gray) King & Rob. MS. Arroyos y laderas rocosas. Escasa. V4659.

Leucelene ericoides (Torr.) Greene. MD. Valles y laderas. Escasa. V4133.

Liatris punctata Hook. var. *mexicana* Gaiser. B. Rara. V3944.

Machaeranthera gypsophila Turner. MD, P. Valles y lomeríos. Común. **MCJ**10123, V4158, 4544, 5574, 5588, 6363.

Machaeranthera pinnatifida (Hook.) Shinners. var. *pinnatifida*. MD, P. Areas perturbadas. **JM**1936, V3927, 6357.

Melampodium argophyllum (Gray ex Rob.) Blake. MD, MS. Valles. Común. **Purp**4730, **R**1479, **Hin**16563, V5210.

Nicolletia edwardsii Gray. MD. Localmente abundante, valles W de la sierra. **JM**754, V4137, 6344.

Palafoxia texana DC. var. *texana*. MD. Areas perturbadas y laderas rocosas. Común. **JM**774, 963, 1024, V3597, 3898, 4746, 5212.

Parthenium argentatum Gray. MD. Laderas bajas. Común. **JM**770. V5649.

Parthenium confertum Gray. var. *lyratum* (Gray) Roll. MS, B. Areas perturbadas. C788, V3941, 5211.

Parthenium incanum H.B.K. MD. Valles y laderas bajas. Común. **JM**765, V5219.

Pectis angustifolia Torr. var. *tenella* (DC.) Keil. MD. Valles. Común. **R**1473, V4138.

Pinaropappus roseus (Less.) Less. MD, MS. Laderas y valles. Común. V4631, 6354.

Porophyllum amplexicaule Engelm. MD, P. Laderas rocosas. Escaso. **JW**083.

Porophyllum scoparium Gray. MD. Arroyos. Muy común. **JM**795, V5595.

Psilactis tenuis Wats. P, MS. Areas perturbadas. Común. V3972, 4139, **VR**2225.

Psilostrophe gnaphalodes DC. MD. Areas perturbadas. Muy común. **JM**796.

Sanvitalia angustifolia Engelm. B, MS. Areas perturbadas. Común. **VR**2234.

Sanvitalia ocymioides DC. MS. Areas perturbadas. Común. V3947, 5323, **VR**.

Sartwellia puberula Rydb. MD. Valles y lomeríos. Muy común. V5580.

Sclerocarpus uniserialis Benth. var. *frutescens* (Brandg.) Feddma. B, MS. Común. V3535, 3910, 5359, 6664.

Senecio coahuilensis Greenm. B. Laderas y valles. Rara. V3946, 5371.

Senecio douglasii DC. var. *longilobus* (Benth.) Benson. MD. Areas pertubadas, N y W de la sierra. Común. **JM**340, **MCJ**10515c, V2895.

Senecio neomexicanus Gray var. *neomexicanus*. B. Laderas y áreas protegidas. Escasa. V4791a.

Solidago velutina DC. MD. Areas perturbadas. Escasa. V4790.

Sonchus oleraceus L. MD, MS. Areas perturbadas, arroyos. Maleza común.

Stevia micrantha Lag. B. Areas protegidas y arroyos. Rara. **Purp** 4721, V5325.

Stevia ovata Willd. B, MS. Areas perturbadas. Escasa. V4782.

Stevia pilosa Lag. MS, B. Valles. Escasa. V3934, 5285, **VR**2251.

Stevia salicifolia Cav. var. *integra* (Blake) Rob. MS, B. Laderas rocosas. Escasa. **Purp**4722, V3935.

Stevia serrata Cav. MS. Areas perturbadas. Común. V3575.

Stevia tomentosa H.B.K. B. Areas perturbadas. Común. JM1042, V4770.

Tagetes lucida Cav. B. Areas perturbadas. Escasa. V3874, 5274.

Thelesperma longipes Gray. MS, B, P. Valles. Común. C473, MCJ10111c, V3606, 3893, 4162, 6356.

Thelesperma megapotamicum (Spreng.) Kuntze. MD, MS, P. Laderas bajas y valles. Común V5224, 5563.

Thelesperma simplicifolium Gray. MS, P, Areas perturbadas. Común MCJ11683a, V3968, VR2240.

Thelesperma subaequale Blake. MS, P. Areas perturbadas. Común. V3967, 5248.

Thymophylla acerosa (DC.) Strother. MD. Valles y lomeríos. Común. V4141, 5587.6345.

Thymophylla pentachaeta (DC.) Small. var. *puberula* (Rydb.) Strother. MD, MS. Areas perturbadas. Muy común. JM1009, 1017, 1055, 2295, V2893, 3077, 3595, 5313, 6346.

Thymophylla pentachaeta (DC.) Small. var. *belenidium* (DC.) Strother. MD. Escasa. CQ621.

Thymophylla setifolia Lag. var. *setifolia*. MD. Valles y laderas. Escasa. C470.

Trixis californica Kell. var. *californica*. MD. Arroyos y laderas. Común. V5597.

Verbesina chihuahuensis Gray. MS, MD. Paredes rocosas. Escasa. Purp4694, MCJ10108d, V3093, 3310.

Verbesina daviesiae Turner. MS. Laderas. Escasa. V5287.

Verbesina encelioides (Cav.) Benth. & Hook. MD, MS. Maleza de áreas perturbadas. JM1007, V6355.

Verbesina microptera DC. MS, B. Valles y arroyos. Común. V3557, 3966, 4756, 5363.

Vernonia greggii Gray. var. *ehrenbergii* (Gray) Champan & Jones. B. Laderas y orilla de caminos. Escasa. V3942, 5351.

Viguiera brevifolia Greenm. MD. Valles y laderas del W de la sierra. Escasa. Endlich916 (MO), Purp4697.

Viquiera cordifolia Gray. MS. Valles. Escasa. V3079, Purp4693.

Viquiera dentata (Cav.) Spreng. MD, MS, P. Areas perturbadas. Común. V3078, 3554, 5339.

Viquiera greggii (Gray) Blake. MD, MS. Laderas. Común. MCJ10104, Purp4698, V4152, 4538, 5439.

Viquiera longifolia (Rob. & Greenm.) Blake. MS, P. Areas perturbadas. Común. JM1068, 2240, V4146, 4776.

Viquiera stenoloba Blake. MD. Laderas. Muy común. JM764, V5438, 5596.

Wedelia acapulcensis Kunth. in H.B.K. var. *hispida* (Kunth.) Strother. MS. Valles y lomeríos. Escasa. V3964.

Xanthium strumarium L. MD. Maleza de áreas perturbadas. Escasa.V4692.

Xylothamia pseudobaccharis (Blake) Nesom. MD. Valles. Escasa. Hin16546.

Zaluzania triloba Gray. MD. Valles y laderas. Común. JM616, MCJ11714a.

Zinnia acerosa (DC.) Gray. MD. Valles y laderas. Muy común. JM990, 1038, Hin16502, V5467, 5594.

Zinnia grandiflora Nutt. MD. Valles y laderas. Común. V4516, 4639, 5451.

BERBERIDACEAE

Berberis eutriphylla (Fedde.) Muller. B. Cañones y laderas. Escasa. MCJ11709b.

Berberis trifoliolata Moric. MD, MS. Valles y laderas. Común. JM1059.

BIGNONIACEAE

Chilopsis linearis (Cav.) Sweet. ssp. *linearis* var. *linearis* MD. Arroyos. Escasa. JM 2251, V5836, 6681.

Tecoma stans (L.) Juss. MD, MS. Laderas y arroyos. CQ745, H16180, JM 1540, 2258.

BORAGINACEAE

Antiphytum heliotropioides A.DC. MS, MD. Laderas. Común. MCJ 10113, V3582, 4491, 5223.

Cordia boissieri A.DC. MS. Arroyos al E. de la sierra. Rara. V5202.

Cryptantha mexicana (Brandg.) I.M.Johnst. MD. Arroyos y caminos. Común. CQ622, V5601.

Heliotropium confertifolium (Torr.) Gray. MS, MD. Escasa. V4540.

Heliotropium greggii Torr. MS. Arroyos. Escasa. V4126.

Heliotropium torreyi I.M.Johnst. MD, MS. Laderas y arroyos. Común. V4492, 6668.

Lithospermum berlandieri I. M. Johnston. MS. Laderas. Común. MCJ 11694a.

Lithospermum viride Greene. MS, B. Areas protegidas. Común. V5256, 5344.

Tiquilia canescens (DC.) Rich. MD. Valles y laderas. Muy común. JM780, V4542.

Tiquilia greggii (T. & G.) Rich. MD. Laderas. Común. JM337, C463.

Tiquilia mexicana (Wats) Rich. MD. Valles. Común. CQ629, V4543, 4677.

BRASSICACEAE (CRUCIFERAE)

Brassica kaber (DC) Wheeler. MD. Orilla de caminos y arroyos, maleza. Escasa. V5583.

Cardamine macrocarpa Brandg. var. *texana* Roll. MS. Arroyos. Rara. V3940.

Descurainia pinnata (Walt.) Britt. MD. Areas protegidas. Común.V6360.

Eruca sativa Mill. MD, MS. Maleza de áreas perturbadas. R796.

Lepidium virginicum L. MD. Maleza de áreas perturbadas. R802.

Lesquerella argyraea (Gray) Wats. ssp. *diffusa* (Roll.) Roll. & Shaw. MD. Valles y laderas pedregosas. Común. V5582.

Lesquerella fendleri (Gray) Wats. MD, MS. Común. R799, 1332, V2890.

Lesquerella purpurea (Gray) Wats. ssp *foliosa* (Roll.) Roll. MS, B. Areas protegidas. Escasa.V3585, 5373.

Nerisyrenia camporum (Gray) Greene. MD. Valles y laderas. Común. CQ790, V2891, 6342.

Nerisyrenia linearifolia (Wats.) Greene. var. *linearifolia*. MD. Valles y laderas del W y N de la Sierra. Común. MCJ10111, 10118a, 10510, R1467.

Sisymbrium auriculatum Gray. MD. Arroyos y áreas perturbadas. Escasa. V4129, 6359.

Sisymbrium irio L. MS, B. Cañones y valles con húmedad. Escasa. V1504.

Sibara vierecki (Schulz.) Roll. MS. Arroyos y laderas con húmedad. Escasa.R1332.

Synthlipsis greggii Gray var. *greggii*. MD. Areas perturbadas. Muy común. R798, V4679.

Thelypodium longipes (Roll.) Roll. MS. Arroyos. Escasa. V3901, VR2204.

BURSERACEAE

Bursera fagaroides (H.B.K.) Engler. var.*fagaroides*. MD. Laderas. Escasa. MCJ10096, 11719, V6680.

CACTACEAE

Ariocarpus fissuratus (Engelm.) Shummann. MD. Rara.

Astrophytum capricorne (Dietr.) B. & R. MD. Laderas. Escasa. Elizondo294 (ANSM), V5648.

Coryphantha borwingii Purp. MD. Laderas y valles. Escasa. JW177, V5630.

Coryphantha delaetiana (Quehl) Berger. MD, MS. Valles. Común. JW153, 163, 172, 176, V5210a, 5631.

Coryphantha difficilis (Quehl) Berger.MD, MS. Valles. Común. JW141, 152.

Coryphantha echinus (Engelm.) B. & R. MD. Valles. Común. Elizondo295 (ANSM).

Coryphantha laui Bremer. MD. Laderas. Escasa. Bremer476–3 (ASU).

Echinocactus horizonthalonius Lem. MD. Valles y lomeríos. Común. JW111.

Echinocereus blanckii (Posel.) Pal. MS. Valles. Escasa. JW146, 159, 183.

Echinocereus delaettii Gurke. B. Valles y laderas. Común. JW157.

Echinocereus enneacanthus Engelm. var. *dubius* (Engelm.) Benson. MD.MS. Valles y lomeríos. Común. JW128.

Echinocereus enneacanthus Engelm. var. *enneacanthus*. MD. Lomeríos. Común. JWL66.

Echinocereus pectinatus (Scheidw.) Engelm. MD. Lomeríos y laderas. Común. JW123.

Echinocereus stramineus (Engelm.) Engelm. MD. Lomeríos. Común. JW106, 116.

Echinomastus mariposensis Hester. MD. Laderas y valles. Escasa. V5629.

Epithelantha micromeris (Engelm.) Weber. var. *greggii* (Engelm.) Ber.MD. Valles y laderas. Común. JW127, 162, V5231a.

Escobaria dasyacantha (Engelm.) B. & R. MD, MS. Laderas y paredes. Común. JW158, 180, V5190a, 5269.

Escobaria tuberculosa (Engelm.) B. & R. MD, MS. Laderas rocosas. Común. V4798.

Ferocactus hamatacanthus (Muhl.) B. & R. MD, MS. Laderas y valles. Común. JW109.

Ferocactus stainesii (Hook.) B. & R. MD, MS. Laderas. Común. JW125.

Ferocactus uncinatus (Gal.) B. & R. MD. Valles y laderas. Común. JW156, V5628.

Grusonia bradtiana Coult. MD. Valles y lomeríos. Común. V4799.

Gymnocactus aguirreanus Glass & Foster. MD. Laderas, W de la sierra. Escasa. ***Glass & Foster*** *3044*, 2206 (POMA).

Leuchtenbergia principis Hook. MD. Valles y lomeríos. Escasa. JW155.

Lophophora williamsii (Lem.) Coult. MD. Valles. Rara.

Mammillaria chionocephala Purp. MD, MS. Laderas. Escasa.

Mammillaria melanocentra Posel. var. *meiacantha* Craig. MD. Valles y laderas. Común. JW161.

Mammillaria pottsii Scheer. MD, MS. Laderas. Común. JW108.

Neolloydia conoidea (DC) B. & R. MD. Laderas y lomeríos. Común. JW132, V5633.

Neolloydia smithii (Muehl.) K. & F. MD. Laderas. Común. JW131, 165, Elizondo478 (ANSM).

Opuntia anteojoensis Pinkava. MD. Valles al N y W de la sierra. Escasa. Lopez sn (ANSM).

Opuntia grahamii Engelm. MD. Lomeríos y laderas bajas. Común. V5592.

Opuntia imbricata (Haw.) DC. MD. Valles. Muy común. JW120.

Opuntia kleiniae DC. MD.MS. Valles. Muy común. JW120.

Opuntia leptocaulis DC. MD. Valles y lomeríos. Muy común. JW117.

Opuntia lindheimeri Engelm. var. *aciculata* (Griff.) Bravo. MS. Laderas. Escasa.

Opuntia lindheimeri Engelm. var. *lindheimeri*. MD, MS. Valles. Común. JW100, 164, V5634.

Opuntia lindheimeri Engelm. var. *subarmata* (Griff.) Eliz. & Wehbe. B, MS. Laderas y valles. Escasa. JW180.

Opuntia lindheimeri Engelm. var. *tricolor* (Griff.) Benson. MD, MS. Laderas. Muy común.

Opuntia macrorhiza Engelm. MD. Valles y laderas bajas. Escasa. Elizondo468, 469 (ANSM).

Opuntia microdasys (Lehm.) Pfeiffer. var. *microdasys*. MD. Laderas y valles. Muy común. JW102, 148, V5591.

Opuntia moelleri Berger. MD. Valles al N de la sierra. Común. Elizondo342 (ANSM).

Opuntia phaeacantha Engelm. var *discata* (Griff.) Benson & Walk. MD. Valles y laderas. Común. Espinosa31, 50 (ANSM).

Opuntia phaeacantha Engelm. var. *mayor* Engelm. MD. Valles y laderas. Común. Elizondo464 (ANSM).

Opuntia rastrera Weber. MD. Valles y lomeríos. Común.

Opuntia violacea Engelm. var. *macrocentra* (Engelm.) Benson. MD. Valles y lomeríos. Escasa. JW167, 178.

Thelocactus bicolor (Gal.) B.& R. var. *bicolor*. MD. Laderas. Común. JW105, 138, V5632.

Thelocactus rinconensis (Pos.) B.& R. var. *nidulans* (Quehl.) Gl.&F. MD, MS. Laderas. Escasa. Gl. & F1689 (POMA).

Wilcoxia tuberosa (Pos.) Berger. MD. Valles al e de la Sierra. Rara.

CAPRIFOLIACEAE

Abelia coriacea Hemsl. MS. Cañones y lugares protegidos. Rara. MCJ11678.

Lonicera pilosa Willd. B. Sobre arbustos. Rara. V4769, VR2210.

CARYOPHYLLACEAE

Drymaria anomala Wats. B. Lugares húmedos. Escasa. V4528.

Drymaria axillaris Brandg. MD. Arroyos y lomeríos. Común. V5579.

Drymaria glandulosa Persl. var. *glandulosa*. MS, B. Lugares húmedos y arroyos. Escasa. V4731.

Drymaria polycarpoides Gray. MD. Lomerios. Escasa. S. Vasquez41 (ANSM).

Drymaria subumbellata I.M.Johnst. MD, MS. Laderas. Escasa. MCJ 10103, 10515b.

Paronychia monticola Cory. MD. Laderas y valles. Rara. MCJ11681e.

CELASTRACEAE

Mortonia latisepala I.M.Johnst. MD. Laderas. Común. JM1054, R 1480, V4681.

Mortonia palmeri Hemsl. MD.MS. Laderas. Escasa. CQ876, MCJ10115.

Schaefferia cuneifolia Gray. MD.MS. Valles y laderas bajas. Escasa. V3104.

CHENOPODIACEAE

Atriplex canescens (Pursh.) Nutt. MD. Valles y laderas. Escasa. V5622.

Chenopodium album L. MS. MD. Areas con disturbio. Escasa. V1509.

Chenopodium graveolens Willd. B, MS. Areas húmedas y perturbadas.Común. V3590, 4168, 4775.

CONVOLVULACEAE

Convolvulus equitans Benth. MS. Maleza de áreas de cultivo. Escasa. V3916, 6367.

Cuscuta glabrior (Engelm.) Yuncker. MD. Parasita de *Flourensia*. Común. V6337.

Dichondra argentea H. & B. MD, MS, B. Común. V3603, 4789, 5358, VR2230.

Dichondra brachypoda Woot. & Standl. B, MS. Lugares protegidos. Común. V3604, 4683.

Evolvulus alsinoides L. var. *hirticulis* Torr. MD, MS. Común. R1468, V3917, 4533, 6666.

Evolvulus sericeus S.Wats. MD. Laderas y arroyos. Escasa. V4497, 5251, 6667.

Ipomoea collina House. MS, B. Sobre arbustos bajos. Común. V3923, 4663, 5247, 5347, VR2242.

Ipomoea costellata Torr. MD. Sobre el suelo o arbustos bajos. Común. V4554, 4690, VR2222.

Ipomoea muricata (L.) Jacq. MS. Sobre arbustos. Escasa. V. 4552, 4664.

Ipomoea purpurea (L.) Roth. MS. Sobre arbustos de áreas perturbadas. Escasa. V4551.

Ipomoea sescossiana Baillon. MS. Arroyos. Escasa. MCJ11690, V4553.

Ipomoea zimmermanii McDonald. MD. Laderas y arroyos. Escasa. Zimmernnan1948 (TEX-LL), V3982, 6672.

CRASSULACEAE

Echeveria strictiflora Gray. MD. Laderas rocosas. Escasa. H16197a, V6669.

Lenophyllum weinbergii Britt. MD, MS. Laderas rocosas. Escasa. MCJ10108b, V3072, 4508.

Sedum wrightii Gray. MS. Laderas y paredes rocosas de arroyos. Escasa. V4180, 5369.

Villadia cucullata Rose. MD. Laderas rocosas. Escasa. MCJ10109e, V4177.

CROSSOSOMATACEAE

Forsellesia spinescens (Gray) Greene. MD. Laderas y arroyos. Escasa. H16170.

CUCURBITACEAE

Cucurbita foetidissima H.B.K. MD. Arroyos y áreas perturbadas. Escasa.

Ibervillea tenuissecta (Gray) Standl. MD. Sobre arbustos bajos o el suelo. Escasa. **V**4670, 5617.

Sicyos angulatus L. MS. Sobre arbustos. Rara. **V**4785.

EBENACEAE

Diospyros texana Scheele. MD, MS. Arroyos y cañones. Escasa. **V**3070, 3564.

ERICACEAE

Arbutus xalapensis H.B.K. B. Común. **V**3873, 4796.

Comarostaphylis polifolia (H.B.K.) Zucc. ssp *coahuilensis* Henrick. B. Laderas y valles. Escasa. **MCJ**10101, 11682.

EUPHORBIACEAE

Acalypha lindheimeri Muell.Arg. B. Arroyos y lugares húmedos. Escasa. **V**3592, **VR**2228.

Acalypha monostachya Cav. MD, MS, B, P. Común. **CQ**783, **V**4547, 5243.

Argythamnia humilis (Engelm. & Gray) Muell. Arg. var. *humilis*. MD, MS. Escasa. **V**4521, 5220.

Bernardia myrcifolia (Scheele) Wats. MD, MS. Cañadas. Común. **V**3107, 3571, 4678.

Chiropetalum schiedeanum (Muell.Arg) Pax. MS. Laderas de los arroyos, E de la sierra. Común. **V**3989, 4655.

Croton dioicus Cav. MD, MS. Laderas. Escasa. **JM**929, 1004.

Croton fruticulosus Torr. Lugares húmedos. Común. **JM**985, **V**3572, 4665, 4741.

Croton hypoleucus Schlecht. MS, B. Arroyos. Muy común. **MCJ**11710, **V**3108, 3924, 4478, 4788, 5233, **VR**2199.

Croton incanus H.B.K. MD, MS. Cañones. Muy común. **V**3113, 3594.

Croton pottsii (Kl.) Muell.Arg. MD. Laderas bajas. Escasa. **R**1464, **VR**2220.

Croton suaveolens Torr. MD, MS, B. Arroyos y laderas. Muy común. **MCJ**11713b, 12753, **V**3533a, 3926, 5275, **VR**2211.

Euphorbia antisyphilitica Zucc. MD. Laderas bajas y valles. Muy común. **V**5565, 5627.

Euphorbia brachycera Engelm. MS, B. Arroyos. Escasa. **V**5293, 5817, **VR**2235.

Euphorbia cinerascens Engelm. MS, MD. Arroyos. Muy común. **CQ**786, **MCJ**10100, 11715, **V**4515, 4751, 5203, 5292.

Euphorbia cyathophora Murr. B, MS. Lugares protegidos y húmedos. **V**3894, **VR**2229.

Euphorbia dentata Michx. MS. Arroyos y areas perturbadas. Común. **V**3885, 4527, 4750, 5297, **VR**2231.

Euphorbia scopulorum Brandg. MD. Laderas bajas del W de la sierra. Común. **R**1478.

Euphorbia villifera Scheele. MS, B. Arroyos. Muy común. **MCJ**11681i, **V**3623, 3897, **VR**2201.

Jatropha dioica Cerv. MD. Valles y laderas bajas. Muy común. **JM**961.

Phyllanthus polygonoides Spreng. MD, MS. Arroyos y laderas bajas. **MCJ**11697, **V**3922, 4475, **VR**2236.

Stillingia treculeana(Muell. Arg.) I.M.Johnst. MD. Cañones. Escasa. **JM**1392.

Tragia amblyodonta (Muell.Arg.) Pax.&Hoffm. MS.MD. Areas perturbadas y arroyos. Común. **V**5296.

FABACEAE (LEGUMINOSAE). MIMOSOIDEAE

Acacia berlandieri Benth. MS, MD. Arroyos y laderas. Muy comun. **C**467, **V**5624.

Acacia constricta Gray. MD. Orilla de caminos y laderas bajas. Común. **C**467, **JM**2280.

Acacia greggii Gray. MD, MS. Arroyos. Escasa. **V**5598.

Acacia hirta T.& G. MS, B. Escasa. **V**4134.

Acacia neovernicosa Isley. MD. Laderas bajas y arroyos. Común. **V**5458.

Acacia rigidula Benth. MS. Valles y arroyos del E de la sierra. Común. **V**3884.

Acacia roemeriana Scheele. MD, MS. Arroyos y laderas bajas. Escasa. **CQ**929, 951, **V**5577.

Calliandra conferta Benth. MD, MS. Arroyos y laderas. Común. **CQ**928, **V**3881, 4145, 4667.

Desmanthus painteri (B.&R) Standl. MD. Rara. **V**3973.

Desmanthus virgatus Willd. var. *glandulosus* Turner. MS, B. Común. **V**4771, 5320.

Leucaena greggii S.Wats. MS. Arroyos y laderas de cañones. Común. **CQ**909, **H**16172, **MCJ**10117, **V**3088, 3589, 3868.

Mimosa biuncifera Benth. MS. Valles y arroyos. Escasa. **V**4536, 5434.

Mimosa emoryana Benth. var. *emoryana*.MD. Valles y laderas bajas. Común. **V**3311, 4483, 5241, 5460, 5593.

Mimosa texana (Gray) Small. MD. Común. **CQ**836.

Mimosa zygophylla Gray. MD. Valles y laderas bajas del N y W de la sierra. Común. **V**5462, 5578.

Mimosa zygphylla Gray. x *M. emoryana* Benth. MD. Laderas bajas. Escasa. **V**5466.

Prosopis glandulosa Torr. var. *glandulosa*. MD. Arroyos y laderas bajas. Común. **CQ**750, 5650.

Zapoteca media (Mart. & Gal.) Her. MS. Arroyos. Escasa. **V**5205.

FABACEAE. CAESALPINOIDEAE

Bauhinia ramosissima Benth. MD. Laderas. Común. **JM**334, 992, 1058, **H**16176, **MCJ**10094, 11717, **V**3610, 4146, 4486, 5461, 6686.

Caesalpinia parryi (Fisher) Eifert. MD. Laderas. Escasa.**V**5589.

Cercidium texanum Gray. MD. Arroyos, lado E y N de la sierra. Rara.

Chamaecrista greggii (Gray) Heller. MS. Laderas de cañones. Común. **V**4490, 4695, 5206, 6688.

Hoffmanseggia glauca (Ort.) Eifert. MD.MS. Areas perturbadas. Común. **MCJ**10509, **V**3584.

Hoffmanseggia oxycarpa Gray. MS. Laderas y arroyos. Escasa. **V**3975, **CQ**692.

Senna bauhinioides (Gray) Irwin & Barneby. Valles. Escasa. **CQ**358, **V**4522.

Senna lindheimeriana (Scheele) Irwin & Barneby. MS. Arroyos. Escasa. **V**3616.

Senna monozyx (Irwin & Barneby) Irwin & Barneby. MD. Valles NW de la sierra. Escasa. **Hin**16565.

FABACEAE. LOTOIDEAE

Astragalus sanguineus Rydb. B. Arroyos y áreas con disturbio. Rara. **V**5355.

Centrosema virginicum (L.) Benth. B, MS. Sobre arbustos. Escasa. **V**3990a.

Cologania angustifolia H.B.K. MS, B. Laderas de arroyos. Común. **V**4793, 5260, **VR**2188.

Cracca caribea (Jacq.) Benth. var. *edwardsii* (Gray) Hassl. MS, B. Lugares húmedos. Común. **V**3586, 3903, 4735, **VR**2193.

Dalea aurea Nutt. MD. Laderas bajas, entre arbustos. Escasa. **V**4772.

Dalea bicolor H.B.K. var. *bicolor*. MS, MD. Arroyos y cañadas. Muy Común **V**3076, 3541, 4763, 5286.

Dalea frutescens Gray. MD. Laderas bajas. Escasa. **CQ**779, **V**3958.

Dalea greggii (Gray) Heller. MD, MS, P. Común. **R**801, **V**2886, 3908, 5573.

Dalea hospens (Rose) Bullock. MS. Arroyos. Muy Común. **C**468, **V**3957, 4170, 5216, **VR**2191.

Dalea lutea (Cav.) Willd. var. *lutea*. MS. Arroyos y laderas bajas. Común. **V**4549, 5240.

Dalea melantha (Schaver) Rydb. MD. Arroyos. Común. **V**4164, 5463.

Dalea nana Torr. var. *carnescens* (Rydb.) Kearn. & Peeb. MD. Valles. Escasa. **V**6689.

Dalea pogonathera Gray. MD. Valles y laderas bajas. Muy común. **CQ**801, **V**3534, 3878, 5599.

Dalea radicans Wats. MS. Arroyos y valles. Común. **MCJ**11702c, V4800.

Dalea wrightii Gray. MD. Valles y laderas bajas. Muy común. **R** 1466, **Purp**4740, V4448, 5228, 5459.

Desmodium grahamii Gray. MS. Arroyos. Escasa. V3962, **VR**2195.

Desmodium neomexicanum Gray. B, MS. Arroyos y laderas protegidas. Escasa. V5231a.

Eysenhardtia parvifolia Brandg. MD. Laderas N y W de la sierra. Común. **MCJ**11716, V4147, 4485.

Eysenhardtia polystachya (Ort.) Sarg. MS. Arroyos y cañadas. Común. **JM**2246, V3930.

Galactia brachystachya Benth. MD. Sobre arbustos bajos. Común. **CQ**680, 744, **MCJ**11720, V4482, 4638, **VR**2189.

Indigofera acutifolia Schlecht. MS, B. Arroyos. Común. **CQ**854, V3974, 5258.

Nissolia platycalyx Wats. MS, B. Sobre arbustos. Común. V3979, 5235, 6687.

Phaseolus plagiocalyx Harms. B. Enredadera. Escasa. **VR**2194.

Phaseolus xanthotrichus Piper. MS. Laderas, en cañones. Escasa. V3961.

Rhynchosia senna Hook. var. *angustifolia* (Gray) Grear. B, MS. Valles. Común. **VR**2190.

Sophora nuttalliana Turner. B. Valles. Común. V5824, **VR**2253.

Sophora secundiflora (Ort.) Lag. MD, MS, B. Arroyos y laderas. Común. **JM**322, **H**16192, 16597, **R**1329, **MCJ**10517, V4724, 5557.

FAGACEAE

Quercus gravesii Sudw. B. Valles y laderas, cañones. Muy común. **JM**1078, 2315, V3617, 3938, 4759, 5357.

Quercus grisea Liebm. MS, B. Cañones y valles. Común. V5825, **VR** 2209

Quercus intricata Trel. MS, MD. Arroyos y cañones. Común. **JM**1048, C464, V3118, **VR**2202.

Quercus invaginata Trel. MS. Arroyos y laderas de cañones. Muy común. **Purp**5030, 5029, **JM**2336, 3935, C465, V3117, 3563, 4178, 4666, 5238, 5334, 5570, **MCJ**11713a.

Quercus laeta Liebm. B. Valles y arroyos. Rara. V3938, 4784, 5295.

Quercus laceyi Small. B. Valles cañones y laderas. Muy común. V3937, 3939, 5356.

Quercus mohriana Buckl. MS. Cañones. Escasa. **JM** sn.

FOUQUIERIACEAE

Fouquieria splendens Engelm. ssp *splendens*. MD. Laderas rocosas y valles. Muy común. **JM**3263.

GARRYACEAE

Garrya ovata Benth. ssp *lindheimeri* (Torr.) Dahling. B, MS. Cañones. Escasa. **JM**1076, **MCJ**11709a, V3074, 3952, 4792, 6682.

Garrya wrightii Torr. B. Cañones. Escasa. V4791.

GENTIANACEAE

Centaurium calycosum (Buckl.) Fern. var. *calycosum*. MS, P, MD. Valles. Común. **H**16181, C474, V3918, 4159, 5367.

HYDROPHYLLACEAE

Nama palmeri Gray. MS. Arroyos y laderas bajas. Común. **CQ**651, 716, V4515, 4684, 6671.

Nama undulatum H.B.K. MD, MS. Areas perturbadas. Común. **CQ**627, V6336.

Phacelia congesta Hook. MS. Arroyos. Escasa. **CQ**701.

JUGLANDACEAE

Juglans microcarpa Berl. MS, B. Arroyos. Escasa. **JM**2248, V3567, 4736, 5839.

KOEBERLINIACEAE

Koeberlinia spinosa Zucc. MD. Arroyos y laderas bajas. Común. **JM**319, 1005.

KRAMERIACEAE

Krameria grayi Rose & Painter. MD. Laderas bajas W de la sierra. Escasa. **H**16503, **V**5626.

Krameria lanceolata Torr. MS, B. Valles. Escasa. **V**3581, 5832.

Krameria ramosissima (Gray) Wats. MD. Laderas bajas. Escasa. **V**4643.

LAMIACEAE (LABIATAE)

Hedeoma costatum Gray var. *costatum*. B, MS. Paredes rocosas y laderas. Común. **V**3876.

Hedeoma microphyllum Irving. MS, B. Valles y laderas. Común. **MCJ**11695, **V**3875, 5327.

Hedeoma montanum Brandg. MD. Laderas bajas y valles N de la sierra. Común. **Purp**4964, **MCJ**10111, **C**461, **V**4539, 5435.

Hedeoma nanun (Torr.) Briq. MD. Laderas y valles al W de la sierra. Común. **V**6366.

Hedeoma plicatum Torr. MS, B. Laderas pedregosas. Escasa. **V**5327.

Marrubium vulgare L. MS, B. Areas perturbadas. Común. **V**5575.

Poliomintha glabrescens Gray. B, MS. Valles y areas cercanas a arroyos. Común. **MCJ**11684a, **V**3532, 3920.

Salvia ballotaeflora Benth. MD, MS. Arroyos. Común. **V**4501, 4608.

Salvia farinacea Benth. MS. Arroyos. Común. **Purp**4754, **V**3075, 3529, 4747.

Salvia greggii Gray. B, MS. Laderas y valles. Común. **MCJ**11691a, **V**3888, 5314.

Salvia reflexa Hornem. MS. Areas perturbadas y arroyos. Escasa. **V**3608.

Salvia regla Cav. MS, B. Laderas. Escasa. **V**3611, 3887.

Salvia roemeriana Scheele. B, MS. Arroyos. Común. **V**4777, 5334, 5834.

Salvia tiliaefolia Vahl. B. Areas perturbadas. Escasa. **V**3547.

Scutellaria hispidula Rob. MS, MD. Arroyos y laderas. Escasa. **MCJ**11686.

Scutellaria wrightii Gray. MS, B. Valles y laderas bajas, cañones. Común. **V**3526, 3877, 4732, 5332, **VR**2244.

LINACEAE

Linum lewisii Pursh. B. Arroyos. Escasa. **JM**2306, **V**3110, 4156.

Linum nelsonii Rose. B. Areas protegidas y arroyos. Escasa. **V**4739.

Linum rupestre (Gray) Gray. MS, MD. Muy común. **CQ**636, **MCJ**10098, 10108f, **V**3151, 4696, 5217, 5249, 6349.

Linum vernale Woot. MD. Laderas bajas y valles. Común. **V**5586.

LOBELIACEAE

Lobelia henricksonii M.C.Johnst. MS. Arroyos. Lugares húmedos. Escasa. **MCJ**11681g, **V**6665.

LOGANIACEAE

Buddleja marrubifolia Benth. MD. Arroyos y laderas. Común. **V**3883.

Buddleja scordioides H.B.K. MS. Areas perturbadas. Escasa. **JM**1067.

Emorya suaveolens Torr. MS. Arroyos y laderas bajas. Cañones. Común. **JM**2226, **V**3066, 3619, 4537, 4646, 4748.

Spigelia lindheimeri Gray. MS. Arroyos pedregosos. Rara. **V**4705, 5229.

LOASACEAE

Cevallia sinuata Lag. MD. Laderas bajas. Escasa. **CQ**804.

Eucnide bartonioides Zucc. MD, MS. Laderas de arroyos y paredes rocosas. Escasa. **V**4535.

Eucnide lobata (Hook) Gray. MD, MS. Laderas de arroyos y paredes rocosas. Escasa. **CQ**843, **V**3596.

Mentzelia asperula Woot. & Standl. MS. Arroyos. Escasa. **V**5237.

Mentzelia hispida Willd. MS, B. Valles y laderas bajas. Común. **V**4520.

Mentzelia mexicana Thomps. & Zavortink. MD. Laderas y valles pedregosos. Escasa.

Mentzelia saxicola Thomps. & Zavortink. MD. Laderas pedregosas. Escasa. **MCJ**10105.

MALPIGHIACEAE

Echinopterys setosa Brandg. MS. Laderas bajas de cañones. Común. **Purp**4950, **MCJ**10121, **V**4519, 6367.

Mascagnia cana Small. MD. Laderas y arroyos. Común. **MCJ**10120, **V**4150, 4524.

Mascagnia lilacina (Wats.) Niedenzu in Endl. & Pranl. MS, B. Sobre arbustos, paredes rocosas. Común. **V**3308, 4530, 5199.

MALVACEAE

Abutilon hypoleucum Gray. B, MS. Escasa. **V**4654, 6679.

Allowissadula holosericea (Scheele) Bates. MS. Areas protegidas. Rara. **V**3869.

Anoda crenatifolia Ort. MS. Areas perturbadas. Escasa. **V**4660.

Anoda pubescens Schlecht. MD. Arroyos. Rara. **CQ**1230.

Anoda thurberi Gray. MD, MS. Areas perturbadas. Común. **V**4701, 4802.

Batesimalva violacea (Rose) Fryx. MD. Laderas. Escasa. **V**3870.

Hibiscus coulteri Gray. MD. Laderas rocosas. Común. **JM**760, **V**4130, 4653, 6361.

Hibiscus martianus Zucc. MD, MS. Laderas y Valles. Común. **JM**761, **V**4652.

Pavonia lasiopetala Scheele. MS. Areas protegidas. Común. **V**3612, 3913, 4651, 5328.

Sida lindheimeri Engelm. & Gray. MS. Valles y áreas perturbadas. Común. **V**3615, 3959, 5376.

Sida longipes Gray. MS, B. Valles. Común. **V**5215, 5319.

Sida spinosa L. MS. Areas perturbadas. Escasa. **V**3615.

Sphaeralcea angustifolia (Cav.) D.Don. MD, B. Areas perturbadas. Común. **CQ**604, 782.

Sphaeralcea endlichii Ulbride. MD. Laderas y lomeríos. Muy común. **Endlich**847, **V**3595, 4127.

Sphaeralcea hastulata Gray. MD. Valles y laderas. Común. **V**4128, 6350.

MARTYNIACEAE

Proboscidea fragrans (Lindl.) Dcne. MD. Orilla de caminos, áreas perturbadas. Común. **V**4693, 5317.

NYCTAGINACEAE

Acleisanthes acutifolia Standl. MS. Orilla de arroyos. Escasa. **V**4474.

Acleisanthes longiflora Gray. MD. Laderas rocosas. Común. *Allionia incarnata* L. MD. Valles. Común. **CQ**799.

Boerhaavia linearifolia Gray. MD. Laderas rocosas. Común. **V**4473, 5224, 5452.

Cyphomeris gypsophiloides (Mart. & Gal.) Standl. MS, MD. Arroyos. Común. **V**3574, 3921, 4525, 4555.

Mirabilis glabrifolia (Ort.) I.M.Johnst. MD. Laderas. Escasa. **V**5465a.

Mirabilis longiflora L. MS. Areas protegidas. Común. **V**3573, 4532, 5265.

OLEACEAE

Forestiera angustifolia Torr. MS. Valles y cañadas. Común. **V**4495.

Fraxinus cuspidata Torr. B, MS. Cañadas y arroyos. Común. **CQ**776, 814, **R**1337, **V**3954, 4760, 5360.

Fraxinus greggii Gray. var. *greggii*. MS. Laderas y arroyos. Muy común. **JM**1045, **V**3953, 4499, 5299.

Menodora coulteri Gray. MD. Laderas. Escasa. **Purp**5020.

Menodora longiflora Gray. MD. Laderas y valles. Muy común. **JM**775, 2274, 2231, **H**16173, **V**3880, 4738, **VR**2215.

ONAGRACEAE

Calylophus hartwegii (Benth.) Raven var. *hartwegii*. MS, MD. Valles. Común. **MCJ**10509b, **V**4733, 5246a, 6339, **VR**2247.

Calylophus tubicola (Gray) Raven. MS, MD. Valles y arroyos. Escasa. **CQ**1051, **V**3990.

Gaura calcicola Raven & Gregory. MS, MD. Arroyos. Común. **CQ**1054, **V**3955, 5255, 5285, 6338.

OROBANCHACEAE

Orobanche cooperi (Gray) Heller. MD. Valles de Larrea y Fouquieria. Escasa. **V**4513, 6352.

OXALIDACEAE

Oxalis albicaulis H.B.K. var. *pilosa* (Nutt.) Eiten. B, MS. Arroyos y áreas protegidas. Escasa. **V**3598.**VR**2217.

Oxalis latifolia H.B.K. MS, B. Arroyos. Común. **MCJ**11681d, **V**2214.

PASSIFLORACEAE

Passiflora tenuiloba Engelm. MD. Valles y cañones. Escasa. **V**6670.

PAPAVERACEAE

Argemone fruticosa Thurb. ex Gray. MD, Valles. Rara. Hin 16582.

Argemone sanguinea Greene. MD, valles. Escasa. Hin 16600, **V**6368.

PHYTOLACCACEAE

Rivina humulis L. MS, B. Arroyos. Común. **CQ**785, **V**4671, 5227.

POLEMONIACEAE

Gilia incisa Benth. B, MS. Areas húmedas. Escasa. **V**4744.

Gilia insignis (Brandg.) Cory & Parks. MS, MD. Cañadas. Escasa.

Gilia rigidula Benth. ssp *rigidula*. MD. Laderas bajas. Común. **CQ**662, **V**2896.

Gilia stewartii I.M.Johnst. MD, MS. Laderas rocosas. Común. **JM**2237, **CQ**647, **MCJ**10515, **V**5561, 6358, **VR**2245.

Loeselia coerulea (Cav.) Cav. MD, P. Valles y laderas bajas. Común.**V**4743, 5453.

Loeselia greggii Wats. MD. Laderas pedregosas. Común. **V**3576, 4556, 5257.

POLYGALACEAE

Polygala alba Nutt. MD, MS. Cañones. Común. **Purp**4760, **JM**2329, **R**795, **H**16186, **V**5271, **MCJ**11711.

Polygala barbeyana Chodt. MD, B. Laderas y valles. Común. **MCJ**11703a, **V**3532, 4529, 4657, 527O, 5639, 6362.**VR**2246.

Polygala dolichocarpa Blake. MD. Arroyos. **MCJ**10521b.

Polygala lindheimeri Gray var. *lindheimeri*. MS. Arroyos y laderas bajas. Común. **JM**3985, 4749, **CQ**818, **V**5827, 6673.

Polygala macradenia Gray. MD. Laderas rocosas. Muy común. **JM**777, 783, **CQ**659, **H**16182, **MCJ**10521c.

Polygala nudata Brandg. MS, MD. Arroyos. Común. **Purp**4762, **H**16168c, **V**4698, 5239, 5560, 5615, **MCJ**10521d, 11720a.

Polygala parrasana Brandg. MS. Laderas bajas. Escasa. **MCJ**11699.

Polygala scoparioides Chodat. MS. Cañones y arroyos. Común. **CQ**661, 685, 723 **Wy**58.

Polygala watsonii Chodat. MD, MS. Laderas. Escasa. **MCJ**11698, **V**5581.

POLYGONACEAE

Eriogonum greggii T. & G. MD. Laderas bajas. Escasa. **V**3981.

Eriogonum jamesii Benth. in DC. var. *undulatum* (Benth.) Stokes ex. Jones. B. Valles. Común. **Robert**4488 (ANSM).

PORTULACACEAE

Portulaca mundula I.M.Johnst. MD, MS. Valles y arroyos. Muy común. V3614, 3919, 4511, 4752, VR2248.

Portulaca retusa Engelm. MD. Arroyos. Rara. V4510.

Talinopsis frutescens Gray. MD. Laderas bajas y paredes rocosas Escasa. V4526.

Talinum aurantiacum Engelm. MD, MS. Valles y laderas bajas. Escasa. V5220.

RANUNCULACEAE

Aquilegia longissima Gray. MS, B. Laderas y arroyos. Escasa. V3528.

Clematis coahuilensis Keil. MS. Arroyos y paredes rocosas. Escasa. V4657.

Clematis drummondii T. & G. MD, MS. Areas perturbadas. Escasa. CQ1055.

Clematis pitcheri T. & G. Sobre arbustos bajos. Escasa. V3893, VR2226.

Thalictrum grandifolium Wats. B, MS. Areas protegidas y húmedas. Muy común. CQ905, V3611, 3929, 5278.

RESEDACEAE

Oligomeris linifolia (Vahl.) Macbr. MS. Laderas bajas pedregosas y lugares inundables. Común. JM468, V5600, 6343.

RHAMNACEAE

Ceanothus greggii Gray. MS, B. Valles y laderas. Común. CQ870, V3609, 5842, VR2227.

Colubrina greggii Gray. MS, B. Cañones y arroyos. Escasa. V3619.

Condalia ericoides (Gray) M.C.Johnst. MS. Laderas bajas y valles. Común. C460, V4144.

Condalia warnockii M.C.Johnst. MD. Valles y laderas bajas. Común

Condalia viridis I.M.Johnst. MS. Cañones. Escasa.CQ1008, V3890, 5841.

Karwinskia humboldtiana (Schult.) Zucc. MS, MD. Valles y cañadas.Común. JM993, V3064, 3566.

Rhamnus betulifolia Greene. B. Cañones. Escasa. V4757.

Rhamnus standleyana C. B. Wolf. B. Valles y cañones. Rara. Purp 4968, V5840, VR2207.

Ziziphus obtusifolia (T. & G.) Gray. MD.MS. Valles y cañones. Común. JMsn, V5618.

ROSACEAE

Amelanchier denticulata (H.B.K.) Koch. MS, B. Laderas bajas, arroyos y cañadas. Común. CQ897, V4149, 4771, 5342, 6685.

Cercocarpus mojadensis Schneid. MS, B. Laderas en cañones. Común.JM2260, 2283, 3272, CQ795, MCJ10518, V3081.

Cercocarpus montanus Raf. var. *paucidentatus* (Wats.) F.L.Martin. MS, B. Cañones. JM2296, V3080, 3914, 4764, 5782.

Prunus serotina Ehrh. var. *virens* (Woot & Standl.) Mc.Vaugh. B. Cañones. Rara. V3943, 5821.

Vauquelinia corymbosa H. & B. ssp. *heterodon* (I.M.Johnst.) Hess & Henrick. MS. Cañones y arroyos. Muy común. JM1518, H16171, 16501, MCJ10110b, 11684, V2888, 4496, 5298, 3091.

RUBIACEAE

Bouvardia ternifolia (Cav.) Schlecht. MS. Arroyos. Escasa. V3530, 4476, 5208.

Coutaportla pailensis Villarreal. MS. Paredes rocosas. Rara. V3063, 3305.

Galium uncinulatum Gray. B. Arroyos y áreas protegidas. Escasa. V4687, 6351.

Hedyotis acerosa Gray. MD. Laderas pedregosas y valles. Común. JM988, R1335, V3090, 3536, 3912, 4534, 4700, 4745.

Hedyotis intricata Fosb. MS, MD. Laderas pedregosas. Común. V3089.

Hedyotis nigricans (Lam.) Fosb. var. *nigricans*. MS, B. Arroyos. Común. V3625, 3904, 4734.

Hedyotis palmeri (Gray) Lewis. MS. Arroyos. Escasa. V4546.

Randia pringlei Gray. MD, MS. Laderas rocosas y valles. Muy común.**JM**994, **CQ**650, **H**16178, **V**3106, 3307, 3569.

Relbunium microphyllum (Gray) Hemsl. MS, B. Arroyos. Común. **MCJ**11681h, **V**3579, 3909, 4645, **VR**2219.

RUTACEAE

Amyris marshii Standl. MS. Cañones. Común.**MCJ**11714, **V**3583, 4766, 6678.

Choisya palmeri Gray. MS. Cañones. Escasa. **MCJ**11691.

Ptelea trifoliata L. MS, B. Cañones y arroyos. Muy común. **MCJ**11702d, **R**1331, **V**3531, 5209, 5568.

Thamnosma pailensis M.C.Johnst. MD. Laderas bajas, N de la sierra. Rara. **MCJ**12751, L. *Woodruf 369* (TEX-LL).

Thamnosma texana (Gray) Torr. f. *purpurea* (Woot. & Standl.) Lundl. MS. Lechos de arroyos. Escasa. **V**4682, 5242.

SAPINDACEAE

Dodonaea viscosa Jacq. MS. Lechos de arroyos. Común. **H**16169, **MCJ**10119, **V**3309, 3546, 5835.

Ungnadia speciosa Endl. MS, B. Arroyos y cañones. Común. **V**3580, 5316.

SAPOTACEAE

Bumelia lanuginosa (Michx.) Pers. var. *rigida* Gray. MS, MD. Cañones. Escasa. **CQ**841, 953, **V**5831.

SAXIFRAGACEAE

Fendlera rigida I.M.Johnst. MS. Laderas rocosas. Escasa. **MCJ**10108c, 11683b, **V**5226.

Fendlerella lasiopetala Standl. MS. Laderas rocosas. Escasa. **JM**1050, **MCJ**11696, **V**5818.

SIMAROUBACEAE

Castela erecta Turp. ssp *texana* (T. & G.) Cronq. MD. Valles. Rara. **JM**333, 615, **V**5619.

Holacantha stewartii Mull. MD. laderas rocosas. Escasa. **JM**3897, **V**6690.

SCROPHULARIACEAE

Castilleja lanata Gray. MD. Valles y laderas bajas. Escasa. **JM**321, **V**6343.

Castilleja lithospermoides H.B.K. MS, MD. Arroyos y laderas pedregosas. Común. **JM**3215, **CQ**687, **V**4755, 5845.

Hemichaena spinulosa (Wats.) Thieret. MS, MD. Paredes rocosas. Común. **MCJ**11679, **V**3306, 4773.

Lamourouxia dasyantha (Cham. & Scht.) Ernst. MD. Laderas pedregosas. Escasa. **MCJ**10116c, **V**4509.

Leucophyllum candidum I.M.Johnst. MD. Laderas bajas y valles del W de la sierra. Escasa. **V**4545.

Leucophyllum frutescens (Berl.) I.M.Johnst. MS, MD. Valles y laderas bajas. Común. **V**3087, 3887, 4675, 5198.

Leucophyllum minus Gray. MD. Laderas bajas. Común. **MCJ**10111b, **V**3086, 4131.

Maurandya antirrhiniflora H. & B. ssp *antirrhiniflora*. MD, MS. Sobre arbustos en arroyos. Escasa **V**4632, 5584.

Maurandya antirrhiniflora H. & B. ssp *hederifolia* (Roth.) Elisens. MD. Sobre arbustos de valles y cañadas.Escasa. **JM**1081.

Mecardonia vandellioides (H.B.K.) Penn. MD, MS, P. Aroyos y lugares húmedos. Escasa. **V**4803.

Penstemon barbatus (Cav.) Roth. MS, B, P. Valles y laderas bajas. Común. **JM**2332, **V**3925, 4804.

Penstemon lanceolatus Benth. MS. Arroyos. Escasa. V4680.

Penstemon punctatus Brandg. MS, B. Arroyos. Común. ***Purp****4747*, CQ1056, MCJ11685, V3601, 3933, 4778, 5236.

Penstemon triflorus Heller. ssp *integrifolius* Penn. MS, B. Valles y arroyos. Escasa. R1339.

Seymeria coahuilana (Penn.) Standl. MS, MD. Valles y laderas bajas. Común. MCJ10109c, V4132, C469.

Seymeria falcata Turner. var. *falcata*. MS. Valles y laderas bajas. Común. V3607, 3965, 4685, 5301.

Seymeria virgata (H.B.K.) Benth. MD, MS. Laderas rocosas. Escasa. MCJ11681b, VR2205.

SOLANACEAE

Chamaesaracha coniodes (Moric. ex Dunal) Britt. MD. Valles al W de la sierra. Común. V5348.

Chamaesaracha coronopus (Dunal) Gray. MS. Valles y arroyos. Escasa. V4650.

Chamaesaracha pallida Averett. MS, MD. Arroyos. Común. CQ1052, R1334, V4649, 5207, 6662, VR2249.

Chamaesaracha sordida (Dunal) Gray. MS, MD. Arroyos. Comùn. V3556, 4648.

Datura inoxia Mill. MD, MS. Arroyos, orilla de caminos. Común. JM964, V4694, 5571.

Datura quercifolia H.B.K. MS, MD. Areas perturbadas y arroyos. Escasa. V4665.

Hunzikeria texana (Torr.) Hunziker & Subils. MS. Arroyos. Común. R1340, JM754, V4647, 5214.

Margaranthus solanaceus Schlecht. MS. Areas perturbadas y arroyos. Común. V4478, 4689, 5261.

Nicotiana glauca Grab. MD. Areas perturbadas y arroyos. Escasa. CQ796.

Physalis viscosa L. var. *cinerascens* (Dun.) Waterfall. MS, B. Lechos de arroyos. Común. V3552.

Physalis microphysa Gray. B, MS. Cañones y valles. Escasa. V5309.

Quincula lobata (Torr.) Raf. MS. Valles. Común. V3537.

Solanum americanum Mill. MS, MD. Lechos de arroyos. Común. V3936, 4758.

Solanum eleagnifolium Cav. MD. Areas perturbadas. Común.

Solanum triquetrum Cav. MS, MD. Entre arbustos y lugares protegidos. Común.V3548, 4644, 5204.

STERCULIACEAE

Ayenia microphylla Gray. MS, MD. Valles y laderas bajas. Escasa. R1459, V5222.

Ayenia pilosa Cristobal. MS, MD. Valles y laderas bajas. Común. MCJ11681, V4477, 4688, 5349.

VERBENACEAE

Aloysia gratissima (Gill. & Hook) Troncoso. MS, MD. Cañadas y valles. Común. CQ798, V5000.

Aloysia wrightii (Gray) Hellor. MD. Laderas rocosas. Escasa. V4493, VR2203.

Bouchea spathulata Torr. MS, B, P. Valles. Escasa. MCJ10107, V3099, 6365.

Citharexylum brachyanthum (Gray) Gray. MS, MD. Valles. Común. V3560, 4674.

Lantana horrida H.B.K. MS. Cañones y arroyos. Escasa. V4636.

Lantana macropoda Torr. MD, MS. Valles y laderas bajas. V4635.

Lippia graveolens H.B.K. MD. Laderas. Muy común. V3907, 5197.

Priva mexicana (L.) Pers. B. Valles y arroyos. Escasa. V5353, VR2224.

Tetraclea coulteri Gray. MD, MS. Valles y arroyos. Común. V5437.

Verbena bipinnatifida Nutt. MD, MS. Valles. Común.

Verbena elegans H.B.K. MS. Valles. Escasa. V4301.

Verbena neomexicana (Gray) Small. MS, MD. Arroyos. Escasa. MCJ1168.

VIOLACEAE

Viola sororia Willd. B, MS. Arroyos y valles. Areas protegidas. Común. R1336, V3985, 4790.

VISCACEAE

Phoradendron lanceolatum Engelm. MS, B. Sobre Quercus. Común. **MCJ**10102, 11709, **V**3112, 3565, 5303.

Phoradendron tomentosum (DC.) Gray ssp *tomentosum*. MS, B. Sobre Acacia. Escasa. **V**3068.

Phoradendron villosum (Nutt.) Nutt. MD, B, MS. Sobre Quercus. Escaso. **V**3984.

VITACEAE

Cissus incisa (Nutt.) Desmoul. MD, MS. Sobre arbustos bajos. Escasa. **V**4673.

Parthenocissus quinquefolia (L.) Planch. MS, B. Paredes rocosas de cañones. Rara. **V**3578.

Vitis berlandieri Planch. B, MS. Sobre árboles y arbustos. Común. **V**3525, 3892, 5823, 6661.

ZYGOPHYLLACEAE

Guaiacum angustifolium Engelm. MD, MS. Valles y cañones. Común. **CQ**621, **V**3105.

Kallstroemia parviflora Morton. MD. Laderas bajas y valles. Común **V**5455.

Larrea tridentata (DC.) Cav. MD. Valles y laderas bajas. Muy común. **JM**759.

Peganum mexicanum Gray. MD. Valles áreas perturbadas. Escasa. **JM** 492.

Sericodes greggii Gray. MD. Valles y laderas bajas del WS de la sierra. Muy común. **V**5602, 5609.

LILIOPSIDA (Monocotideloneas)

AGAVACEAE

Agave lechuguilla Torr. MD, MS. Laderas rocosas. Muy común. **JM**sn, **H**16196, **V**5610.

Agave macroculmis Tódaro. Laderas. Escaso. **H**16185, **Gentry** 20050.

Agave parrasana Berger. MS. Laderas de cañones. Escasa.

Agave scabra Salm-Dyck. ssp *scabra*. MD, MS. Laderas rocosas.Común. **V**5638

Agave striata Zucc. ssp. *falcata* (Engelm.) Gentry. MD, MS. Laderas y valles. Común. **Endlich**879a, **V**5566, 5612.

Dasylirion palmeri Trel. MD, MS. Laderas rocosas y arroyos. Muy común. **Endlich**7.

Hesperaloe funifera (Koch.) Trel. MD. Arroyos y valles del E y N de la sierra. Escasa.

Nolina cespitifera Trel. MD, MS. Laderas bajas rocosas. Común. **JM**2347, **V**5340.

Yucca carnerosana (Trel.) McKelvey. MS. Laderas rocosas de cañones. Común. **JM**s.n., **V**2897, 5576, 5637.

Yucca endlichiana Trel. MD. Valles al W de la sierra. Común **V**2126, 6340.

Yucca filifera Chabaud. MD. Valles y arroyos. Común. **V**3986.

Yucca torreyi Schafer. MD. Laderas pedregosas bajas. Común. **JM** 459.

Yucca treculeana Carr. MD. Laderas y valles. Común. **V**5611.

AMARYLLIDACEAE

Cooperia drummondii Herb. MD. Valles y arroyos. Escasa. **CQ**781, **V**6676.

Zephyranthes longiflora Hemsl. MD. Valles al N. Escasa. **V**6677.

ARECACEAE (PALMAE)

Brahea berlandieri Bartlett. MS. Paredes rocosas y arroyos de cañones. Común. **V**3620.

BROMELIACEAE

Hechtia texensis Wats. MD. Laderas y valles rocosos. Muy común. **V**5569, 5613, 5844.

Tillandsia recurvata L. MD, B. Sobre *Fouquieria*, *Quercus* y *Pinus*. Común. **CQ**817, **V**3114, 3871, 5828.

Tillandsia usneoides (L.) L. B. Sobre *Pinus* y *Quercus*. Valles. Común. **V**5837.

COMMELINACEAE

Commelina erecta L. var. *angustifolia* (Michx.) Fern. MD, MS, B. Laderas rocosas. Común. **V**3971, 4488, 4640, 5366.

Gibasis linearis (Benth.) Rohw. MD, MS. Valles y laderas pedregosas Común. V4641, 5338.

Tradescantia brachyphylla Greenm. MS, MD. Laderas rocosas. Escasa. V5266, **VR**2237.

Tradescantia crassifolia Cav. MS. Paredes rocosas de cañones. Escasa. V4702, 5337, **VR**2238.

CYPERACEAE

Carex schiedeana Kuntz. MS, B. Arroyos y cañadas. Común. **MCJ**10109a, 11691b, 11693, V4753, 6674.

Cyperus acuminatus T. & H. MS. Lechos de arroyos. Rara. V4500.

IRIDACEAE

Sisyrinchium scabra C & S. MS, B. Arroyos y cañones. Escasa. **JM**1071, **MCJ**11681a.

LILIACEAE

Allium kunthii Don. MD. Arroyos. Común. **MCJ**10116a.

Echeandia chandleri (Greenm. & Thomps) Cruden. B. Valles y laderas bajas. Común. V3960, 5345, **VR**2208.

Muilla purpusii Brandg. MD. Valles y laderas bajas. Escasa. **Purp**4959, V3980.

Schoenocaulon coulteri Baker. MS, B. Valles, cañones. Rara. V5245.

Smilax bona–nox L. MS, B. Sobre arbustos y árboles, cañones. Escasa. V3976.

ORCHIDACEAE

Dichromanthus cinnabarinus (Have & Lex.) Gray. MD. laderas pedregosas. Común. **MCJ**10097, 10108c, V4548, 5221, 5279.

Spiranthes chiangii M.C.Johnst. MS. Laderas rocosas. Rara. **MCJ**10108a.

POACEAE (GRAMINEAE)

Andropogon spadiceus Swallen. MS. Valles y arroyos. Escasa. V3084, 3630–6, **VR**2185.

Aristida adscensionis L. MD, P. Valles y laderas. Común. **Ca**44, V3627, 4506, 5192.

Aristida arizonica Vasey. MD. Valles y lomeríos. Común. **Ca**39, V5385.

Aristida brawnii Warnock. MD, MS. Valles. Escasa. V5469.

Aristida purpurea Nutt. var. *nealleyi* (Vasey) Allred. MD, MS. Valles. Común. V5181, 5470, 5635.

Aristida purpurea Nutt. var. *wrightii* (Nash) Allred. MD, MS, P. Valles y laderas. Muy común. **Ca**40, V4810.

Aristida ternipes Cav. MD. Valles y laderas. Común. V4558, 5441.

Bothriochloa barbinodis (Lag.) Herter var. *barbinodis*. MD.MS, B.Valles y arroyos. Común. **Ca**56, V5188.

Bothriochloa laguroides(DC.) Hertor. ssp *torreyana* (Steud.) Allred & Gould. MD, MS. Común. **VR**2157.

Bothriochloa saccharoides (Wats) Rydb. ssp *reevesii* (Gould) Allred & Gould. MS. Valles. Escasa. V4808.

Bouteloua barbata Lag. MD, MS. Laderas y lomeíos. Muy común. **Ca**9, V5193.

Bouteloua curtipendula (Michx.) Torr. MD, MS, P. Valles y laderas. Común. **Ca**12, V5333, **VR**2171.

Bouteloua gracilis (H.B.K.) Lag. MD, P. Valles y lomeríos. Común. **Ca**7, V5352, 5433.

Bouteloua hirsuta Lag. MS. Valles y arroyos. Común. **Ca**63, V5336, 5450.

Bouteloua johnstonii Sallen. MD. Laderas y valles. Escasa. **IMJ**8491, 8751, **R**1483, V4173.

Bouteloua ramosa Scribn. MD. Laderas y lomeríos. Común. **Ca**8, V5189.

Bouteloua trifida Thurb. MD, MS. Valles y arroyos. Común. **Ca**6, V3628, 4812, **VR**2180.

Brachiaria meziana Hitchc. B, P. Valles y áreas perturbadas. Escasa. **VR**2162.

Brachypodium pringlei Scribn. MS, MD. Laderas. Escasa. **MCJ**11705, 11705a.

Bromus anomalus Ropr. MS, B. Valles y laderas. Escasa. **Ca**51, **VR**2167.

Buchloe dactyloides (Nutt.) Engelm. MD, B, P. Valles y laderas. Común. **VR**2163.

Cenchrus incertus M.A.Curtis. MD, MS. Valles. Escasa. **Ca**21, **VR**2154.

Cenchrus ciliaris L. MD. Orilla de caminos. Escasa. **V**5445.

Cottea pappophoroides Kunth. MS, B. Valles y arroyos. Común. **V**5187.

Cynodon dactylon (L.) Pers. MS, B. Arroyos. Escasa. **Ca**23.

Chloris gayana Kunth. MS. Arroyos y areas perturbadas. Escasa. **Ca**34.

Chloris virgata Swartz. MD, MS. Areas perturbadas. Escasa. **Ca**33, **V**4503.

Chloris submutica H.B.K. B. Areas perturbadas. Rara. **VR**2166.

Dasyochloa pulchella (H.B.K.) Willd. MD. Valles. Escasa. **Ca**10.

Dichanthelium oligosanthes (Schult.) Gould var. *scriberianum* (Nash.) Gould. B.MS. Arroyos y cañones. Escasa. **V**3630–7, 5306, **VR**2181.

Digitaria californica (Benth.) Herard. MS, B. Valles y arroyos. Común. **Ca**37.

Digitaria hitchcockii (Chase) Stuck. MS, B. Valles y arroyos. Común. **Ca**36, **V**5191, **VR**2175.

Echinocloa colonum (L.) Link. MS. Arroyos. Escasa. **Ca**36, **V**3629, **VR**2169.

Enneapogon desvauxii Daveau. MS, MD. Valles y laderas. Común. **Ca**59, **V**5231.

Eragrostis barrelieri Daveau. MD, MS. Valles y arroyos. Común. **V**5194, 5447.

Eragrostis cilianensis Link. MD. Valles y areas perturbadas. Escasa. **Ca**32.

Eragrostis curvula (Schard.) Nees. MS. Valles y arroyos. Común. **Ca**29.

Eragrostis intermedia Nees. MS, MD. Valles. Común. **Ca**61, 27, **V**3626, 5324, 5383, **VR**2167.

Eragrostis mexicana (Hornem.) Link. MS. Arroyos. Escasa. **V**5470a.

Eragrostis palmeri Wats. MS. Valles y laderas bajas. Esacasa. **V**4806.

Eragrostis pectinacea (Michx.) Nees. MD, MS. Valles y arroyos. Común. **Ca**30, **V**3630–3.

Erioneuron avenaceum (H.B.K.) Tateoka MD, MS. Valles y laderas. Común. **MCJ**11708a, **V**5196, 5364.

Erioneuron nealleyi (Vasey) Tateoka. MD, MS. Valles. Común. **Ca**3, **V**5443. **VR**2155.

Erioneuron pilosum (Buckl.) Nash. MS. Valles. Escasa. **Ca**13, **VR**2179.

Heteropogon contortus (L.) Beauv. MS, MD. Orilla de caminos. Común. **Ca**24, **V**5195.

Hilaria mutica (Buckl.) Benth. P. Valles. Escasa. **Ca**25, **V**3988.

Koeleria pyramidata (Lam.) Beauv. B. Laderas. Rara. **Ca**15.

Leptochloa dubia (H.B.K.) Nees. MS, B. Valles y areas perturbadas. Común. **Ca**5, **V**4507, 5283, 5449.

Leptoloma cognatum (Schult.) Chase. Arroyos. Común. **Ca**28, **V**5280.

Lycurus phleoides H.B.K. MD, P. Valles y laderas bajas. Común. **Ca**26, **V**5330.

Melica montezumae Piper. MS, B. Laderas rocosas. Escasa. **MCJ**11704.

Metcalfia mexicana (Scribn.) Conert. MS. Valles y arroyos. Común. **Ca**58, **MCJ**10108, 10514, **V**5444.

Muhlenbergia dubia Fourn. B. Valles y laderas. Escasa. **V**5380, **VR**2184.

Muhlenbergia emersleyi Vasey. MS, B. Laderas. Escasa. **Ca**18.

Muhlenbergia glauca (Nees) Mez. MS, B. Laderas. Escasa. **V**5284.

Muhlenbergia lindheimeri Hitchc. MS, B. Laderas bajas. Escasa. **V**5436.

Muhlenbergia microsperma (DC.) Kunth. MS. Laderas y valles. Común. **Ca**16, **V**5272.

Muhlenbergia monticola Buckl. MS. Laderas. Común. **Ca**45, **MCJ**11705b, 11707, 11708.

Muhlenbergia porteri Scribn. MD. Valles y laderas bajas. Común. **Ca**46, **V**5446.

Muhlenbergia pubigluma Swallen. MS, B. Laderas. Escasa. **V**5464.

Muhlenbergia rigens (Benth.) Hitchc. MS, B. Laderas. Escasa. **Ca**18.

Muhlenbergia rigida (H.B.K.) Kunth. MS, B. Valles y laderas. Común. **Ca**47, **V**5379.

Muhlenbergia setifolia Vasey. MS, MD. Laderas. Muy común. **Ca**19, **V**4171, 4811, 5378, 5468, **VR**2184.

Muhlenbergia tenuifolia (H.B.K.) Kunth. MS, P. Valles y laderas. Muy común. **V**3084, 4504, 4557, 5186, 5448.

Nassella leuchotricha (Trin. & Rupr.) Pohl. B, Ms. Valles y laderas bajas. Común. V5264, **VR**2165.

Nassella tenuissima (Trin.) Barkw. B, P. Valles. Escasa. **Ca**31, V5276.

Panicum hallii Vasey. MS. Arroyos y areas protegidas. Común. **Ca**43, **MCJ**11716a, V3640–4, 5190, **VR**2164.

Panicum obtusum H.B.K. MS, P. Valles y lugares inundados. Escaso. **Ca**57.

Pappophorum bicolor Fourn. MD. Valles y laderas bajas. Escasa. **Ca**38, V3630–5, 5431.

Pappophorum vaginatum Buckl. MD. Valles. Escasa. **Ca**60.

Piptochaetium fimbriatum (H.B.K.) Hitchc. B, MS. Común. **Ca**52, V5281.

Poa annua L. MS, B. Lugares húmedos. Rara. **Ca**1.

Poa involuta Hitchc. MS, B. Laderas protegidas. Rara. **MCJ**11706.

Schizachyrium scoparium (Michx.) Nash. var. *neomexicanum* (Nash.) Gould. MS. Arroyos. Común. **Ca**50, V3987, 4809, **VR**2158, 2160.

Scleropogon brevifolius Phil. MD, P. Valles y laderas bajas. Rara. **Ca**54.

Setaria grisebachii Fourn. MS. Valles y arroyos. Común. **Ca**22, V5184, 5383, **VR**2159.

Setaria leucopila (Scribn. & Merr.) Schumann. MS. Arroyos. Común. **Ca**20, **MCJ**10122, 11716b, V5182, 5382, **VR**2182.

Setaria scheelei (Steud.) Hitchc. B. Valles. Escasa. **VR**2186.

Sorghastrum brunneum Swallen. MS, B. Laderas. Escasa. V5311, **VR**2161.

Sorghum halepense (L.) Pers. MD. Areas perturbadas. Rara. V3630–2.

Sporobolus airoides (Torr.) Torr. P, MS, MD. Valles y arroyos. Común. **Ca**49, V5183.

Sporobolus cryptandrus (Torr.) Gray. MS, MD. Valles. Común. **Ca**48, V3631–1, 5246.

Sporobolus pyramidatus (Lam.) Hitchc. Valles y arroyos. Escasa. **Ca**42.

Sporobolus wrightii Munro. Valles. Escasa.

Stipa alta Swallen. MS. Arroyos. Escasa. **MCJ**11704a, V5185, 5432, **VR**2174.

Stipa eminens Cav. MS, B. Valles y laderas. Común. **Ca**55, V5442, **VR**2172.

Stipa lobata Swallen. MS. Arroyos. Escasa. **VR**2168.

Stipa multinodis Beal. MS, B. Laderas. Común. **MCJ**11707a, V4502.

Stipa neomexicana (Thurb.) Scribn. MS. Valles y laderas bajas. Rara. **Ca**62.

Tragus berteronianus Schult. MS. Areas perturbadas. Escasa. **Ca**35.

Tridens muticus (Torr.) Nash. MS. Valles y arroyos. Común. **Ca**4, V4505, 4807, 5310, **VR**2153.

Tridens texanus (Wats) Nash. MS, MD. Valles y arroyos. Escasa. **Ca**14, V3630.

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VASCULAR PLANT TYPE SPECIMENS IN THE UNIVERSITY OF GEORGIA HERBARIUM, WITH A BRIEF HISTORY OF THE HERBARIUM

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ABSTRACT

The University of Georgia Herbarium contains 162 vascular plant specimens that have been designated as types, and for which some form of documentation has been found. These types are catalogued here with label data (locality, date, collector), the kind of type, and a citation of the original publication.

RESUMEN

El Herbario de la Universidad de Georgia contiene 162 especímenes de plantas vasculares que han sido designados como tipos y de los cuales se ha encontrado alguna documentación. Estos tipos están catalogados aquí con datos de etiqueta (localidad, fecha, colector), especificación concreta del tipo, y una cita de la publicación original.

The herbarium at the University of Georgia was founded in the 1920s by John N. Reade, and underwent its first reorganization by Joseph H. Pyron and Rogers McVaugh in the 1930s. It was expanded under the direction of Wilbur H. Duncan who served as curator until his retirement in 1978. Samuel B. Jones, Jr., was appointed curator in 1978 and Nancy C. Coile served as assistant curator. During 1978-1980, the herbarium was reorganized and its scope and activities broadened. In addition, the herbarium library was formally established. In 1981, Samuel B. Jones was named Director of the herbarium and Nancy C. Coile became the curator. Michael O. Moore became curator in 1989, and David E. Giannasi became Director in 1991. The University of Georgia herbarium serves as a repository of samples of southeastern U.S., with emphasis on the flora of the state and has as one of its major goals elucidating the flora of Georgia. During 1979, the herbarium staff prepared check-lists for the floras of Clarke County and the state of Georgia (Jones and Coile 1979a, 1979b). In 1985, the 2nd edition of the Georgia Plant List was issued (Coile and Jones 1985). In 1985-1986, an electronic high density mobile storage system (compactor) was installed in the herbarium. This compactor system almost doubled the storage capacity of the herbarium and will allow for continued growth of the collection. In 1988, Jones and Coile published *The Distribution of the Vascular Flora of Georgia* (Jones and Coile 1988). This publication has distribution maps by

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counties for all native or naturalized plant species occurring in Georgia based upon voucher specimens deposited in institutional herbaria. Although 5,000 copies were printed, demand for this publication has been great, and it is now out of print. The publication represented an important next step toward the development of a state Flora.

The herbarium now holds over 206,000 mounted specimens, of which 162 have been documented as types. This latter number does not include topotypes, paratypes, or specimens suspected as being types, but for which no literature citation could be found. A number of these specimens are of historical significance, particularly collections of 22 taxa made by A.H. Curtiss, a prominent early collector in the southeastern United States from 1884-1899.

Catalogued specimens were documented in at least one three ways: (1) through citation in the original publication; (2) through citation as a type in a secondary publication, and (3) through annotation as a type by a later researcher. Where the original or a secondary publication was consulted, the location of the holotype is also given. The label data (locality, date, collector, collection number), the reference citation, the kind of type, and source(s) of documentation are given for each specimen. The following catalogue is divided into four sections: Pteridophyta, Gymnospermae, monocotyledons and dicotyledons. Within each section, taxa are listed alphabetically by genus.

CATALOGUE OF TYPE SPECIMENS

PTERIDOPHYTA

Isoetes tagetiformans P.M. Rury, Amer. Fern J. 68:99–108. 1978. ISOTYPE. U.S.A. GEORGIA. Columbia Co.: Heggies Rock, 3.8 mi E from Columbia Junior High School along GA 232 and County Rd 2122, 33° 32'30" N, 82° 15'05" W, 21 Jan 1978, *P.M. Rury & M. Treiber 259*; cited in original publication (HOLOTYPE: NCU).

Thelypteris pilosa (M. Martens & Galeotti) Craw. var. **alabamensis** Craw., Amer. Fern J. 41:15–20. 1951. SYNTYPE. U.S.A. ALABAMA. Winston Co.: in fissures of Pottsville Sandstone on W fork of Sipsey River, 5 mi E of Double Springs, 26 Nov 1949, *L.C. Crawford & C.B. Segars 1103;* cited in original publication.

Woodsia scopulina D. Eaton ssp. **laurentiana** Windham, Contr. Univ. Michigan Herb. 19:59. 1993. ISOTYPE. CANADA. QUEBEC. Gaspe Co.: on sandstone sea-cliffs, 19–21 Aug 1905, *Collins & Fernald 25351*; annotated as isotype by M.D. Windham, 1993.

GYMNOSPERMAE

Podocarpus lucienii Laubenf., Brittonia 12:80. 1960. ISOTYPE. NEW CALEDONIA: scattered and locally common on slopes above and N of Riviere Bleue River, 5 mi from confluence with Yate River, 10 Oct 1957, *D.J. de Laubenfels P137;* cited in original publication (HOLOTYPE: GH).

ANGIOSPERMAE

MONOCOTYLEDONS

Aletris lutea Small forma **albiflora** E.T. Browne, Rhodora 63:305. 1961. HOLOTYPE. U.S.A. GEORGIA. Chatham Co.: low ground at edge of Cypress stand 15.3 mi W 4° S of

Savannah City Hall, NW of Old Ogeechee Canal on Bamboo Farm-Pembroke Road, 13 Jun 1958, *W.H. Duncan 20982*; cited in original publication.

Allium passeyi N.H. Holmgren & A.H. Holmgren, Brittonia 26:309. 1974. ISOTYPE. U.S.A. UTAH. Box Elder Co.: SW part of Howell Valley, T11N, R5W, S7, 13 Jun 1960, *A.H. Holmgren, H.B. Passey & V.K. Hugie 13125*, cited in original publication (HOLOTYPE: NY).

Andropogon brachystachyus Chapm., Fl. S U.S. ed. 2:688. 1883. ISOLECTOTYPE. U.S.A. FLORIDA: dry pine barrens near Jacksonville, Oct no year, *A.H. Curtiss 3632*; annotated as isolectotype by C.S. Campbell, 1980.

Andropogon virginicus L. var. **glaucus** Hack. in DC., Monogr. Phan. 6:411. 1889. ISOTYPE. U.S.A. FLORIDA: dry pine barrens near Jacksonville, Nov no year, *A.H. Curtiss 3638b*; annotated as isotype by C.S. Campbell, 1980.

Aristida lanuginosa Scribner ex Hitchc., Contr. U.S. Natl. Herb. 17:278. 1913. ISOTYPE. MEXICO. JALISCO: hills near Guadalajara, 28 Oct 1889, *C.G. Pringle 2375*; cited in original publication (HOLOTYPE: US).

Calochortus rhodothecus Clokey, Bull. S. Calif. Acad. Sci. 37:1. 1938. ISOTYPE. U.S.A. NEVADA. Clark Co.: Charleston Mountains, Charleston Park, 21 Jul 1937, *I.W. Clokey 7479*; cited in original publication.

Carex × absconditiformis Fernald, Rhodora 44:387. 1942. ISOTYPE. U.S.A. VIRGINIA. Sussex Co.: bottomland woods along Nottoway River, E of Huske, 13 Jun 1941, *M.L. Fernald & B. Long 12969*; cited in original publication, annotated as isotype by C.T. Bryson, 1980 (HOLOTYPE: GH).

Carex amplisquama F.J. Herm., Rhodora 57:157–158. 1955. ISOTYPE. U.S.A. GEORGIA. Gilmer Co.: 8 mi E of Chatsworth, 15 May 1938, *J.H. Pyron & R. McVaugh 2951*; cited in original publication (HOLOTYPE: US).

Carex austrocaroliniana F.M. Bailey, Am. J. Sci. 45:173. 1843. ISOTYPE. U.S.A. CAROLINA AND GEORGIA: in montibus, no date, *S.B. Buckley s.n.*; annotated as isotype by C.T. Bryson, 1980.

Carex digitalis Willd. var. **asymetrica** Fernald, Rhodora 43:544. 1941. ISOTYPE. U.S.A. VIRGINIA. Southampton Co.: steep wooded banks, ravines and clearings near Three Creek, NW of Applewhite Church, 8 May 1940, *M.L. Fernald and B. Long 11791*; cited in original publication, annotated as isotype by C.T. Bryson, 1980 (HOLOTYPE: GH).

Carex interior F.M. Bailey var. **charlestonensis** Clokey, Bull. S. Calif. Acad. Sci. 38:1. 1939. ISOTYPE. U.S.A. NEVADA. Clark Co.: Charleston Mountains, Charleston Peak, damp soil by spring, 19 Jun 1937, *I.W. Clokey 7468*; annotated as isotype by A.A. Reznicek, 1978.

Carex lucorum Willd. ex Link var. **austrolucorum** J.H. Rettig, Sida 13:449–450. 1989. HOLOTYPE. U.S.A. NORTH CAROLINA. Buncombe Co.: along NC 9, 5.0 mi N of jct. with US 74 in town of Bat Cave, 6 May 1986, *J.H. Rettig 1554*; cited in original publication, annotated as holotype by J.H. Rettig, 1988.

Carex manhartii Bryson, Castanea 50:15–17. 1985. HOLOTYPE & ISOTYPE. U.S.A. NORTH CAROLINA. Macon Co.: Coweeta Hydrologic Lab, Stewart Trail, 17 May 1981, *J.R. Manhart 293*; annotated as holotype and isotype by C.T. Bryson, 1985.

Carex mohriana Mackenzie, N. Amer. Fl. 18:106. 1931. ISOTYPE. U.S.A. FLORIDA: swamp near Wauchula, 15 Apr 1901, *A.H. Curtiss 6761*; annotated as isotype by A.A. Reznicek, 1978.

Carex shortiana Dewey, Mss. Dewey, Car. XXX, p. 60. ISOTYPE. U.S.A. KENTUCKY: Lexington, no date, *Short s.n.*; annotated as isotype by S. McDaniel, 1971.

Cyperus granitophilus McVaugh, Castanea 2:103. 1937. HOLOTYPE. U.S.A. GEORGIA. Walton Co.: sandy depression in granite rocks, 1 mi E of Loganville, 3 Oct 1936, *J.H. Pyron & R. McVaugh 971*; cited in original publication.

Eragrostis chiquitaniensis T. Killeen, Ann. Missouri Bot. Gard. 77:153. 1990. ISOTYPE.

BOLIVIA. Santa Cruz, Chiquitos, Est. San Ignacio, 22 km N of San Jose, 17° 35' S, 60° 45' W, 1 Feb 1986, *T. Killeen 1728*; cited in original publication.

Erythronium umbilicatum C. Parks & Hardin ssp. **monostolum** C. Parks & Hardin, Brittonia 15:254. 1963. ISOTYPE. U.S.A. NORTH CAROLINA. Swain Co.: rich woods near Indian Gap, 6 May 1961, *J.W. Hardin 2360*; cited in original publication (HOLOTYPE: NCSC).

Erythronium umbilicatum C. Parks & Hardin ssp. **umbilicatum**, Brittonia 15:252–253. 1963. ISOTYPE. U.S.A. NORTH CAROLINA. Iredell Co.: along slope above stream, 9 mi W of Statesville off I40, 13 May 1961, *J.W. Hardin 2368*; cited in original publication (HOLOTYPE: NCSC).

Fimbristylis diphylla (Retz.) Vahl ssp. **diffusa** D.B. Ward, Castanea 33:127. 1968. ISOTYPE. U.S.A. FLORIDA. Alachua Co.: FL 121, Williston Rd., ca. 4 mi SW of Gainesville near NW corner of Paynes Prairie, 13 Aug 1966, *D.B. Ward 5867*; cited in original publication (HOLOTYPE: FLAS).

Habenaria blephariglottis (Willd.) Hook. var. **integrilabia** Correll, Bot. Mus. Leafl. 9:153–156. 1941. ISOTYPE. U.S.A. KENTUCKY. McCreary Co.: in *Sphagnum* bog with *Xyris* 3 mi N of Whitley City, 27 Aug 1940, *F.T. McFarland & H.J. Rogers 97*; cited in original publication (HOLOTYPE: AMES).

Hosta jonesii M.G. Chung, Ann. Missouri Bot. Gard. 76:920. 1989. HOLOTYPE. KOREA: KYEONGSAN NAM DO PROVINCE: Namhae Gun, Sangu Myeon, Mt. Kumsan, 28 Aug 1988, *M.G. Chung 1613*; cited in original publication.

Hypoxis curtissii Rose in Small, Fl. SE U.S. 287, 1329. 1903. ISOTYPE. U.S.A. FLORIDA: swamps near Jacksonville, 19 May 1894, *A.H. Curtiss 4727*; annotated as isotype by A. Herndon, 1990.

Najas major All. var. **gracilis** Morong, Bot. Gaz. 10:255. 1885. ISOTYPE. U.S.A. FLORIDA: Palm Creek near Cape Romano, Jul no year, *A.H. Curtiss 2705*; annotated as isotype by R.R. Haynes, 1974.

Nolina atopocarpa Bartlett, Rhodora 11:81. 1909. ISOTYPE. U.S.A. FLORIDA: Indian River, Eau Gallie, no date, *A.H. Curtiss 5702*; cited in original publication (HOLOTYPE: GH).

Rhynchospora curtissii Britton ex Small, Fl. SE U.S. 195, 1327. 1903. ISOTYPE. U.S.A. FLORIDA: low roadside near Milton, 8 Jul 1897, *A.H. Curtiss 5929*; annotated as isotype by S.M. Kooyman, 1980.

Rhynchospora oligantha A. Gray var. **breviseta** Gale, Rhodora 46:128–130. 1944. ISOTYPE. U.S.A. FLORIDA: damp pine barrens near Jacksonville, 19 Jun 1896, *A.H. Curtiss 5687*; cited in original publication, annotated as isotype by S.M. Kooyman, 1980 (HOLOTYPE: GH).

Sagittaria secundifolia Kral, Brittonia 34:12–13. 1982. ISOTYPE. U.S.A. ALABAMA. DeKalb Co.: cracks in sandy flatrock shallows, sandy shallow pools and depths up to 0.75 m even at low stage, Little River above AL 35 bridge, 27 Jul 1977, *R. Kral 60639*; cited in original publication (HOLOTYPE: US).

Scirpus rubiginosus Beetle, Amer. J. Bot. 28:697. 1941. ISOTYPE. U.S.A. CALIFORNIA. Marin Co.: tide flat N of Stinson Beach, 9 May 1941, *A.A. Beetle 2686*; cited in original publication.

Sporobolus teretifolius R.M. Harper, Bull. Torrey Bot. Club 33:229–231. 1906. ISOTYPE. U.S.A. GEORGIA. Colquitt Co.: moist pine barrens near Moultrie, 20 Sep 1902, *R.M. Harper 1642*; cited in original publication (HOLOTYPE: NY).

Trillium decipiens J.D. Freeman, Brittonia 27:17–18. 1975. ISOTYPE. U.S.A. GEORGIA. Early Co.: common in rich woods on W facing bluff of Chattahoochee River, just below Tenneco Oil Depot and S of GA 162, 28 Mar 1968, *J.D. Freeman 615*; cited in original publication, annotated as isotype by J.D. Freeman, 1968 (HOLOTYPE: GH).

Trillium foetidissimum J.D. Freeman, Brittonia 27:31–32. 1975. ISOTYPE. U.S.A. MISSISSIPPI. Adams Co.: in loess ravines under rich hardwoods S of US 61-84-98, 1.2 mi E of St. Catherine Creek in Natchez, 30 Mar 1967, *J.D. Freeman 535*; cited in original publication, annotated as isotype by J.D. Freeman, 1968 (HOLOTYPE: GH).

Trillium lancifolium Raf., Autik. bot.:132. 1840. ISONEOTYPE. U.S.A. FLORIDA. Gadsden Co.: moist slopes in woods, Chattahoochee, 14 Mar 1901, *A.H. Curtiss 6747*; cited as isoneotype by J.D. Freeman, 1975, Brittonia 27:10 (NEOTYPE: GH).

Trillium persistens W. Duncan, Rhodora 73:244–246. 1971. ISOTYPE. U.S.A. GEORGIA. Rabun Co.: open deciduous woods on S facing slope of Tallulah Gorge, 23 Mar 1971, *W.H. Duncan 23548*; cited in original publication (HOLOTYPE: US).

Trillium reliquum J.D. Freeman, Brittonia 27:21. 1975. ISOTYPE. U.S.A. GEORGIA. Columbia Co: (Richmond Co. on label and original publication, but Freeman says Columbia), rich woods on bluff slope at mouth of ravine, E facing bluff of Savannah River, ca. 5 mi above Augusta, 30 Mar 1968, *J.D. Freeman 625*; cited in original publication, annotated as isotype by J.D. Freeman, 1967 (HOLOTYPE: GH).

Yucca smalliana Fernald, Rhodora 46:8. 1944. ISOTYPE. U.S.A. FLORIDA: sandy soil near Jacksonville, May no year, *A.H. Curtiss 2950*, cited in original publication (HOLOTYPE: GH).

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Agalinis acuta Pennell, Bull. Torrey Bot. Club 42:338. 1915. ISOTYPE. U.S.A. MASSACHUSETTS. Martha's Vineyard, Edgartown, dry sandy downs, 12 Sep 1901, *M.L. Fernald 45*; cited in original publication, annotated as isotype by J.M. Canne, 1985 (HOLOTYPE: US).

Agalinis edwardsiana Pennell, Proc. Acad. Nat. Sci. Philadelphia 73:522. 1922. ISOTYPE. U.S.A. TEXAS. Kendall Co.: dry adobe hills 5 mi NE of Boerne, 16 Sep 1913, *F.W. Pennell 5482*; cited in original publication (HOLOTYPE: PENN).

Agalinis homolantha Pennell, Proc. Acad. Nat. Sci. Philadelphia 73:525. 1922. ISOTYPE. U.S.A. TEXAS. Colorado Co.: sandy oak woodland NW of Sheridan along SA & AP railroad, 21 Sep 1913, *F.W. Pennell 5522*; cited in original publication (HOLOTYPE: PENN).

Amorpha georgiana Wilbur, Rhodora 56:261–263. 1954. ISOTYPE. U.S.A. GEORGIA. Telfair Co.: 3 mi NW of Lumber City on US 23, dry savannah and river bank, 9 May 1953, *R.L. Wilbur 3158*; cited in original publication (HOLOTYPE: GH).

Amorpha ouachitensis Wilbur, Rhodora 77:394–397. 1975. ISOTYPE. U.S.A. OKLAHOMA. LeFlore Co.: dry rocky (sandstone) hills, Page, 23 Sep 1921, *E.J. Palmer 20572*; cited in original publication, annotated as isotype by R.L. Wilbur, 1973 (HOLOTYPE: A).

Amorpha virgata Small, Bull. Torrey Bot. Club 21:17. 1894. ISOLECTOTYPE. U.S.A. GEORGIA. DeKalb Co.: NW slope of Stone Mountain, 3 Jul 1893, *J.K. Small s.n.*; cited as isolectotype by R.L. Wilbur, 1977, Rhodora 77:398 (LECTOTYPE: NY).

Aquilegia scopulorum Tidestrom ssp. **perplexans** Clokey, Bull. S. Calif. Acad. Sci. 37:3. 1939. ISOTYPE. U.S.A. NEVADA. Clark Co.: Charleston Mountains, Charleston Peak, broken rocky slope above timberline, 16 Jul 1936, *I.W. Clokey 7094*; cited in original publication.

Arenaria lanuginosa (Michaux) Rohrb. var. **longipedunculata** W. Duncan, Phytologia 3:282. 1950. ISOTYPE. U.S.A. GEORGIA. Fulton Co.: S side of Chattahoochee River, E of Marsh Creek, 5 Jun 1949, *W.H. Duncan 9701*; cited in original publication (HOLOTYPE: NY).

Aster divaricatus L. var. **deltoideus** E.S. Burgess in Britton & Brown, Ill. Fl. N U.S. 3:357. 1898. ISOLECTOTYPE. U.S.A. DISTRICT OF COLUMBIA. Opposite Analostan, thickets, 27 Sep 1888, *E.S. Burgess s.n.*; cited as isolectotype by W.F. Lamboy & A.G. Jones, 1987, Brittonia 39:290.

Aster erectus E.S. Burgess, Mem. Torrey Bot. Club 13:147. 1906. ISOLECTOTYPE. U.S.A. NEW YORK: vicinity of New York City, Bryn Mawr Park, 26 Sep 1896, *E.S. Burgess s.n.*; cited as isolectotype by W.F. Lamboy & A.G. Jones, 1987, Brittonia 39:290.

Aster jonesiae Lamboy, Syst. Bot. 13:192–193. 1988. HOLOTYPE & ISOTYPE. U.S.A. GEORGIA. Upson Co.: oak-hickory woods at E base of Pine Mountain, near Pasley Shoals, W of Thomaston, 10 Sep 1947, *A. Cronquist 4694*; cited in original publication, annotated as holotype and isotype by W.F. Lamboy, 1988.

Aster roscidus E.S. Burgess in Britton & Brown, Ill. Fl. N U.S. 3:360. 1898. ISOLECTOTYPE. U.S.A. NEW YORK: Bryn Mawr Park, 14 Sep 1897 (1898?), *E.S. Burgess s.n.*; cited as isolectotype by W.F. Lamboy & A.G. Jones, 1987, Brittonia 39:290.

Aster tenuifolius L. var. **aphyllus** R. Long, Rhodora 72:40–41. 1970. ISOTYPE. U.S.A. FLORIDA. Hillsborough Co.: NW of Tampa, S of FL 580 and W of Rocky Creek, 24 Dec 1962, *O. Lakela 25610*; cited in original publication, annotated as isotype by S. Sundberg, 1986 (HOLOTYPE: GH).

Astragalus aequalis Clokey, Madroño 6:215. 1942. ISOTYPE. U.S.A. NEVADA. Clark Co.: Charleston Mountains, hillside Juniper belt, Harris Springs Road, 4 Jun 1937, *I.W. Clokey 7572*; cited in original publication.

Astragalus hemigyrus Clokey, Madroño 6:220. 1942. ISOTYPE. U.S.A. NEVADA. Clark Co.: Charleston Mountains, rock ledges, *Larrea* belt, S of Indian Springs, 18 Apr 1939, *I.W. Clokey 8409*; cited in original publication.

Baptisia arachnifera W. Duncan, Rhodora 46:29–31. 1944. ISOTYPE. U.S.A. GEORGIA. Wayne Co.: sandy soil in open pine woods 10 mi S of Jesup, 4 Jul 1943, *W.H. Duncan 5693*; cited in original publication (HOLOTYPE: GH).

Baptisia pendula Larisey, Ann. Missouri Bot. Gard. 27:171. 1940. ISOTYPE. U.S.A. GEORGIA. Decatur Co.: dry open woods bordering the Flint River near Bainbridge, 19 Jul 1901, *A.H. Curtiss 6810*; annotated as isotype by D. Isely, 1978.

Bidens mariana S.F. Blake, Rhodora 31:88. 1929. ISOTYPE. U.S.A. MARYLAND: sandy shore of Northeast River near Carpenters Point, Charleston, 17 Sep 1926, *S.F. Blake 9698*; cited in original publication (HOLOTYPE: US).

Bigelowia nuttallii L.C. Anderson, Sida 3:460–461. 1970. ISOTYPE. U.S.A. GEORGIA. Tattnall Co.: W bank of Ohoopee River 3.5 mi W of Reidsville, 12 Nov 1969, *L.C. Anderson 3455*; cited in original publication (HOLOTYPE: KSC).

Bumelia thornei Cronquist, Castanea 14:103. 1949. HOLOTYPE. U.S.A. GEORGIA. Early Co.: in dry live oak woods by cypress swamp, 1 mi E of Nantz Spring, 22 Oct 1947, *R.F. Thorne 7345*; cited in original publication.

Calycanthus brockiana Ferry & Ferry f., Sida 12:339. 1987. HOLOTYPE. U.S.A. GEORGIA. Lumpkin Co.: 12.8 mi SW of Dahlonega, S of E-W dirt farm road in open deciduous forest, 10 May 1982, *R.J. Ferry Sr. 637*, annotated as holotype by R.J. Ferry & R.J. Ferry f., 1987.

Castilleja christii N.H. Holmgren, Bull. Torrey Bot. Club 100:91. 1973. ISOTYPE. U.S.A. IDAHO. Cassia Co.: Cache Peak Range, Harrison Mountain, near top, T13S, R24E, S9, 12 Jul 1966, *N.H. Holmgren & J.L. Reveal 2866*; cited in original publication (HOLOTYPE: NY).

Castilleja clokeyi Pennell, Proc. Acad. Nat. Sci. Philadelphia 89:420. 1938. ISOTYPE. U.S.A. NEVADA. Clark Co.: Kyle Canyon, gravelly loam on N slope, 8 Jul 1936, *I.W. Clokey & C.B. Clokey 7322*; cited in original publication.

Cirsium clokeyi S.F. Blake, Proc. Biol. Soc. Wash. 49:8. 1938. ISOTYPE. U.S.A. NEVADA. Clark Co.: Charleston Mountains, ridge near peak, gravelly open slopes, 6 Aug 1937, *I.W. Clokey 7456*; cited in original publication (HOLOTYPE: US).

Clematis morefieldii Kral, Ann. Missouri Bot. Gard. 74:665. 1987. ISOTYPE. U.S.A. ALABAMA. Madison Co.: SE of Huntsville along upslope side of eastward unpaved extension of Deborah Ave., 0.75 mi SSW of Red Top Mountain, 17 Jun 1983, *R. Kral 70176*; cited in original publication.

Clematis socialis Kral, Rhodora 84:287–289. 1982. ISOTYPE. U.S.A. ALABAMA. St. Clair Co.: silt and clay of alluvial openings in bottoms of Dry Creek and contiguous hardwood forested edges, ca. 3 mi S of Ashville, 2 May 1980, *R. Kral 64852*; cited in original publication (HOLOTYPE: US).

Clitoria fragrans Small, Torreya 26:57. 1926. ISOTYPE?. U.S.A. FLORIDA. Highlands Co.: sandhills near DeSoto City, 20 May 1925, *J.K. Small & E.T. Wherry 12626*; note on label states that Gleason could not find the type at NY in 1945, annotated as possible isotype by "J.M.," 1959.

Cordylanthus glandulosus Pennell & Clokey, Proc. Acad. Nat. Sci. Philadelphia 90:11. 1938. ISOTYPE. U.S.A. NEVADA. Clark Co.: Charleston Mountains, brushy hills, Juniper Belt, Harris Springs Road, 16 Jul 1937, *I.W. Clokey 7715*; cited in original publication.

Coreopsis leavenworthii T. & G. var. **curtissii** Sherff, Bot. Gaz. 94:592. 1933. ISOTYPE. U.S.A. FLORIDA: dry pasture ground along the Suwannee River near Branford, 23 Oct 1900, *A.H. Curtiss 6734*; annotated as isotype by E.B. Smith, 1976.

Coreopsis longifolia Small var. **godfreyi** Sherff, Bot. Leafl. 6:3. 1952. HOLOTYPE. U.S.A. GEORGIA. Wheeler Co.: boggy, sphagnous depression in sandhills 7 mi S of McRae, 14 Oct 1950, *R.K. Godfrey 50793*; annotated as "type" by E.E. Sherff, no date.

Coreopsis saxicola Alex. var. **duncanii** Sherff, Bot. Leafl. 6:2. 1952. HOLOTYPE. U.S.A. GEORGIA. Oglethorpe Co.: shallow soil at edge of thickly vegetated drain at Echols Mill, SE of Point Peter, 4 Aug 1941, *W.H. Duncan 3832*; annotated as "type" by E.E. Sherff, no date.

Couepia dolichopoda Prance, Brittonia 26:302. 1974. ISOTYPE. PERU. DEPT. OF LORETTO: Varadera de Mazon from Rio Amazonas to Rio Napo, primary forest, 21 Aug 1972, *T.B. Croat 19382*; cited in original publication (HOLOTYPE: NY).

Dedeckera eurekensis Rev. & J.T. Howell, Brittonia 28:246–248. 1976. ISOTYPE. U.S.A. CALIFORNIA. Inyo Co.: Last Chance Range in a rock canyon, ca. 3 air mi SE of Eureka Valley sand dunes and 3.5 air mi NW of Marble Valley VABM 7559 in T10S, R40E, 29 Jul 1975, *J.L. Reveal, M.C. DeDecker & P.W. DeDecker 3909*; cited in original publication (HOLOTYPE: US).

Dicerandra frutescens Shinners, Sida 1:89–90. 1962. ISOTYPE. U.S.A. FLORIDA. Highlands Co.: 20 mi S of Sebring along Route 27, 28 Aug 1953, *F.H. Sargent 6600*; cited in original publication, annotated as isotype by R.B. Huck, 1984 (HOLOTYPE: SMU).

Dipsacus sylvestris Hudson f. **albidus** Steyerm., Rhodora 60:175. 1958. ISOTYPE. U.S.A. ILLINOIS. Cook Co.: undeveloped section, Mt. Hope Cemetery, Chicago, 115th Street, 25 Aug 1957, *K.E. Bartel s.n.*; cited in original publication (HOLOTYPE: F).

Enceliopsis nudicaulis (A. Gray) Nelson var. **corrugata** Cronquist, Bull. Torrey Bot. Club 99:246. 1973. ISOTYPE. U.S.A. NEVADA. Nye Co.: about outcrops of pale hard limestone in *Larrea* desert about 15 (airline) mi SE of Lathrop Wells, T17S, R51E, about S20, 20 Apr 1966, *A. Cronquist 10648*; cited in original publication (HOLOTYPE: NY).

Eriogonum aliquantum Rev., Phytologia 34:460–461. 1976. ISOTYPE. U.S.A. NEW MEXICO. Colfax Co.: 0.3 mi W of NM 21, 4.4 mi S of US 64 at Cimmaron on the Philmont Scout Ranch, 14 Jul 1972, *J.L. Reveal 277*; cited in original publication (HOLOTYPE: US).

Eriogonum capistratum Rev., Phytologia 66:254. 1989. ISOTYPE. U.S.A. IDAHO. Custer Co.: Antelope Pass, upper end of Cooper Basin on a ridge SW of the pass, 11 Jul 1975, *J.L. Reveal 3876*; cited in original publication.

Eriogonum lewisii Rev., Great Basin Nat. 45:277. 1985. ISOTYPE. U.S.A. NEVADA. Elko Co.: White Elephant Butte, S of Elk Mountain, S4, T46N, R16E, 30 Jul 1976, *J.L. Reveal 4596*; cited in original publication.

Eriogonum ochrocephalum S. Watson var. **alexanderae** Rev., Great Basin Naturalist 45:276. 1985. ISOTYPE. U.S.A. NEVADA. Lyon Co.: along NV 3 in Wilson Canyon, between Smith and Mason, 12.8 mi NE of Smith, 21 Jun 1978, *J.L. Reveal 4737*; cited in original publication.

Eriogonum ovalifolium Nutt. var. **pansum** Rev., Phytologia 66:259. 1989. ISOTYPE. U.S.A. IDAHO. Boise Co.: along ID 21 ca. 12.5 mi S of Lowman, near West Ford Creek at milepost 59.5, 12 Jul 1975, *J.L. Reveal & B.J. Ertter 3883*; cited in original publication.

Euphorbia gracilior Cronquist, Castanea 14:102–103. 1949. ISOTYPE. U.S.A. GEORGIA. Tattnall Co.: sandhills 3 mi NW of Reidsville, 16 Jun 1948, *A. Cronquist 5334*; cited in original publication, annotated as isotype by M.J. Huft, 1979 (HOLOTYPE: US).

Flaveria linearis Lag. var. **latifolia** J.R. Johnston, Proc. Amer. Acad. Arts 39:289. 1903. SYNTYPE. U.S.A. FLORIDA. Palm Beach Co.: shore of Lake Worth near Palm Beach, 31 Aug 1895, *A.H. Curtiss 5524*; cited as type in original publication, annotated as type by A.M. Powell, no date.

Forestiera pubescens Nutt. var. **glabrifolia** Shinners, Field & Lab. 18:99. 1950. ISOTYPE. U.S.A. TEXAS. Bosque Co.: thin soil over limestone, 12.5 mi NNE of Walnut Springs, 26 May 1949, *L.H. Shinners 11331*; annotated as isotype by C.J. Brooks, 1975.

Galactia minor W. Duncan, Phytologia 37:59–60. 1977. HOLOTYPE. U.S.A. GEORGIA. Long Co.: sandhills adjacent to Altamaha River bottom SW of Ludowici, 2 Aug 1953, *W.H. Duncan 16993*; cited in original publication, annotated as holotype by W.H. Duncan, 1977.

Halesia tetraptera J. Ellis, original publication unknown. ISONEOTYPE. SOUTH CAROLINA. Williamsburg Co.: floodplain on N bank of the Santee River along SC 17, 0.6 mi N of the Berkeley Co. line, about 2.7 mi N of Jamestown, 6 Apr 1975, *J.L. Reveal & M.J. Seldin 3832*; cited by J. Reveal and M. Seldin, 1975, Taxon 25:135.

Helenium floridanum Fernald, Rhodora 45:494. 1943. ISOTYPE. U.S.A. FLORIDA. Hernando Co.: low open woods near Fitzgerald, 14 Jun 1900, *A.H. Curtiss 6663*; cited in original publication, annotated as isotype by W.M. Bierner, 1971 (HOLOTYPE: GH).

Hexastylis shuttleworthii (Britton & Baker) Small var. **harperi** Gaddy, Sida 12:54. 1987. ISOTYPE. U.S.A. GEORGIA. Madison Co.: acid bog just N of GA 106, 14.2 mi NE of Athens, 9 May 1986, *L.L. Gaddy s.n.*; cited in original publication (HOLOTYPE: CLEMS).

Hoita hirsuta Rusby, Mem. New York Bot. Gard. 7: 261. 1927 ISOTYPE. BOLIVIA: Pongo, 12 Jul 1921, *O.E. White 154*; annotated as isotype by J. Grimes, 1990.

Hymenoxys turneri K.F. Parker, Phytologia 20:192. 1970. ISOTYPE. U.S.A. TEXAS. Karnes Co.: limestone soil along roadside 2 mi N of Karnes City, 21 Apr 1965, *B.L. Turner 5154*; cited in original publication (HOLOTYPE: US).

Hypericum adpressum Barton var. **spongiosum** B. Robinson, Rhodora 4:136. 1902. ISOTYPE. U.S.A. MASSACHUSETTS. Barnstable Co.: sandy margin of Flax Pond, Bourne, 15 Sep 1901, *G.G. Kennedy, E.F. Williams & M.L. Fernald 234*; cited in original publication (HOLOTYPE: GH).

Hypericum canadense L. var. **galiiforme** Fernald, Rhodora 49:154–155. 1947. ISOTYPE. U.S.A. VIRGINIA. Sussex Co.: sandy and peaty shore of Airfield Millpond, SW of Wakefield, 11 & 12 Sep 1945, *M.L. Fernald & B. Long 14962*; cited in original publication (HOLOTYPE: GH).

Hypericum exile P. Adams, Contr. Gray Herb. 189:33. 1962. ISOTYPE. U.S.A. FLORIDA. Gulf Co.: 2.5 mi SE of Port St. Joe, sandy dry soil of pine flatwoods, 20 May 1960, *P. Adams 456*; cited in original publication (HOLOTYPE: GH).

Hypericum lissophloeus P. Adams, Contr. Gray Herb. 189:21. 1962. ISOTYPE. U.S.A. FLORIDA. Bay Co.: shores of Merial Lake, 10 mi N of Panama City, 14 Jun 1960, *R.K. Godfrey & J.N. Triplett 59844*; cited in original publication (HOLOTYPE: GH).

Hypericum mutilum L. var. **latisepalum** Fernald, Rhodora 38:372. 1936. ISOTYPE.

U.S.A. FLORIDA. Duvall Co.: low grounds, Jun-Aug no year, *A.H. Curtiss 264**, cited in original publication (HOLOTYPE: GH).

Ilex decidua Walter var. **curtissii** Fernald, Bot. Gaz. 33:155. 1902. ISOTYPE. U.S.A. FLORIDA. Suwannee Co.: woods along the Suwannee River near Branford, 24 Oct 1900, *A.H. Curtiss 6736*; annotated as isotype by R.C. Clark, 1983.

Ilex glabra (L.) A. Gray f. **leucocarpa** F.W. Woods, Rhodora 58:25–26. 1956. ISOTYPE. U.S.A. FLORIDA. Jackson Co.: open woodland 4 mi S of Marianna, 20 Jan 1955, *F.W. Woods C.E.F.-2*; cited in original publication, annotated as isotype by R.C. Clark, 1983 (HOLOTYPE: US).

Justicia cooleyi E.C. Leonard & J. Monachino, Rhodora 61:184. 1959. ISOTYPE. U.S.A. FLORIDA. Hernando Co.: Indian Hill, 2 mi NW of Chinsegut Hill, 20 Nov 1957, *G.R. Cooley 5481*; cited in original publication (HOLOTYPE: NY).

Lesquerella perforata Rollins. Rhodora 54:190. 1952. ISOTYPE. U.S.A. TENNESSEE. Wilson Co.: open field 5 mi N of Lebanon, 30 Mar 1952, *R.C. Rollins & D. Rollins 5207*; cited in original publication (HOLOTYPE: GH).

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Zornia bracteata (Walter) J.F. Gmel., Syst. Nat.:1096. 1791. ISONEOTYPE. U.S.A. GEORGIA. McDuffie Co.: open pine hickory woods 5 mi E, 43° south of Thomson, 29 Jul 1950, *W.H. Duncan 11557*; cited as isoneotype by R.H. Mohlenbrock, 1961, Webbia 16:29–30 (NEOTYPE: US).

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BOOK REVIEW

TAYLOR, WALTER KINGLSEY. 1992. **The Guide to Florida Wildflowers.** (ISBN 0-87833-747-4, hbk) Taylor Publishing Company, 1550 West Mockingbird Lane, Dallas, TX 75235. $24.95. 320 pp.

Are you headed to Florida this year and would like to identify some of the roadside flowers you meet? If so, you should consider obtaining this handbook before embarking. This handy book is designed be a pictorial guide to many of the commonly occurring wildflowers, especially of central and northern Florida. Taylor's prowess as a photographer and enthusiastic field botanist comes through clearly, as the user will find a usually high quality color photograph of each species discussed. The photos are further supported by thumbnail descriptions, flowering times and geographic occurrences within the state. Conspicuous fruits are shown as photo insets for a number of the species, as well. However, close-ups of some with small, diffusely arranged flowers would have been a welcomed addition.

One's first impression, based on the crisp layout and handsome photos, is that this book is a user-friendly guide; frustration lies ahead. Species are arranged first by color (color tabs at the top of each page), and secondly by an outdated sequence of relationships. Thus, one is guided to the species by looking through all the photographs of a particular color group. This task is complicated by the blurred definition of color groups. That is, should a particular species be searched for in the pink or the violet group, the white or green group, or the white or yellow group? The author's choice is not always obvious because the violet group contains both blue flowers and rose-pink ones. Furthermore, in the yellow group a number of species with light yellow petals are illustrated with washed-out pictures showing white petals.

Florida always presents a problem to designers of plant identification manuals. In the frost-free tip of the state, there is a myriad of diverse tropical elements that occur only there or that have invaded from more tropical areas, with or without human assistance. National guides usually ignore all of the tropical species, while state guides struggle with which to include. For this reason, visitors traveling to South Florida will be frustrated further by this guide. One glaring omission is that of lantana, a prominently colorful flower of roadsides in not only South Florida but the citrus area of central Florida, as well. The author might be excused based on his statement, "...excluded for the most part the woody plants, except for some trees, shrubs, and vines that are rather common and produce attractive flowers." However, lantanas are not obviously woody to the casual observer; and furthermore, he did include the more northern and less showy scrub plum, red chokeberry, gopher apple, greenbriers, Itea and others. Other plants that are conspicuously absent: *Abrus, Allamanda, Caesalpinia bonduc, Carica, Echites, Epidendrum, Ernodia, Guzmannina, Hamelia, Neptunia, Oncidium, Ricinus, Thalia, Tillandsia, Urechites,* and *Waltheria.*

Although this book has several problems, it is certainly no worse than other similar guides for Florida. It is well worth the money, if you do not already own one of the other guides and you do not expect to be guided through tropical Florida.—*Roger W. Sanders, Botanical Research Institute of Texas.*

CAREX LUTEA (CYPERACEAE), A RARE NEW COASTAL PLAIN ENDEMIC FROM NORTH CAROLINA

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ABSTRACT

Carex lutea (section *Ceratocystis*) is described from the outer coastal plain of southern North Carolina. It is the only species of this section to occur south of New Jersey along the Atlantic Coast, and appears to be a localized endemic of wet savannas underlain by limestone deposits. From all other species of this section, *C. lutea* is distinguished by its pale scales, tall ((40)65 110(125) cm), slender culms, and elongate inflorescences (4.5)5.4–25(41) cm long with usually only one or two widely separated pistillate spikes below the ± long peduncled ((0.3)1–6(10.2) mm) staminate spike.

RESUMEN

Carex lutea se distinque de todas las demás especies de esta sección por sus escamas pálidas, altura ((40-)65–110(-125) cm), tallos delgados, inflorescencias alargadas de (4.5-)5.4–25(-41) cm que usualmente llevan debajo de las espigas estaminadas ± largamente pedunculadas ((0.3-)1–6(-10.2) mm) una o dos espigas pistiladas ampliamente separadas.

INTRODUCTION

Field surveys in 1991 by R.J. LeBlond of a rare, wet savanna habitat underlain by coquina limestone deposits on the outer coastal plain in Pender

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County, North Carolina disclosed an unfamiliar *Carex* with clear affinity to the well-defined boreal section *Ceratocystis*, and more specifically with the *C. flava* L. complex as defined by Crins & Ball (1988, 1989a, 1989b). Subsequent searches for the plant by LeBlond and A.S. Weakley disclosed four additional populations in Onslow and Pender counties. However, the populations were all clustered within a radius of about 4 km. Furthermore, only the original population was large; all the others consisted of fewer than 60 clumps each.

Diagnostic characters of the *Carex flava* complex include globose to ovoid, more or less approximate, short-peduncled to sessile pistillate spikes with the perigynia spreading (the lowermost often reflexed) (Crins & Ball 1989b). Three species of the complex, *C. cryptolepis* Mack., *C. flava*, and *C. viridula* Michx. subsp. *viridula*, are known from the northern coastal plain, but none has been found south of northern New Jersey (Crins & Ball 1989b). Two additional subspecies of *C. viridula*, *C. viridula* subsp. *oedocarpa* (Andersson) B. Schmid and subsp. *brachyrrhyncha* (Celak.) B. Schmid, are known from boreal habitats farther north along the Atlantic coast in the Gulf of St. Lawrence region and in Eurasia. Several other, distinct species are found elsewhere in the old world and in the temperate parts of the southern hemisphere, but the relationships of the North Carolina plants are clearly with the North American members of the *C. flava* complex.

Close examination of the North Carolina plant discloses a number of significant points of difference from the other species of the *Carex flava* complex in North America. The pistillate scales of the North Carolina plant are pale yellowish-green, immediately separating it from *C. flava* and most subspecies of *C. viridula*, the scales of which are coppery or tinged with red or brown. The larger (up to 5.2 (5.8) mm long), reflexed lower perigynia separate it from those subspecies of *C. viridula* that may have paler scales. The North Carolina plants can be separated from the pale-scaled *C. cryptolepis* by its usually sparsely serrulate perigynium beaks, as well as its taller stature and longer inflorescences.

Several features unique to the North Carolina plant separate it from all other species in the *C. flava* complex both in North America and world-wide. The North Carolina plant is taller than any other members of the section, with taller mature flowering individuals typically over 65 cm tall and reaching heights of up to 1.25 m. Even though the plants are tall, the number of pistillate spikes is normally only one or two, extremely rarely three. As well, the inflorescences of the North Carolina plants (particularly those of culms that produce two pistillate spikes) are much longer than any other species, the longest ranging from 18–41 cm. All other members of the *C. flava* complex are much shorter, rarely reaching heights of over 65 cm, and routinely producing 2–3 pistillate spikes in shorter inflorescences 1.5–12(20) cm long.

Based on its unique morphology, this rare and highly localized North Carolina plant is here described as a new species.

Carex lutea LeBlond, sp. nov. (section *Ceratocystis*). (Fig. 1)

Plantae cespitosae; culmi (40)65–110(125) cm alti; vaginae basales pallide brunneae, glabrae. Folia 3–7, plerumque basalia; laminae 5.5–28 cm longae, 1.8–3.8 mm latae; vaginae 2.5–11 cm longae; ligulae obtusae 1.4–3.6 mm longae. Inflorescentia (4.5)5.4–25(41) cm longae; spicae 2–3(4), ascendentes, spica terminalis staminata, ceterae pistillatae; bracteae infimae laminis 5–25 cm longis, 1.2–2.5 mm latis et vaginis (0)0.2–4 cm longis. Squamae pistillatae pallide flavovirentes. Perigynia (3.5)3.9–5.2(5.8) mm longa, 1.4–2.2 mm lata, patentia, extrorsus curvata, plus minusve trigona, lutea, glabra, in rostrum contracta; rostra 1.4–2.2 mm longa. Achenium 1.4–1.9 mm longum, 1.2–1.5 mm latum. Styli marcesentes; stigmata 3. Antherae 3, 2.1–3.6 mm longae.

Plants cespitose in small to large (up to ca. 45 fertile culms) clumps, with short ascending rhizomes; roots pale brown, not densely felted with root hairs; fertile culms (40)65–110(125) cm tall, 0.6–0.9 mm wide at base of lowermost spike, central, more or less trigonous, smooth except at apex where often slightly scabrous-angled, with glabrous, stramineous to pale brown bladeless basal sheaths. Leaves 3–7, mostly basal; blades 5.5–28 cm long, much shorter than culms, 1.8–3.8 mm wide, plicate, yellowish-green, glabrous, the margins antrorsely scabrous, the widest leaves 2.4–3.8 mm wide; leaf sheaths 2.5–11 mm long, more or less tightly enveloping culms, glabrous, green; inner band of sheath glabrous, whitish-hyaline, the apex thin and friable, irregularly concave, more or less truncate, or occasionally slightly prolonged; ligules obtuse, 1.4–3.6 mm long, the free portion more or less entire, whitish-hyaline, to 0.7 mm long. Vegetative shoots 40–65(90) cm tall; leaves 5–11, similar to those of fertile culms but up to 65(90) cm long and 4.6 mm wide, more or less evergreen (at least the proximal portions of the blades); pseudoculms ca. 5–13 cm tall. Inflorescences (4.5)5.4–25(41) cm long, with all spikes quite separate, the lowest 2 pistillate spikes (if present) (1.6)4.5–18(33) cm distant; spikes single at nodes, ascending; lowermost spikes with peduncles 0.4–4.5(16.5) cm long, the uppermost pistillate spike sessile; peduncles smooth and terete proximally, more or less trigonous and serrulate-angled distally; lowermost bracts usually reflexed (except when subtending long-peduncled spikes), with blades 5–25 cm long and 1.2–2.5 mm wide and sheaths (0)0.2–4 cm long, 0.5–1.3(1.9) times as long as the inflorescence, the uppermost bracts also reflexed, but much reduced. Spikes 2–3(4), the terminal staminate (very rarely with an additional small, accessory staminate spike at base), the lateral pistillate (very rarely with a small staminate apex up to 8 mm long). Terminal spikes (9)17–39 mm long, 1.4–2.5 mm wide, ca. 45–90-flowered, peduncles (0.3)1–6(10.2) cm long, (0.1)0.7–2.5(5.1) times as long as the spikes. Lateral spikes 0.7–2.7 cm long, 8–11 mm wide, globose to ellipsoid or short-cylindric,

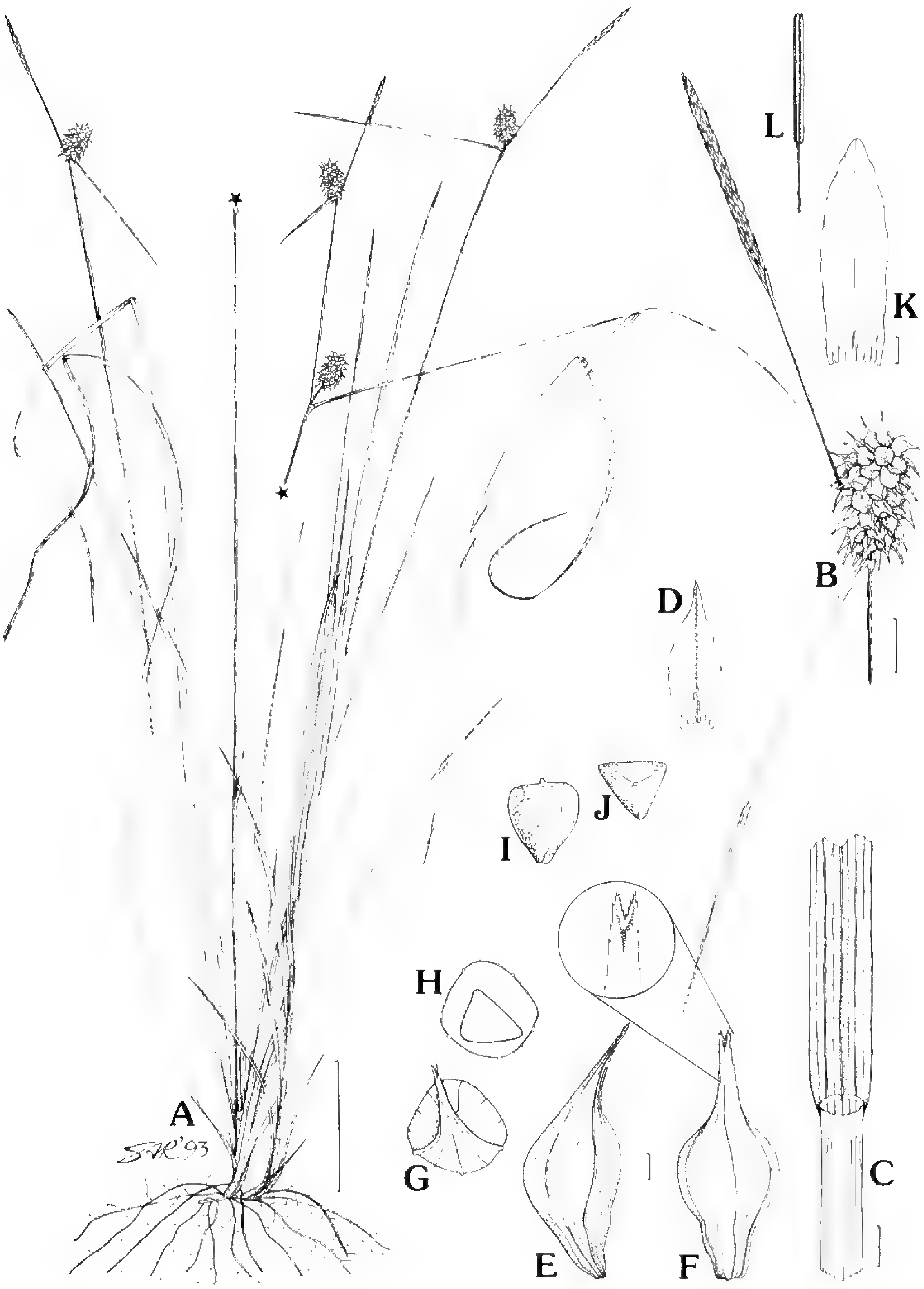

FIG. 1. *Carex lutea*, A. Habit. B. Portion of inflorescence. C. Sheath and ligule. D. Pistillate scale. E. Perigynium, side view. F. Perigynium, front view. G. Perigynium, top view. H. Perigynium and achene, transverse section. I. Achene, front view. J. Achene, top view. K. Staminate scale. L. Anther. Bar equals 5 cm in A, 5 mm in B, 2 mm in C, and 0.5 mm in D–L. Drawn by Susan A. Reznicek from the holotype.

densely 15–60-flowered. Pistillate scales 2.1–3.3 mm long, 0.9–1.3 mm wide, lanceolate to narrowly ovate, obtuse to more or less acuminate, glabrous, pale yellowish-green with a green center and wide hyaline (sometimes stramineous-tinged) margins and apex, 1-nerved, almost totally concealed by the crowded perigynia. Staminate scales 2.9–5.6 mm long, 1.2–1.9 mm wide, narrowly obovate to narrowly oblong, obtuse to acute, glabrous, stramineous to pale brown with a green center and wide hyaline margins and apex, 1(3)-nerved. Perigynia (3.5)3.9–5.2(5.8) mm long, 1.4–2.2 mm wide, spreading, strongly outcurved and squarrose in the spikes, the lowermost strongly reflexed, somewhat inflated, irregularly and asymmetrically trigonous with convex, obovate sides, glabrous, bright yellow proximally, pale yellowish-green distally, short-stipitate and tapered to the base, 7–13-nerved with two nerves much more prominent than the rest, contracted into a strongly deflexed beak; beaks 1.4–2.2 mm long, finely and sparsely serrulate or sometimes smooth, green, the apex bidentulate with teeth 0.2–0.5 mm long. Achenes 1.4–1.9 mm long, 1.2–1.5 mm wide, trigonous with flat to slightly concave, strongly obovate sides, essentially truncate apically, brown, sessile. Styles withering; stigmas 3. Anthers 3, 2.1–3.6 mm long.

TYPE: UNITED STATES. NORTH CAROLINA. Pender Co.: SW of N.C. Hwy 50, ca. 1.8 mi W of Onslow Co. line, ca. 11 mi NNW of Holly Ridge. S of secondary Rd 1532, 0.85 mi SW of N.C. Hwy 50, "Lanier Quarry Savanna," 20 May 1993, *A.A. Reznicek 8942 with S.A. Reznicek, R.J. LeBlond & B.A. Sorrie* (HOLOTYPE: MICH; ISOTYPES: BRIT/SMU, FLAS, GA, NCU, TAES, US, VDB, herb. C.T. Bryson).

Additional specimens examined: NORTH CAROLINA. **Onslow Co.:** NE side N.C. Hwy 50, ca. 10.4 mi NNW of Holly Ridge, "Powerline Savanna," 20 May 1992, *A.A. Reznicek 8954 with S.A. Reznicek, R.J. LeBlond, & B.A. Sorrie* (MICH, VPI). **Pender Co.:** Lanier Quarry Savanna, S of secondary road 1532 0.85 mi SW of Hwy NC 50, 11 Apr 1990, *R.J. LeBlond 1188* (NCU); 24 Apr 1991, *R.J. LeBlond 1985* (NCU); 22 May 1991, *R.J. LeBlond 2056* (MICH, NCU); 27 Jun 1991, *R.J. LeBlond 2267* (NCU); 20 Apr 1992, *R.J. LeBlond 2723* (NCU); Sandy Run Savanna along Hunt Club Rd 0.5 mi S of Hwy NC 50, 12 May 1992, *A.S. Weakley & R.J. LeBlond s.n.* (NCU); Watkins Savanna, 0.1 mi N of Hwy N.C. 50 ca. 0.5 mi W of the Onslow Co. line, 12 May 1992, *A.S. Weakley & R.J. LeBlond s.n.* (NCU); N side N.C. Hwy 50, ca. 1 mi W of Onslow Co. line, ca. 11.5 mi NNW of Holly Ridge, "Watkins Savanna," 20 May 1992, *A.A. Reznicek 8949 with S.A. Reznicek, R.J. LeBlond & B.A. Sorrie* (MICH, USCH).

DISCUSSION

In the key to the *Carex flava* complex in Crins & Ball (1989b), *C. lutea* keys closest to *C. cryptolepis* because of its pale, yellowish-green scales, narrow leaves, and perigynia of similar size. The overall yellowish-green color of *C. lutea* is also similar to that of *C. cryptolepis*. Insertion of the following couplet in place of the first lead of couplet 3, however, will complete the key, and allow easy separation of *C. lutea* from *C. cryptolepis.*

1. Tallest culms 65–125 cm; lowermost pistillate spike bracts 0.5–1.3(1.9) times as long as the inflorescence; staminate spike peduncles mostly 0.7–2.5 times as long as the staminate spikes; achenes 1.2–1.5 mm wide; perigynium beaks often sparsely serrulate .... *C. lutea*
1. Tallest culms 25–50 cm; lowermost pistillate spike bracts about 1.5–4 times as long as the inflorescence; staminate spike peduncles 0.2–0.5 times as long as the staminate spikes; achenes 1–1.2 mm wide; perigynium beaks smooth .... *C. cryptolepis*

Although *Carex lutea* keys with *C. cryptolepis* due to its pale scales, its elongate inflorescence is most similar in aspect to that of *C. viridula* subsp. *brachyrrhyncha* var. *elatior* (Schltdl.) Crins (*C. lepidocarpa* Tausch), a boreal and subarctic taxon of highly calcareous, open wetlands in the Gulf of St. Lawrence region and Europe. *Carex lutea* differs most obviously from *C. viridula* subsp. *brachyrrhyncha* var. *elatior* in plant size, inflorescence size, and paler scales. The two taxa can be separated by the following couplet.

1. Pistillate scales pale yellowish-green, nearly the same color as the perigynia and thus inconspicuous; tallest culms 65–110(125) cm; longest inflorescences 18–41 cm .... *C. lutea*
1. Pistillate scales with brown coloration, conspicuous among the greenish to yellowish perigynia; tallest culms (10)20–60(85) cm; longest inflorescences 2–12(18) cm long .... *C. viridula* subsp. *brachyrrhyncha* var. *elatior*

In addition to the scale color and size differences, *Carex lutea* differs from *C. viridula* subsp. *brachyrrhyncha* var. *elatior* in inflorescence proportions. In *C. lutea*, the bracts of the lowest pistillate spikes are shorter than or equalling the inflorescence and most staminate spikes are shorter than their peduncles. In *C. viridula* subsp. *brachyrrhyncha* var. *elatior*, the bracts of the lowest pistillate spikes often equal or exceed the inflorescence and most staminate spikes are longer than their peduncles. Because of the great variability in these proportions due to differences in the number of pistillate spikes in the inflorescence and the considerable plasticity of inflorescences depending on the vigor of the plants, there is modest overlap in these proportions, rendering them unsuitable as key characters. *Carex lutea* also has proportionately narrower leaves than *C. viridula* subsp. *brachyrrhyncha* var. *elatior.* Although a significantly shorter plant than *C. lutea*, the widest leaves of *C. viridula* subsp. *brachyrrhyncha* var. *elatior* range up to 5.6 mm whereas those of *C. lutea* are at most 4.6 mm wide. Other differences include the larger staminate spikes of *C. lutea*, which are up to 39 mm long, much larger than the maximum of 25 mm in *C. viridula* subsp. *brachyrrhyncha* var. *elatior*; and larger perigynia up to 5.2(5.8) mm long in *C. lutea* whereas those of *C. viridula* subsp. *brachyrrhyncha* var. *elatior* are only up to 4.2 mm long.

It is tempting to suggest that the character of pale scales, which uniquely defines the two North American endemics, *C. cryptolepis* and *C. lutea*, indicates a close relationship. However, until genetic, breeding system, and micromorphological evidence comparable to that available for the other taxa is known for *C. lutea*, statements of putative relationship are speculative. Nevertheless, when a character compatibility analysis was run with *C. lutea* added to the data matrix of Crins (1990), *C. lutea* consistently clustered with *C. cryptolepis* (unpublished data). Although genetic and micromorphological data are not yet available for *C. lutea*, it can be recognized readily and warrants description.

The ecology of *C. lutea* is quite distinctive within the section; not surprisingly, since its occurrence is so far removed from all the other species. All the sites occur in sandy soils overlying coquina limestone deposits, and the species shows a preference for the ecotone between the longleaf pine savanna and nonriverine swamp forest communities. Soil from a Lanier Quarry microsite for *C. lutea* had a pH of 5.6. This is similar to pH levels recorded at *Thalictrum cooleyi* H.E. Ahles microsites at the Lanier Quarry Savanna. *Thalictrum cooleyi* is the most frequent associate of *C. lutea*, and is similarly restricted in distribution. Soils not supporting *T. cooleyi* at the Lanier Quarry site regularly test at lower pH levels.

Most *Carex lutea* plants occur in the partially to moderately densely tree shaded savanna-swamp ecotone, with scattered shrubs and a moderate to dense herb layer. The savanna-swamp ecotone is subject to occasional to frequent fires which favor a herbaceous ground layer and suppress shrub dominance. *Carex lutea* is a subdominant to patch dominant at two of the five known sites. Occurrences are densest in areas of partial to moderate tree shading with an absence of a shrub understory. Frequent associates include *Taxodium ascendens* Brongn., *Liriodendron tulipifera* L., *Acer rubrum* L., *Myrica cerifera* L. var. *cerifera*, *Thalictrum cooleyi*, *Aletris farinosa* L., *Carex lonchocarpa* Willd., *Osmunda regalis* L. var. *spectabilis* (Willd.) A. Gray, *Physostegia purpurea* (Walter) S.F. Blake, and *Parnassia caroliniana* Michx.

Though the height of *Carex lutea* suggests that it might be easily found, the plants are slender, occur in areas with substantial graminoid cover, and, except for one site, are rare and localized. Thus, a colony may remain quite inconspicuous, even in fruit. This suggests the possibility that additional colonies may be discovered elsewhere in similar sites on the southeastern coastal plain, though the association with narrowly endemic species in an unusual habitat suggests that *C. lutea* may be a highly localized species.

The occurrence of a localized disjunct species of the boreal *Carex flava* complex on the outer coastal plain of North Carolina is quite striking. This constitutes a disjunction of about 750 km from the nearest known populations of other members of sect. *Ceratocystis*. In Eurasia, species of this complex occur as far south as Spain, Morocco, Turkey, and Iran. The most substantial range separation among close relatives in Europe is that between *C.*

viridula subsp. *brachyrrhyncha* vars. *elatior* and *nevadensis* (Boiss. & Reut.) Crins from southeastern France to southern Spain (ca. 800 km).

The type locality of *Carex lutea*, Lanier Quarry Savanna, and the other locations where it has been found are ecologically highly unusual and phytogeographically notable. The combination of fairly open conditions underlain by a calcareous substrate is very rare on the Atlantic coastal plain. Over 26 species regarded as rare in North Carolina by the state Natural Heritage Program are found at the Lanier Quarry site. Nine of these are listed as endangered, threatened or candidate species by the U.S. Fish and Wildlife service. Many of these rare plants have very restricted distributions, either being endemic to small areas or with highly scattered occurrences. The affinities of these taxa are variable, but include connections to the calcareous savannas of the Gulf Coast states, alkaline marshes of the Atlantic tidewater, calcareous glades, barrens, and prairies of the Appalachian region, and pinelands of the Carolinas and southern New Jersey. Most notable are the two endemic species closely associated with *Carex lutea*, *Thalictrum cooleyi* and an undescribed species of *Allium*. *Thalictrum cooleyi* is endemic to about a dozen sites, all savanna margins in sites underlain by calcareous deposits, in North Carolina, Georgia, and Florida. It has the highest ploidy level known in the genus (30× at $2n = 210$), suggesting its derivation from a more widespread northern and inland species such as *T. revolutum* (Park 1992). The undescribed *Allium* is related to the widespread inland species *A. cernuum* Roth and *A. stellatum* Ker and is known from only 5 sites, four of them shared with *C. lutea*.

Because of their unusual edaphic conditions, these savannas underlain by calcareous deposits have evidently served as a small archipelago of phytogeographic islands for species poorly adapted to present conditions on the southeastern coastal plain. It seems likely that *Carex lutea* is a narrowly distributed, very rare endemic. It may reflect a southern extension of the *C. flava* complex during the Pleistocene glaciation, followed by isolation in a few suitable sites and speciation. Alternatively, *C. lutea* could represent the relictual occurrence of a formerly more widespread and older species in the *C. flava* complex.

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ANNOUNCEMENT

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SPOROBOLUS POTOSIENSIS (POACEAE: ERAGROSTEAE): A NEW RHIZOMATOUS SPECIES FROM SAN LUIS POTOSÍ, MÉXICO, AND A NEW COMBINATION IN *S. AIROIDES*

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ABSTRACT

Sporobolus potosiensis is a new rhizomatous species from San Luis Potosí, México that differs from its closest putative relative, *S. airoides*, by 1.) having conspicuous and slender rhizomes, 2.) lacking trichomes behind the ligule, and 3.) generally smaller in stature. A new combination is proposed at the subspecific rank: *S. airoides* subsp. *regis*. A key to the rhizomatous species of Mexican *Sporobolus*, as well as *S. nealleyi* and *S. airoides*, is provided.

RESUMEN

Sporolobus potosiensis es una nueva especie rizomatosa de San Luis Potosí, México, que difiere de su pariente putativo más próximo *S. airoides* por 1.) tener rizomas conspicuos y más delgados, 2.) ausencia de tricomas detrás de la lígula, y 3.) tamaño más pequeño generalmente. Se propone una nueva combinación de rango subespecífico: *S. airoides* subsp. *regis*. Se ofrece una clave para las especies rizomatosas mexicanas de *Sorolobus*, así como para *S. nealleyi* y *S. airoides*.

Sporobolus is a genus of approximately 160 species, distributed throughout the tropics, subtropics and temperate areas (Clayton and Renoize 1986). The species of *Sporobolus* intergrade to such an extent that their limits are seldom sharply defined (Clayton and Renvoize 1986). There are approximately 60 species of *Sporobolus* known to occur in the New World (Judziewicz and Peterson 1989) and 28 species are reported from México (Beetle 1987), only two species of which have been reported as rhizomatous: *S. virginicus* (L.) Kunth and *S. regis* I.M. Johnston. *Sporobolus virginicus,* a strongly rhizomatous perennial, is found on sandy beaches and at the bases of sand dunes from Virginia to Texas, south to Brazil and Peru, the West Indies, and the tropics of the Old World (Reeder 1975; Pohl 1980).

Sporobolus regis is only known from Coahuila, México (Beetle 1987). Johnston (1943) stated that his new species, *S. regis*, was probably most closely related to *S. airoides* (Torr.) Torr. and *S. wrightii* Munro *ex* Lamson-Scribner and differed from these species in having pubescent leaf sheaths, tufts of trichomes in the axils of the panicle branches, and very coarse rhizomes. Johnston (1943) also mentioned that "the bases of the culms and the younger nodes of the rhizomes bear shredded remnants of old leaves." The presence of shredded remnants of old leaves on the rhizomes needed further investigation, since grass rhizomes usually produce modified leaves termed "scale leaves" (Gould and Shaw 1983). Examination of the holotype [*Stewart 2653* (GH, acronyms according to Holmgren et al. 1990)], revealed that *S. regis* is not rhizomatous and that the "rhizomes" are the portion of the culms covered by soil, with their sheaths decomposed and their nodes developing adventitious roots, thus resembling rhizomes. All of the tillers, or shoots, of the type specimen are erect and lack lateral (horizontal) shoots. Because of the obvious remnants of the culm sheaths, and the lack of "scale leaves" on the culms, there is little doubt that the "rhizomes" of *S. regis* are in fact culms responding to being buried.

Sporobolus regis is distinguished from *S. airoides* by its densely pubescent sheaths and tuft of trichomes in the axils of the panicle branches. In our opinion, these characters are not significant to warrant the recognition of *S. regis* at the specific rank, but are significant to warrant infraspecific recognition. The lack of rhizomes places this taxon in *S. airoides*. However, these unique and distinct characters coupled with its restricted distribution (SW Coahuila) justify the recognition of this taxon at the subspecific rank, thus necessitating the following new combination.

Sporobolus airoides (Torr.) Torr. subsp. **regis** (I.M. Johnst.) Wipff & S.D. Jones, comb. et stat. nov. BASIONYM: *Sporobolus regis* I.M Johnst., J. Arnold Arbor. 24: 393–394 (1943). TYPE: MÉXICO. COAHUILA: salt flat 4 km SE of Laguna del Rey, abundant, 18 Sep 1942, *Stewart 2653* (HOLOTYPE: GH!).

Sporobolus potosiensis Wipff & S.D. Jones is the second rhizomatous species known to occur in México. This new species was originally identified at TAES from specimens that were either unidentified or misidentified as *S. nealleyi* Vasey. Specimens were requested from MEXU, MICH, MO, TEX and US to determine whether additional collections could be found.

Sporobolus nealleyi is a cespitose, non-rhizomatous, gypsophilous species of the southwestern United States and northern México. Chase (1951) and Correll and Johnston (1970) reported *S. nealleyi* as rhizomatous or subrhizomatous. None of the specimens examined, including the holotype (*Nealley*, US), had rhizomes. However, the densely tufted and persistent bases can be covered by soil and then appear to be shortly rhizomatous or subrhizomatous, as already discussed above. *Sporobolus nealleyi*, in México, is reported from Coahuila, Nuevo León, and San Luis Potosí (Reeder 1975; Beetle 1987). It appears that reports from San Luis Potosí are based on misidentified collections of *S. potosiensis*. Based upon specimens examined, the distribution of *S. nealleyi* in México is probably restricted to northern Coahuila and Nuevo León.

The closest putative relative of *S. potosiensis* is *S. airoides*. Specimens of *S. potosiensis* superficially resemble depauperate individuals of *S. airoides*, but differ from *S. airoides* by 1.) having conspicuous and slender rhizomes, 2.) lacking trichomes behind the ligule, and 3.) being smaller in stature. *Sporobolus airoides* does not have rhizomes and usually has conspicuous trichomes behind the ligule, though some very depauperate specimens were examined that did not have trichomes. *Sporobolus airoides* is usually a robust plant to 150 cm tall, but depauperate specimens may resemble *S. potosiensis* in general appearance, except for the conspicuous rhizomes.

KEY TO THE RHIZOMATOUS SPECIES OF *SPOROBOLUS* IN MÉXICO, AS WELL AS *S. AIROIDES* AND *S. NEALLEYI*

1. Plants without rhizomes 2
1. Plants with rhizomes 4
    2. Inflorescences (5-) 15–25 cm wide; found on dry soils in open ground, prairies and along saline or alkaline flats 3
    2. Inflorescences 1–3.5 cm wide; restricted to gypsiferous soils .... *S. nealleyi* Vasey
        3. Back of sheaths densely pubescent; base of inflorescence primary branches adaxially pubescent .... *S. airoides* subsp. *regis* (I.M. Johnst.) Wipff & S.D. Jones
        3. Back of sheaths glabrous; base of inflorescence primary branches glabrous .... *S. airoides* subsp. *airoides*
            4. Inflorescences 4.0–9 cm wide, 12–18 cm long, open; branches spreading; plants inland, not coastal .... *S. potosiensis* Wipff & Jones
            4. Inflorescences 0.6–1.0 cm wide, 2–8 cm long, contracted; branches appressed; plants coastal .... *S. virginicus* (L.) Kunth

Sporobolus potosiensis Wipff & S.D. Jones, sp. nov. (Figs. 1–4)

Gramen perenne, 18–51 cm altum; rhizomatibus ad 14.5 cm longis, 1.3–3.5 mm latis. Inflorescentia 12–18 cm longa, ad 9 cm lata, diffusa; spiculis 1.6–2.5 mm longis, glabris; antheris 3, 1.2–1.4 mm longis, luteolis.

Plants (Fig. 1) perennial, erect, 18–51 cm tall with slender *rhizomes* (Fig. 2) to 14.5 cm long, 1.3–3.5 mm wide. *Leaves* 4–5, cauline, subcoriaceous; *sheaths* glabrous, margins ciliate; *collar* (Fig. 4) abaxially glabrous, yellowish, margins conspicuously long ciliate with trichomes to 5.5 mm long; *blades* 6.2–24.0 cm long, 0.6–2.5 mm wide, flat, folded or involute; abaxial surface glabrous; adaxial surface minutely papillose, antrorsely scaberulous along raised veins; margins antrorsely scaberulous; *ligules* 0.1–0.3 mm long, ciliolate membrane, truncate, lacking long trichomes behind the ligule. *Inflorescences* an open panicle, 12–18 cm long, 4.0–9.0 cm wide, glabrous; lower branches 3.0–8.0 cm long, nonfloriferous in the proximal 1/3–1/2; pedicels 0.2–2.2 mm long, glabrous; spikelets appressed to tertiary branches. *Spikelets* (Fig. 3) 1.6–2.5 mm long, 0.5–1.1 mm wide, glabrous, mottled purplish, with one floret; *glumes* unequal; *first glumes* 1.0–1.5 mm long,

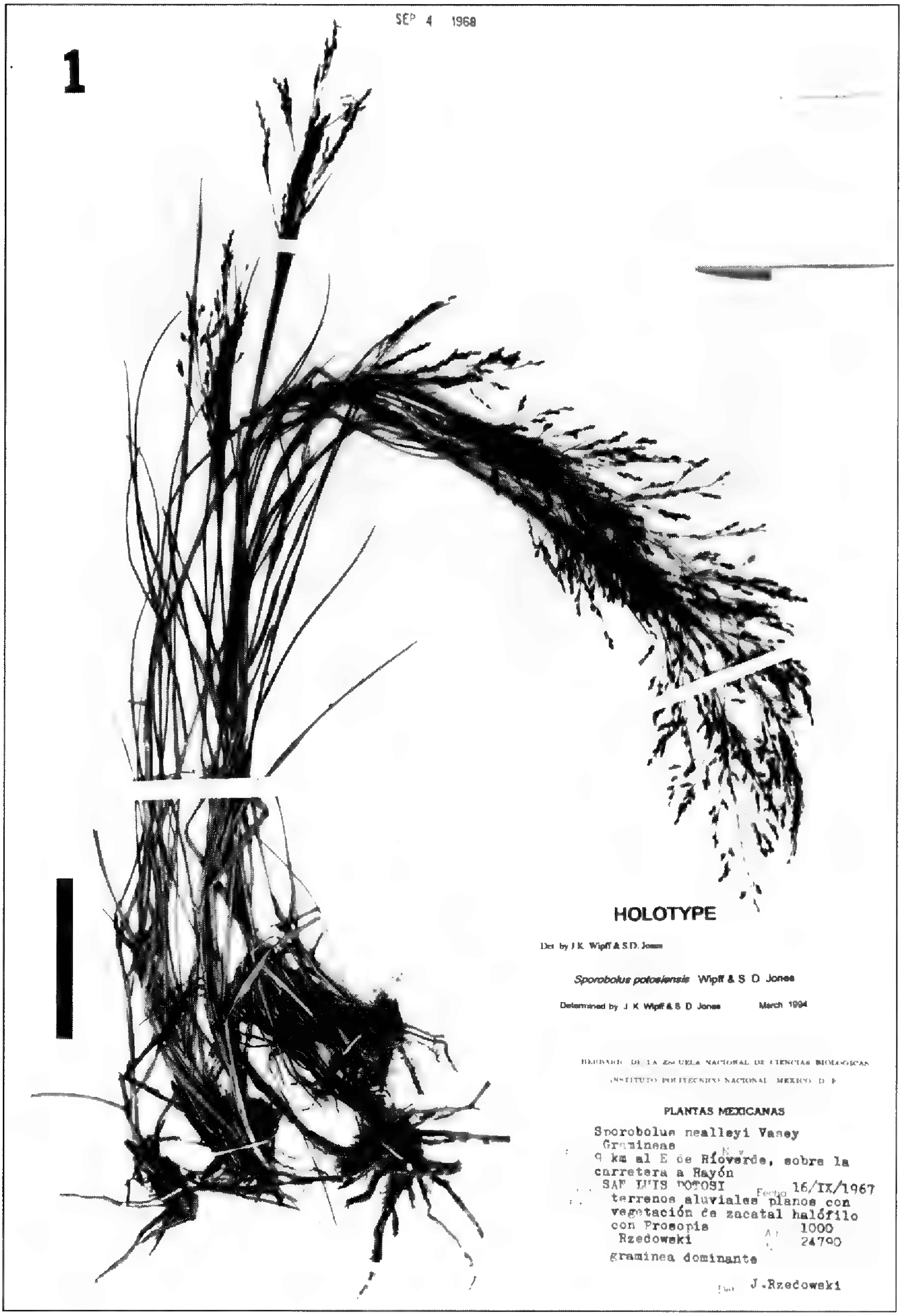


FIG. 1. Photograph of *Sporobolus potosiensis* [*Rzedowski 24790* (MICH)]. Bar = 5 cm.

FIG. 2. Photograph of the rhizomes of *Sporobolus potosiensis* [*Bravo 14* (MEXU)]. Bar = 1 cm.

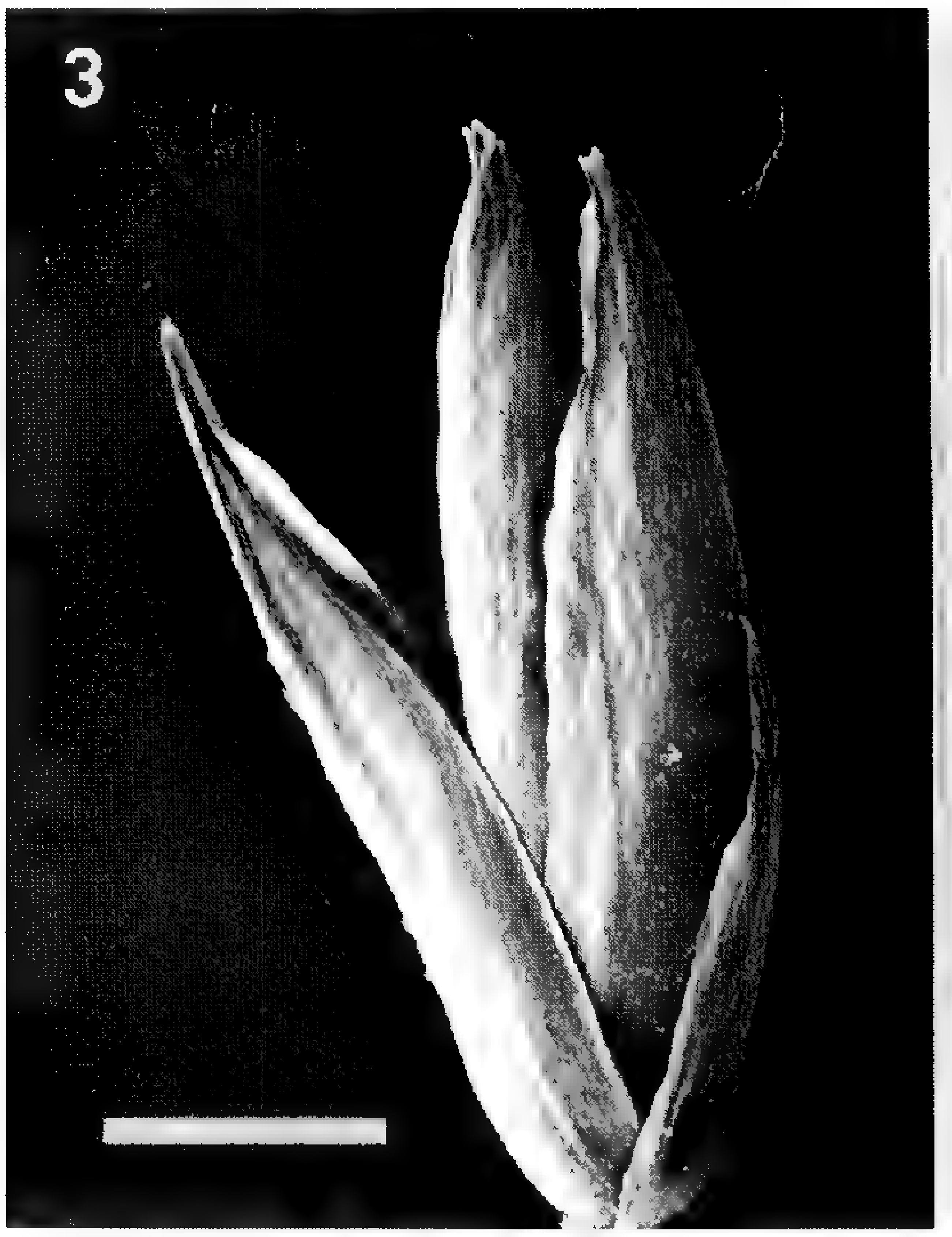
veinless, lanceolate; *second glumes* 1.3–2.1 mm long; conspicuously 1-veined, vein green; lanceolate with white-hyaline margins in the distal half, slightly shorter than lemma; *lemmas* 1.5–2.3 mm long; conspicuously 1-veined, vein green, ovate-lanceolate, mottled purplish with white-hyaline margins in distal half; *paleas* 1.6–2.2 mm long, 2-veined, grooved or furrowed between veins, similar to lemma texture and color; *anthers* 3, 1.2–1.4 mm long, yellowish. *Caryopses* 0.9–1.0 mm long, 0.4–0.5 mm wide. *Chromosome number* unknown.

The specific epithet refers to the State of San Luis Potosí, México; the only area in which this species is currently known to occur.

Distribution: Known only from the Río Verde River Valley, San Luis Potosí, México.

TYPUS: MÉXICO. SAN LUIS POTOSI: 9 km al E de Río Verde, sobre la carretera a Rayón, alt. 1000 m, terrenos aluviales planos con vegetación de zacatal halófilo con *Prosopis*, graminea dominante, 16 Sept 1967, *J. Rzedowski 24790* (HOLOTYPE: MICH!; ISOTYPES: LL!, MICH!, TAES!, WIS).

Additional specimens examined (paratypes): MÉXICO. San Luis Potosi: in the valley of the Rio Verde, between Río Verde and San Ciro, alt. 850–1000 m, 12 Sep 1954, *Sohns 1228* (TAES); in the valley of the Río Verde and in the Sierra de Cuates along the route, Río Verde-San Francisco-Patios-Cardenas-Rayón, 14–15 Sept 1954, *Sohns 1254* (TAES); Mpio. Ciudad del Maiz, 0.7 mi N of Las Tablas (RR crossing in town), alkaline flats dominated by grass and *Juncus*, gypseous soil, scattered mesquite, endemic *Hedyotis*, *Pinaroppapus*, *Chenopodium*, *Samolus*, *Viguiera*, *Flaveria*, alt. 1010 m, 22°17'N, 99°52'W, 14 Sep 1988, *Nesom 6680 & Wells* (ARIZ, TEX); ± 5 km al SW de Tablas, alt. 1000 m, 22 Jan 1959, *Rzedowski 9613*



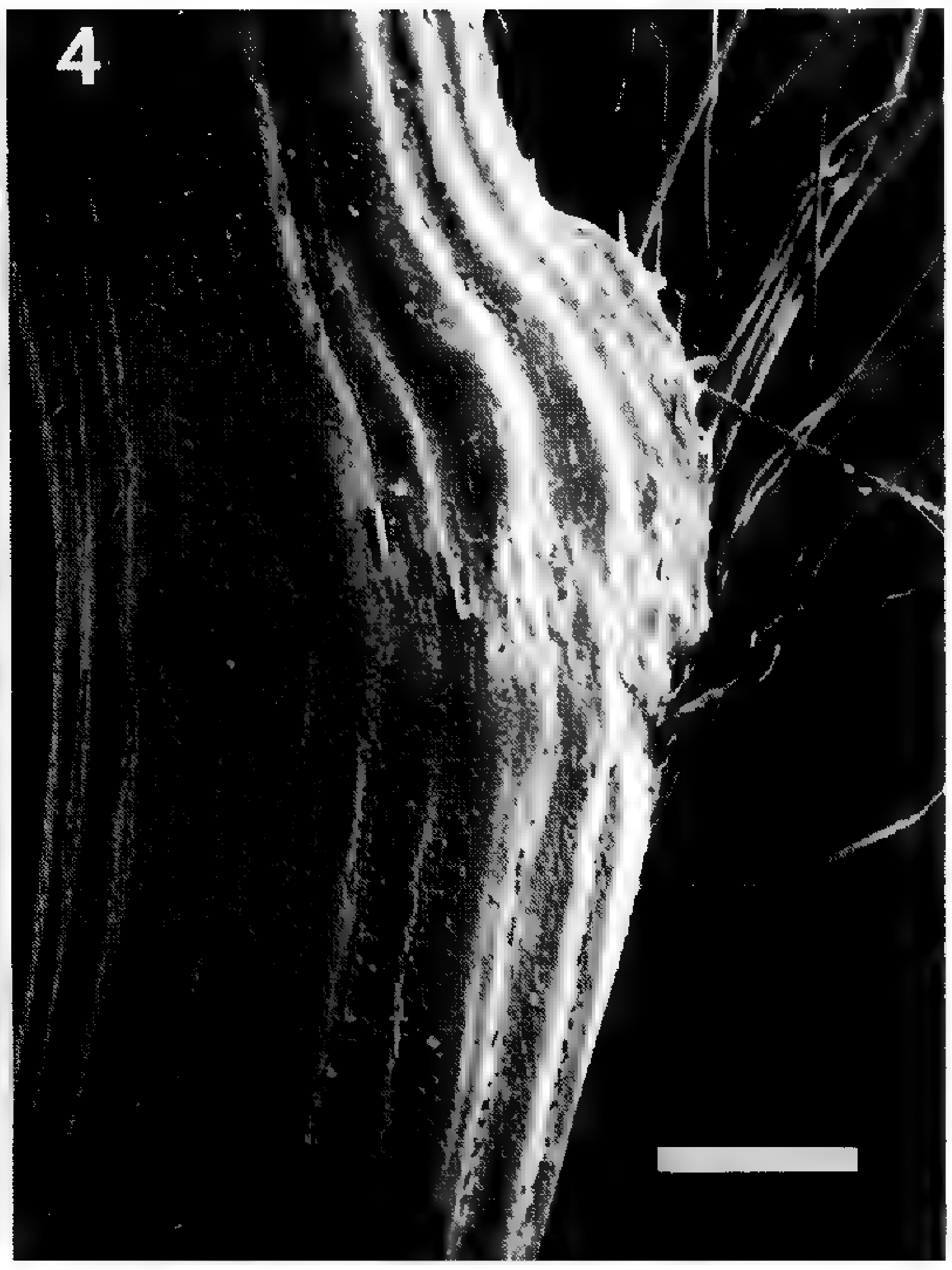


FIG. 3. Scanning electron micrograph of the spikelet of *Sporobolus potosiensis* [*Rzedowski 24790* (TAES)]. Bar = 0.5 mm.

FIG. 4. Scanning electron micrograph of the collar of *Sporobolus potosiensis* [*Rzedowski 24790* (TAES)]. Bar = 0.5 mm.

(MEXU); Región de Llanos de Angostura municipio de Río Verde, alt. 900 m, 29 Jul 1980, *Bravo 14* (MEXU); 0.65 km (0.4 mi) N of the Escuela Primera in Las Tablas, on gravel road running between Hwys 70 and 80, alt. 1097 m (3600 ft), 27 Jul 1979, *Lane 25386 & J. E. Fryxell* (TEX).

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ANNOUNCEMENT

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Our Gopher Server provides electronic access with key word searching to several documents that previously were available only as printed matter. These include the *Checklist of the Plants of the Guianas (Guyana, Surinam, French Guiana) (1992),* the *Biological Conservation Newsletter* (1981-present) and, on behalf of the American Society of Plant Taxonomists, the *ASPT Newsletter* (1987-present).

We hope you will bring this announcement to the attention of your readers. We would also appreciate expressions of support for our efforts to make this information available. A strong and favorable response from the botanical community will enable us to make more databases and documents available in the future.

NOTES ON *CAREX*, *CYPERUS*, AND *KYLLINGA* (CYPERACEAE) IN MISSISSIPPI WITH RECORDS OF EIGHT SPECIES PREVIOUSLY UNREPORTED TO THE STATE

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ABSTRACT

Field and herbaria explorations have yielded the following as new to Mississippi, U.S.A.: *Carex bicknellii* var. *opaca*, *C. fissa* var. *fissa*, *Cyperus drummondii*, *C. elegans*, *C. entrerianus*, *C. eragrostis*, *C. louisianensis*, and *Kyllinga brevifolioides*. Two of these, *C. entrerianus* and *K. brevifolioides*, have the potential to become threats as pernicious agricultural and lawn weeds, respectively, in the southeastern United States. Additional range extensions are presented for *C. aggregatus*, *C. difformis*, *C. flavicomus*, *C. lancastrensis*, *C. ovatus*, and *C. pilosus* in Mississippi. Locality and habitat data are presented for all species reported.

RESUMEN

Exploraciones de campo y de herbario han dado los siguientes taxa como nuevos para Mississippi, U.S.A.: *Carex bicknellii* var. *opaca, C. fissa* var. *fissa, Cyperus drummondii, C. elegans, C. entrerianus, C. eragrostis, C. louisianensis* y *Kyllinga brevifolioides.* Dos de éstos, *C. entrerianus* y *K. brevifoioides,* tienen potencial para llegar a ser una amenaza como malas hierbas para la agricultura y los céspedes, respectivamente, en el sudeste de los Estados unidos. Se presentan ampliaciones de área para *C. aggregatus, C. difformis, C. flavicomus, C. lancastrensis, C. ovatus,* y *C. pilosus* en Mississippi. Se presentan datos de localidad y hábitat de todas las especies citadas.

INTRODUCTION

While continuing to prepare a synoptical treatment of *Carex*, *Cyperus*, and *Kyllinga* as a contribution to the Flora of Mississippi Project, we have examined herbaria specimens and conducted field surveys for species with potential to occur within Mississippi. We have also continued assessment of population size, distribution, and habitat requirements of recently reported species, especially those which have potential to become weedy. This article adds to the knowledge of *Carex*, *Cyperus*, and *Kyllinga* which has been reported in recent years (Bryson 1984a; Bryson & Jones 1990; Bryson et al.

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1991; Bryson & Carter 1992; Bryson et al. 1992; Carter et al. 1987; Morris & Bryson 1986; Naczi & Bryson 1990). As we previously discussed, the flora of Mississippi is still poorly known in comparison with several adjacent states. Lowe's *Plants of Mississippi* (1921), although outdated, must continue to serve as a base line for the general floristic work in the state. Other references that we used as sources of distributional data are Mackenzie (1931–1935), Kükenthal (1935–1936), McGivney (1938), Corcoran (1941), Horvat (1941), Radford et al. (1964), and Godfrey & Wooten (1979).

The terminology of physiographic regions or resource areas in Mississippi follows Lowe (1921) as adapted by Morris (1989). Herbarium abbreviations follow Holmgren et al. (1990), except ctb, MMNS, and USMH (personal herbarium of Charles T. Bryson, Mississippi Museum of Natural Science, Jackson, and University of Southern Mississippi, Hattiesburg, respectively).

NEW STATE RECORDS

Carex bicknellii Britton var. **opaca** F.J. Herm. was described from three collections by Dr. Delzie Demaree from river terraces in Lonoke and Prairie counties, Arkansas (Hermann 1972). In his discussion of this puzzling variety of *C. bicknellii*, Hermann (1972) emphasized its large, nearly nerveless, and partially translucent perigynia and indicated they were similar to perigynia of *C. brittoniana* Bailey and *C. merritt-fernaldii* Mack. as well as *C. bicknellii*. However, the perigynia of *C. bicknellii* var. *opaca* are much larger (5.5–7 mm long, 4–4.75 mm wide) compared to those of *C. merritt-fernaldii* (4–5 mm long, 2.5–3.5 wide). *Carex bicknellii* var. *opaca* differs from the Oklahoma-Texas *C. brittoniana* in usually having 5–7(9) (rarely only 4) spikes per culm; perigynia (2)4–7 nerved (sometimes faintly) over the achene ventrally; and staminate and pistillate scales obtuse to long-acuminate, but with the midrib not excurrent as a scabrous awn (rarely a short mucro present). *Carex brittoniana* has culms with normally (2)3–4(5) spikes; perigynia nerveless over the achene ventrally, or nearly so; and staminate scales (and sometimes the lowermost pistillate scales) with the midrib excurrent as a scabrous awn 0.1–0.9(2.4) mm long. *Carex bicknellii* var. *bicknellii* is a dry prairie species not known from Mississippi. *Carex bicknellii* var. *opaca* was found at the same site in the Black Prairie Region of Mississippi where *C. oklahomensis* Mack. was first collected in the state by the senior author in 1991 (Bryson et al. 1992). It was associated with *C. bushii* Mack., *C. complanata* Torr. & Hook., *C. glaucodea* Tuckerman, *C. longii* Mack., and *C. vulpinoidea* Michx. The following are data reporting *C. bicknellii* var. *opaca* from Mississippi for the first time.

Voucher specimens: U.S.A. MISSISSIPPI. **Lee Co.:** E of Tupelo, NE of jct. of hwy US 78 and Auburn Road, 26 May 1993, *Bryson 12400* (ctb, IBE, MICH, SWSL).

Carex fissa Mack. var. **fissa** is herewith reported new to Mississippi. *Carex fissa* was described by Mackenzie (1931) from specimens collected in eastern Oklahoma where it was believed to be endemic. Kolstad (1986) reported *C. fissa* from southeastern Kansas and eastern Oklahoma. Hermann (1965) described *Carex fissa* var. *aristata* from north central Florida. Jones et al. (1990) reported *C. fissa* new to Texas. The Mississippi collection of *C. fissa* var. *fissa* was found in a wet ditch between old hwy US 78 and railroad tracks in with *C. annectens* Bicknell, *C. triangularis* Boeck., and *C. vulpinoidea* Michx. in the North Central Plateau Region. It is possible that this species may have been introduced into Mississippi by highway or rail traffic. However, its habitat in Mississippi is similar to that in Arkansas, and it is likely that *C. fissa* is native to Mississippi. It is probable that *C. fissa* var. *aristata* will be found in southern Mississippi. The following data report *C. fissa* var. *fissa* new to Mississippi.

Voucher specimens: U.S.A. MISSISSIPPI. **Benton Co.:** 1.7 mi NW Hickory Flat, 18 May 1990, *Bryson 9977A* (ctb, IBE, MICH).

Cyperus drummondii Torr. & Hook. [=*C. virens* Michx. var. *drummondii* (Torr. & Hook.) Kükenthal] in North America is restricted to the coastal plain and is known from Texas and Louisiana (Denton 1978). Specimens have also been seen from Florida and Georgia (Carter, unpublished data). It is also known from Nicaragua, Jamaica, the Galapagos Islands, Surinam, and Brazil (Denton 1978). Although Denton (1978) considered *C. drummondii* to be a variety of *C. virens* Michx., we think the morphological differences are sufficient for recognition as a species. *Cyperus drummondii* is generally a taller plant with a more compact inflorescence and fewer primary inflorescence bracts, shorter scales, and a greater achene length to scale length ratio. At the site reported here, *C. drummondii* was associated with *C. haspan* L., *C. ovatus* Baldwin, *C. polystachyos* Rottb., *C. strigosus* L., *C. virens*, and *Fimbristylis* spp. in the Coastal Pine Meadows Region. The following are data for the first collection of *C. drummondii* from Mississippi.

Voucher specimens: U.S.A. MISSISSIPPI. **Jackson Co.:** Moss Point, ditch along W side of hwy MS 63 between Frederick Street and Dr. Martin Luther King Drive, 0.5 mi S Escatawpa River Bridge, 16 Sep 1993, *Carter 11315* (ctb, SWSL, VSC).

Cyperus elegans L. is known from coastal Texas, Louisiana, and Florida; it has not previously been reported from Mississippi. It is related to *C. oxylepis* Nees ex Steud. and can be distinguished from that species by its black, obovoid achenes (0.7–1.0 mm broad) and grayish brown, semi-translucent scales versus the brown, oblong, ca. 0.5 mm broad achene and golden yellow to orangish scales of *C. oxylepis* (Bryson & Carter 1992). Like *C. oxylepis*, *C. elegans* has a distinctive and pleasantly aromatic fragrance somewhat like that of cured juniper wood, which can often be detected several meters away from live plants in the field. The authors have on several occasions smelled these species in the field prior to making visual contact. Both species are locally abundant in heavily disturbed fill areas along the coast in Jackson County, Mississippi, and the populations of *C. elegans* and *C. oxylepis* consist of more than 2000 plants each and cover an area greater than 121 ha (300 acres). *Cyperus elegans* was found in association with *C. odoratus* L., *C. oxylepis*, *C. entrerianus* Boeckler, *C. filicinus* Vahl, *C. flavescens* L., *C. surinamensis* Rottb., and *C. virens* in the Coastal Pine Meadows Region. Collection data for *C. elegans* in Mississippi follow.

Collection data. U.S.A. MISSISSIPPI. **Harrison Co.:** Orange Grove Community Center, 0.3 mi N jct. hwys I-10 and US 49; W of US 49, 16 Oct 1993, *Bryson 13160 and Carter* (ctb, SWSL, VSC). **Jackson Co.:** Pascagoula, vicinity of Bayou Casotte, S jct. of Louise and Washington Streets, 9 Aug 1993, *Bryson 12595* (ctb, IBE, MICH, VDB, VSC); *Carter 11339* (VSC, others to be distributed).

Cyperus entrerianus Boeck. is an apparent introduction from South America or Mexico (Carter 1990) and was reported from 21 counties in Georgia, Florida, Alabama, Louisiana, and Texas (Carter 1990; Carter & Jones 1991). Although *C. entrerianus* is not recognized in some floras, it is quite distinct from other taxa in the *Cyperus* section *Luzuloidei* in temperate North America, and a comprehensive discussion and key was provided for this section by Carter (1990). This perennial is a copious producer of seeds and possesses a hard, stout, deeply set rhizome. It seems to be a more aggressive weed than other members of *Cyperus* section *Luzuloidei* that occur in Mississippi (e.g., *C. acuminatus* Torr. & Hook., *C. drummondii*, *C. eragrostis* Lam., *C. pseudovegetus* Steud., *C. surinamensis*, and *C. virens*). *Cyperus entrerianus* is often locally abundant in eastern Texas and southern Louisiana where it seems to be associated with rice production, and it has been found in a rice field in Paraguay (Carter 1990). *Cyperus entrerianus* was found growing in the Coastal Pine Meadows Region with *C. elegans* and its associates listed in the preceding discussion. The following are data for the first collections of *C. entrerianus* in Mississippi.

Voucher specimens: U.S.A. MISSISSIPPI. **Jackson Co.:** Pascagoula, vicinity of Bayou Casotte, S jct. of Louise and Washington streets, 9 Aug 1993, *Bryson 12598* (ctb); 31 Aug 1993, *Bryson 12821 and Newton* (BRIT/SMU, ctb, DSC, FLAS, FSU, GA, IBE, KNK, MICH, MISS, MISSA, MMNS, MO, NLU, SWSL, TAES, USMH, VDB, VSC, others to be distributed).

Cyperus eragrostis Lam. is native to California, Oregon, and Washington in North America; Bolivia, Peru, and Surinam south to Argentina, Brazil, Chile, and Uruguay in South America; and Easter and Juan Fernandez Islands in the Pacific (Denton 1978). This species has not previously been reported from Mississippi although two specimens collected by Ken Rogers (cited below) were collected in Forrest and Hinds counties in 1971 and 1981, respectively, and determined by R. Kral (VDB) and R. Carter. In Rankin County, collections were made along shallow narrow ditches. These sites are across the Pearl River and within five miles of the earlier Hinds County site of Ken Rogers. The Mississippi plants seem to be intermediate in size between typical *C. eragrostis* var. *eragrostis* and the diminutive form *C. eragrostis* var. *compactus* (Desv.) Kük. Denton (1978) treated *C. eragrostis* var. *compactus* as a synonym of *C. eragrostis* because the diminutive form occurs throughout the range of the species. When transplanted into pots and grown under controlled conditions (i.e., with regular watering and fertilizer) in the greenhouse at the USDA, ARS, Jamie Whitten Delta States Research Center, Stoneville, MS, individuals of *C. eragrostis* from the Rankin County collection produced new stems that were longer than those observed in the field and that were typical of *Cyperus eragrostis* var. *eragrostis*. Thus, it appears periodic mowing of ditches and roadsides apparently caused plants to be shorter than typical for the species in the Rankin County, Mississippi population observed by the senior author. In Rankin County, *C. eragrostis* was associated with *Carex longii*, *Cyperus haspan*, *C. odoratus*, *C. pseudovegetus*, *C. strigosus*, *C. virens*, and *Kyllinga brevifolia* Rottb. [=*Cyperus brevifolius* (Rottb.) Hassk.]. Each of the collections were made in the Longleaf Pine Belt Region. The following data are the first records *C. eragrostis* from Mississippi.

Voucher specimens: U.S.A. MISSISSIPPI. **Forrest Co.**: Hattiesburg, drainage ditch at Kemper Park, 16 Jul 1971, *Rogers 6708* (VDB). **Hinds Co.**: Jackson, Riverside Park, 8 Jun 1981, *Rogers 46975* (VDB). **Rankin Co.**: Flowood, 0.3 mi E of Pearl River; S of hwy MS 25, 7 Sep 1993, *Bryson 12966* (ctb, VSC); *Bryson 12975* (ctb, SWSL, VSC); Flowood, 0.7 mi E Pearl River; S of hwy MS 25, 14 Oct 1993, *Bryson 13128 and Bryson* (ctb, SWSL, VSC).

Cyperus louisianensis Thieret was previously reported from only two sites, including the type locality, in Tangipahoa Parish, Louisiana (Thieret 1977). Its lenticular achene and two-branched style place it in subgenus *Pycreus*, and it appears to be closely related to the North American species, *C. diandrus* Torr. (Thieret 1977). The scales of *C. louisianensis* are similar to those of *C. diandrus*, but *C. louisianensis* is distinguished by three stamens and styles that are divided less than half way to the base (Thieret 1977). *Cyperus louisianensis* is also closely related to the widespread old world species, *C. sanguinolentus* Vahl (Thieret 1977). Our observations indicate that *C. louisianensis* is typically found in disturbed habitats, such as road ditches and margins of artificial ponds, where it often forms dense, nearly monotypic, stands. Also, it is found in association with introduced weeds, e.g. *C. pilosus* Vahl (Bryson & Carter 1992) and *Sacciolepis indica* (L.) Chase (Bryson & Lockley 1993), in the Coastal Pine Meadows Region. We have also observed that *C. louisianensis* flowers and fruits from late August until frost and that it is much more easily detected late in the season when its distinctive reddish scale pigmentation has developed completely. Thus, this may explain why it has been overlooked previously in Mississippi. *Cyperus louisianensis* has been listed as a candidate for protection (U.S. Fish and Wildlife Service 1993). Additional field and herbarium studies by the authors are currently in progress to determine the status of this taxon. The following data are the first records of *C. louisianensis* from Mississippi.

Collection data. U.S.A. MISSISSIPPI. **Hancock Co.**: W side of hwy MS 43, 0.44 mi N of jct. hwys US 90 and MS 43 in Waveland, 16 Sep 1993, *Carter 11342* (VSC, SWSL, others to be distributed); 16 Oct 1993, *Bryson 13166 and Carter 11545* (ctb, SWSL, VSC, others to be distributed); W of Mill Creek, between Mill Creek and Indian Ridge Road, S of MS 43, ca. 5 mi E jct. hwys MS 43 and I-59 in Picayune, 18 Oct 1993, *Bryson 13265 and Carter 11567* (ctb, SWSL, VSC, others to be distributed); 9.0 mi NW of jct. hwys 43 and 603 in Kiln, at Petroleum Pipeline crossing of hwy MS 43, S side of hwy MS 43, 18 Oct 1993, *Carter 11568 and Bryson* (VSC, others to be distributed); N of Kiln, 0.6 mi S of jct. hwys MS 43 and MS 603, by W side of hwy MS 43, 18 Oct 1993, *Bryson 13267 and Carter 11569* (ctb, SWSL, VSC, others to be distributed); Kiln, beside Shifalo Baptist Church and across hwy MS 43 from Kiln Post Office, by W side of hwy MS 43, 18 Oct 1993, *Bryson 13268 and Carter 11570* (ctb, SWSL, VSC, others to be distributed); SE jct. hwys MS 43 and I-10, 18 Oct 1993, *Bryson 13271 and Carter 11571* (ctb, SWSL, VSC, others to be distributed). **Harrison Co.**: Orange Grove Community Center, 0.3 mi N jct. hwys I-10 and US 49; W of US 49, 16 Oct 1993, *Bryson 13164 and Carter 11544* (ctb, SWSL, VSC, others to be distributed); Orange Grove, 1.1 mi S jct. hwy US 49 and O'Neal Road, 18 Oct 1993, *Bryson 13276* (ctb, SWSL, VSC, others to be distributed); N Gulfport, 0.3 mi W of jct. of Harrison Drive and 34th Avenue, ditch along Harrison Drive, 18 Oct 1993, *Carter 11574* (VSC, others to be distributed); 3.32 mi W of jct. of Popps Ferry Road and D'Iberville Boulevard (=hwy MS 67), along Popps Ferry Road, ca 50 m W of jct. with Camp Four Jacks Road, 18 Oct 1993, *Carter 11577* (VSC, others to be distributed); NW jct. hwys I-10 and US 49, 18 Oct 1993, *Bryson 13279* (ctb, SWSL, VSC, others to be distributed). **Jackson Co.**: Pascagoula, just SE jct. of Washington and Louise Streets, vic. Bayou Cassotte, 16 Sep 1991, *Bryson 11032 and Newton* (ALA, BRIT/SMU, ctb, DSC, GA, FLAS, FSU, IBE, KNK, MICH, MISS, MISSA, MMNS, MO, NLU, NY, SWSL, TAES, TENN, UARK, US, USMH, VDB, VSC, others to be distributed); 16 Sep 1993, *Carter 11337* (VSC, others to be distributed); St. Martin, 0.2 mi N of jct. of Old Fort Bayou Road and Rosefarm Road, along Rosefarm Road S of creek, 18 Oct 1993, *Carter 11579* (VSC, others to be distributed); vicinity of St. Martin, 1.13 mi W of jct. of Old Fort Bayou Road and Yellow Jacket Boulevard, between Lancaster Road and Mayfair Road, 18 Oct 1993, *Carter 11580* (VSC, others to be distributed); vicinity of St. Martin, 0.19 mi E of jct. of Fort Bayou Road and Yellow Jacket Drive, by Old Fort Bayou Road, 18 Oct 1993, *Carter 11581* (VSC, others to be distributed). **Pearl River Co.**: Picayune, ca. 250 m N jct. hwys I-59 and MS 43 by frontage road along W side of I-59, 18 Oct 1993, *Bryson 13222 and Carter 11565* (ctb, SWSL, VSC, others to be distributed); Picayune, 0.5 mi W jct. hwys I-59 and MS 43; N of MS 43, 18 Oct 1993, *Bryson 13257 and Carter 11562* (ctb, SWSL, VSC, others to be distributed).

Kyllinga brevifolioides (Thieret & Delahoussaye) G.C. Tucker {=*C. brevifolioides* Thieret & Delahoussaye} (Tucker 1984) was cited from Connecticut, North Carolina, Pennsylvania, and Virginia in North America by

Delahoussaye and Thieret (1967) in the original description. Subsequently, it has been reported from Maryland (Sipple 1978; Naczi et al. 1986), Tennessee (Kral 1981; Webb et al. 1981), Alabama and Georgia (Webb et al. 1981), New Jersey (Snyder 1983, 1984), Delaware (Naczi 1984; Naczi et al. 1986), and Arkansas (Sundell & Thomas 1988). Like *K. brevifolia*, *K. brevifolioides* is a rhizomatous perennial; however, it can be separated from *K. brevifolia* by its smooth scale keel and 2–3 stamens versus the denticulate scale keel and a single stamen of *K. brevifolia*. Like *K. brevifolia* and *K. odorata*, *K. brevifolioides* is weedy and was probably introduced from Asia (Ferren and Schuyler 1980; Webb & Dennis 1981). *Kyllinga brevifolia* and *K. brevifolioides* have been observed by the authors to be weeds in periodically wet or frequently irrigated areas of lawns, roadsides, ditches, cemeteries, golf courses, and flower beds, often associated with the following sedges: *Carex longii*, *Cyperus polystachyos*, *C. pseudovegetus*, *C. strigosus*, *Eleocharis obtusa* (Willd.) Schult., and *Kyllinga pumila* Michx. The collections reported herein are from the Loess Bluffs and Tennessee River Hills Regions. The following are data for the first collections of *K. brevifolioides* from Mississippi.

Voucher specimens: U.S.A. MISSISSIPPI. **Alcorn Co.**: Corinth, S of jct. hwy US 72 and Cass Street, 29 Sep 1993, *Bryson 13082* (ctb, FSU, IBE, KNK, NYS, SWSL, VDB, VSC); Corinth, SE of jct. hwy US 72 and Harper Road, 29 Sep 1993, *Bryson 13094* (ctb, IBE, NLU, SWSL, VDB, VSC). **De Soto Co.**: Olive Branch, 0.3 mi W of jct. hwys US 78 (old) and MS 302 (=Goodman Road); N of Goodman Road, 7 Oct 1993, *Bryson 13102 and Bryson* (BRIT/SMU, ctb, DSC, FSU, GA, IBE, KNK, MICH, MISS, MMNS, NLU, SWSL, USMH, VDB, VSC); ca. 0.8 mi N jct of Goodman Road and Getwell Road; W of Getwell Road, 13 Oct 1993, *Bryson 13124* (ctb, VSC).

OTHER NOTEWORTHY COLLECTIONS

Cyperus aggregatus (Willd.) Endl. {previously known as *C. huarmensis* (H.B.K.) M.C. Johnst., *C. cayennensis* (Lam.) Britton, and *C. flavus* (Vahl) Nees; see Tucker (1985)} is reported from Florida (Kral 1966; Clewell 1985), Louisiana (Horvat 1941), and Texas (Correll & Johnston 1970). Since it was first discovered in Stone County, Mississippi, in 1991 (Bryson & Carter 1992), *C. aggregatus* has been observed to be an aggressive weed of open sandy hilltops, roadsides, poorly kept lawns, and disturbed vacant lots on coarse sandy soils in similar habitats and often growing in association with *C. croceus* Vahl and *C. retrorsus* Chapman. The number, sizes, and distribution of populations in Mississippi suggest that *C. aggregatus*, if not a native, was introduced many years ago into the Coastal Pine Meadows and Longleaf Pine Belt Regions of Mississippi. The following are additional records of this weedy species, including two new county records.

Voucher specimens: U.S.A. MISSISSIPPI. **Forrest Co.**: Fruitland Park, E of hwy US 49, 9 Aug 1993, *Bryson 12580* (ctb, IBE, SWSL, VSC). **Harrison Co.**: 0.2 mi N of Howison, E of hwy US 49, 9 Aug 1993, *Bryson 12581* (ctb, IBE, NYS, VSC); Gulfport, vacant lot W of hwy US 49 between 34th and Madison Streets, 12 Aug 1993, *Bryson 12664* (ctb, SWSL, VSC). **Stone Co.**: Wiggins, hilltop just NE of jct hwy US 49 and MS 26, 16 Oct 1993, *Carter 11542 and Bryson* (VSC, others to be distributed).

Cyperus difformis L. ranks as one of the world's worst weeds (Holm et al. 1991) and occurs from Europe, Asia, Central America, North America (Lipscomb 1980), Australia, the Pacific Islands (Kükenthal. 1935), Mexico (McGivney 1938), and South America (S. McDaniel pers. comm.). It is a particularly pernicious annual weed because of its relatively short generation period (as little as 4 to 6 weeks from seed to seed) and high reproductive potential (Holm et al. 1991). This species seems to be spreading in the United States especially along major waterways, through introduction at ports-of-entry, and in rice production in California. In the United States *C. difformis* has been known from Virginia since 1934 and is a troublesome weed of rice in California (Bryson 1984b). It is also known from Alabama (Kral 1973), Florida (Burkhalter 1985), Louisiana (Thieret 1964), Mississippi (Bryson & Carter 1992), Nebraska (Lemaire 1970), North Carolina (Tyndall 1983), Pennsylvania (Smith 1986), Tennessee (Webb & Dennis 1981), and Texas (Carr 1988). During field work in 1993, new populations were discovered, and previously known populations (Bryson & Carter 1992) were observed. Population size, in area covered and number of individuals, had increased by 2- to 400-fold since 1991. The following are data for recently discovered populations of *C. difformis* in Mississippi from the Coastal Pine Meadows and Longleaf Pine Belt Regions.

Voucher specimens: U.S.A. MISSISSIPPI. **Forrest Co.**: Hattiesburg, Alcorn Street between James and Tipton streets, beside Hattiesburg Water Works, 16 Oct 1993, *Bryson 13148, Carter and Rosso* (BRIT/SMU, ctb, FSU, IBE, KNK, MISS, MMNS, MO, NLU, NYS, SWSL, TAES, USMH, VDB, VSC). **Hancock Co.**: Kiln, wet ditch W of hwy MS 43, 6 Aug 1992, *Bryson 11941* (ctb, IBE, VSC). **Harrison Co.**: Gulfport, wet ditch between Seaway Road and RR; S of hwy I-10, 6 Aug 1992, *Bryson 11993* (ctb, IBE, VSC); Orange Grove, 0.3 mi N jct. hwys I-10 and US 49; W of US 49, 31 Aug 1993, *Bryson 12805 and Newton* (ctb). **Jackson Co.**: Moss Point, SE jct. hwys I-10 and MS 63, 31 Aug 1993, *Bryson 12818 and Newton* (ctb); Moss Point, NE of jct. hwys US 90 and MS 63, 1 Sep 1993, *Bryson 12835 and Newton* (ctb, IBE, NLU, VDB, VSC); Pascagoula, Bayou Casotte area, adjacent to City Animal Shelter just S of S end of Louise Street, 16 Sep 1993, *Carter 11338* (VSC, others to be distributed).

Cyperus flavicomus Michx. (=*C. albomarginatus* Martius & Schrad. ex Nees) was previously known from only Lafayette and Tishomingo counties, both in northeastern Mississippi in the North Central Plateau and Tennessee River Hills Regions. *Cyperus flavicomus* was found growing on wet soil often in shallow standing water in association with *Carex longii, Cyperus difformis, C. esculentus* L., *C. iria* L., *C. haspan*, *C. odoratus*, *C. pilosus*, *C. polystachyos*, *C. strigosus*, *C. surinamensis*, *C. virens*, *Eleocharis obtusa*, *E. tuberculosa* (Michx.) Roem. & Schult., *Fimbristylis autumnalis* (L.) Roem. and Schult., *F. miliacea*

(L.) Vahl, *Kyllinga brevifolia*, and *Rhynchospora corniculata* (Lam.) Gray. Based on our examination of herbarium specimens and field surveys, *C. flavicomus* seems to occur sporadically throughout much of the southeastern United States. The following are additional county records from the Coastal Pine Meadows Region of southern Mississippi.

Voucher specimens: U.S.A. MISSISSIPPI. **Harrison Co.:** Orange Grove, 0.3 mi N jct. hwys I-10 and US 49; W of US 49, 31 Aug 1993, *Bryson 12815 and Newton* (ctb, DSC, IBE, MISS, MMNS, MO, NLU, SWSL, USMH, VDB, VSC); *Bryson 13162 and Carter* (ctb, VSC). **Jackson Co.:** Moss Point, SE of jct. hwys I-10 and MS 63, 31 Aug 1993, *Bryson 12816 and Newton* (ctb).

Cyperus lancastrensis Porter in Gray was first reported from Mississippi by Morris (1988) in the North Central Plateau Region. Subsequently, it was reported from Lee and Tishomingo counties in the Tennessee River Hills Region (Bryson & Carter 1992). Following are data from an additional three counties all from northern Mississippi in the North Central Plateau and Tennessee River Hills Region. *Cyperus lancastrensis* was found growing in association with *C. echinatus* (L.) Wood and *C. strigosus* in small damp depressions on open hillsides.

Voucher specimens: U.S.A. MISSISSIPPI. **Itawamba Co.:** 1.6 mi N Dorsey SW of jct. of hwy US 78 and Fawn Grove exit, 26 Aug 1993, *Bryson 12784* (ctb, VSC). **Marshall Co.:** N of Galena, jct. of old and new hwys MS 7, 24 Aug 1993, *Bryson 12731* (ctb, IBE, VDB, VSC). **Tate Co.:** Thyatira, S of hwy MS 4, 7 Oct 1993 *Bryson 13114 and Bryson* (ctb, VSC).

Cyperus ovatus Baldwin {=*C. pollardii* Britton in Small} occurs throughout Florida and northward in the outer Atlantic coastal plain into North Carolina and westward along the Gulf Coast into Louisiana (Carter, in prep.). It is related to *C. retrorsus* and is discussed previously from Mississippi (Bryson & Carter 1992). At the time of our previous paper, we were unable to locate *C. ovatus* in Hancock County despite field surveys in suitable habitats (e.g., pond margins, edges of salt marshes, banks of black water streams, and bogs and ditches in pineland savannas). Following are data for additional recent collections of *C. ovatus* from Mississippi in the Coastal Pine Meadows Region.

Voucher specimens: U.S.A. MISSISSIPPI. **Hancock Co.:** Port Bienville Waterfront Industrial Park, 17 Oct 1993, *Bryson 13182 and Carter 11555* (ctb); Kiln, W of hwy MS 43; across hwy MS 43 from Kiln Post Office, beside Shifalo Baptist Church; ca. 2.0 mi S jct. hwys MS 43 and 603, 18 Oct 1993, *Bryson 13269 and Carter* (ctb).

Cyperus pilosus Vahl, a weed of tropical and subtropical regions of Asia, Australia, and West Africa (Kükenthal 1935, McGivney 1938), was apparently introduced into North America from the old world and was first reported in the United States from Tangipahoa Parish, Louisiana, by O'Neill (1938). Subsequently, *C. pilosus* was reported from Florida by Burkhalter

(1985), relocated in Louisiana by Carter (Bryson & Carter 1992), and discovered in Mississippi by Bryson & Carter (1992). In Mississippi, *C. pilosus* was found most frequently growing in disturbed soil at the edge of standing water in ditches, along slow moving streams, and around ponds often in association with many other *Cyperus* species including: *C. difformis, C. iria, C. louisianensis, C. odoratus, C. strigosus,* and *C. virens*. The following data report *C. pilosus* from additional counties in Mississippi in the Coastal Pine Meadows Region.

Voucher specimens: U.S.A. MISSISSIPPI. **Hancock Co.:** SE of Napolean, in ditch E of jct. hwys I-10 and MS 607; N of I-10, 10 Aug 1993, *Bryson 12606* (ctb, IBE, MO, NLU, SWSL, VDB, VSC); N of Waveland, W of hwy MS 43, 0.44 mi N of jct. hwys US 90 and 43, 16 Sep 1993, *Carter 11346* (VSC). **Harrison Co.:** Gulfport, ditch between Seaway Road and RR; S of I-10, 6 Aug 1992, *Bryson 11996* (ctb, IBE, MICH, NLU, TENN, VDB, VSC); Gulfport, ditch along Industrial Road, 9 Aug 1993, *Bryson 12582 and Lockley* (ctb); *Bryson 12584* (ctb, IBE, SWSL, VSC); *Bryson 12625* (ctb, IBE, VDB, VSC); Orange Grove Community Center, 0.3 mi N jct. hwys I-10 and US 49; W of US 49, 31 Aug 1993, *Bryson 12813 and Newton* (ctb, VSC); *Bryson 13158 and Carter* (ctb, VSC). **Pearl River Co.:** Ca. 1 mi S Picayune; ca. 3 mi N Mississippi/Louisiana state line; E of hwy I-59 at Mississippi Welcome Center, 17 Oct 1993, *Bryson 13220 and Carter* (ctb, SWSL, VSC); Picayune, 0.5 mi W jct. hwys I-59 and MS 43; N of MS 43, 18 Oct 1993, *Bryson 13254 and Carter* (ctb, SWSL, VSC).

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NEW TAXA AND NEW COMBINATIONS IN CHINESE PLANTS

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ABSTRACT

This paper describes two new conifers found in boreal China, namely, *Larix gmelini* (Rupr.) Rupr. *genhensis* S.Y. Li & K.T. Adair and *Pinus sylvestris* L. var. *manguiensis* S.Y. Li & K.T. Adair. Also, it presents two new combinations, *Polemonium hingganicum* (P.H. Huang & S.Y. Li) S.Y. Li & K.T. Adair and *Penthorum sedoides* L. subsp. *chinense* (Pursh) S.Y. Li & K.T. Adair.

RESUMEN

En este artículo se describen dos coníferas nuevas que se encuentran en el norte de China, *Larix gmelini* (Rupr.) Rupr. subsp./var. *genhensis* S.Y. Li & K.T. Adair y *Pinus sylvestris* L. var. *manguiensis* S.Y. Li & K.T. Adair. También se presentan dos combinaciones nuevas *Polemonium hingganicum* (P.H. Huang & S.Y. Li) S.Y. Li & K.T. Adair y *Penthorum sedoides* L. subsp. *chinense* (Pursh) S.Y. Li & K.T. Adair.

This article describes two new taxa and two new combinations from China. The study is largely based on collections Shiyou Li made in a four-year forest resource investigation in Northeast China during 1984–1987. The specimens are mainly deposited in the herbarium of Northeast Forestry University (NEFI) China.

Larix gmelini (Rupr.) Rupr. var. **genhensis** S.Y. Li & K. T. Adair, var. nov. (Fig. 1)

A var. *genhensis* brachlis longis et pendula differt.

Larix gmelini (Rupr.) Rupr. var. *genhensis* (GENHEN LARCH) is distinguished from var. *gmelini* (DAHURIAN LARCH) by its long, slender and pendulous branches. The first-year branches of var. *genhensis* are about two times longer than those of var. *gmelini*. The tree reaches 20 meters tall and 50 cm in diameter in favorable conditions.

TYPE: CHINA. NEIMONGGU: Genhe, 4 Jul 1986, *S.Y. Li 861-643* (HOLOTYPE: NEFI!).

Larix gmelini (Rupr.) Rupr. var. *genhensis* is sparsely distributed in Genhe, Da Xingan Ling, Neimonggu, China (Fig. 3). It usually grows in wetlands or occasionally in the *Larix gmelini* (Rupr.) Rupr. var. *gmelini* forest on lower

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FIG. 1. *Larix gmelini* (Rupr.) Rupr. var. *genhensis*.

slopes. It has withstood temperatures of -45°C. This larch should receive horticultural attention because of pendulous branching and cold tolerance.

Pinus sylvestris L. var. **manguiensis** S.Y. Li & K. T. Adair, var. nov. (Fig. 2)

Differt a *Pinus sylvestris* L. var. *sylvestris*, var. *mongolica* Litvin., var. *sylvestrifomis* (Takenouchi) Cheng et C.D. Chu foliis 0.5–4.0 cm longis.

Pinus sylvestris L. var. *manguiensis* is one of the shortest leaf pines in the world. This variety can be distinguished from other varieties of *Pinus sylvestris* by its extremely short and slightly or non-twisted needles (Table 1).

FIG 2. *Pinus sylvestris* L. var. *manguiensis.*

TYPE: CHINA. NEIMONGGU: Mangui, 26 Jun 1986, *S.Y. Li 861-917* (HOLOTYPE: NEFI!).

Additional specimens examined: CHINA. NEIMONGGU: Jinhe, 20 Jun 1986, *S.Y. Li 860-300* (NEFI).

Pinus sylvestris L. var. *manguiensis* (SHORT-LEAF SCOTCH PINE) occurs in pure stands on dry rocky slopes (400–800 m at elevation) in Mangui and Jinhe, Da Xingan Ling, Neimonggu, China (Fig. 3). *Pinus sylvestris* L. var. *manguiensis* predominates the canopy and is occasionally associated with *Larix gmelini.* The regeneration seedlings under canopy are common, especially in gaps. The common shrubs in undergrowth are *Rhododendron mucronulatum* Turcz., *Spiraea sericea* Turcz., *Rosa acicularis* Lindl., *Vaccinium vitis-idaea* L., and *Rubus* sp. Main associated herbaceous plants include: *Carex* spp., *Calamagrostis* sp., *Iris ensata* Thunb., *Pyrola incanata* Fisch., *Artemisia* sp., *Convallaria majalis* L., *Fragaria orientalis* Lozinsk., and *Sanguisorba officinalis* L.

The new pine is a beautiful large tree with a short crown and a straight reddish-brown trunk. It is usually 20–25 m tall and 50 cm in diameter. It is adapted to an extremely continental climate. It has withstood temperatures of -47°C. The new pine should be managed for timber.

Polemonium hingganicum (P.H. Huang & S.Y. Li) S.Y. Li & K.T. Adair, comb. et stat. nov. BASIONYM: *Polemonium boreale* Adams subsp. *hingganicum* P.H.

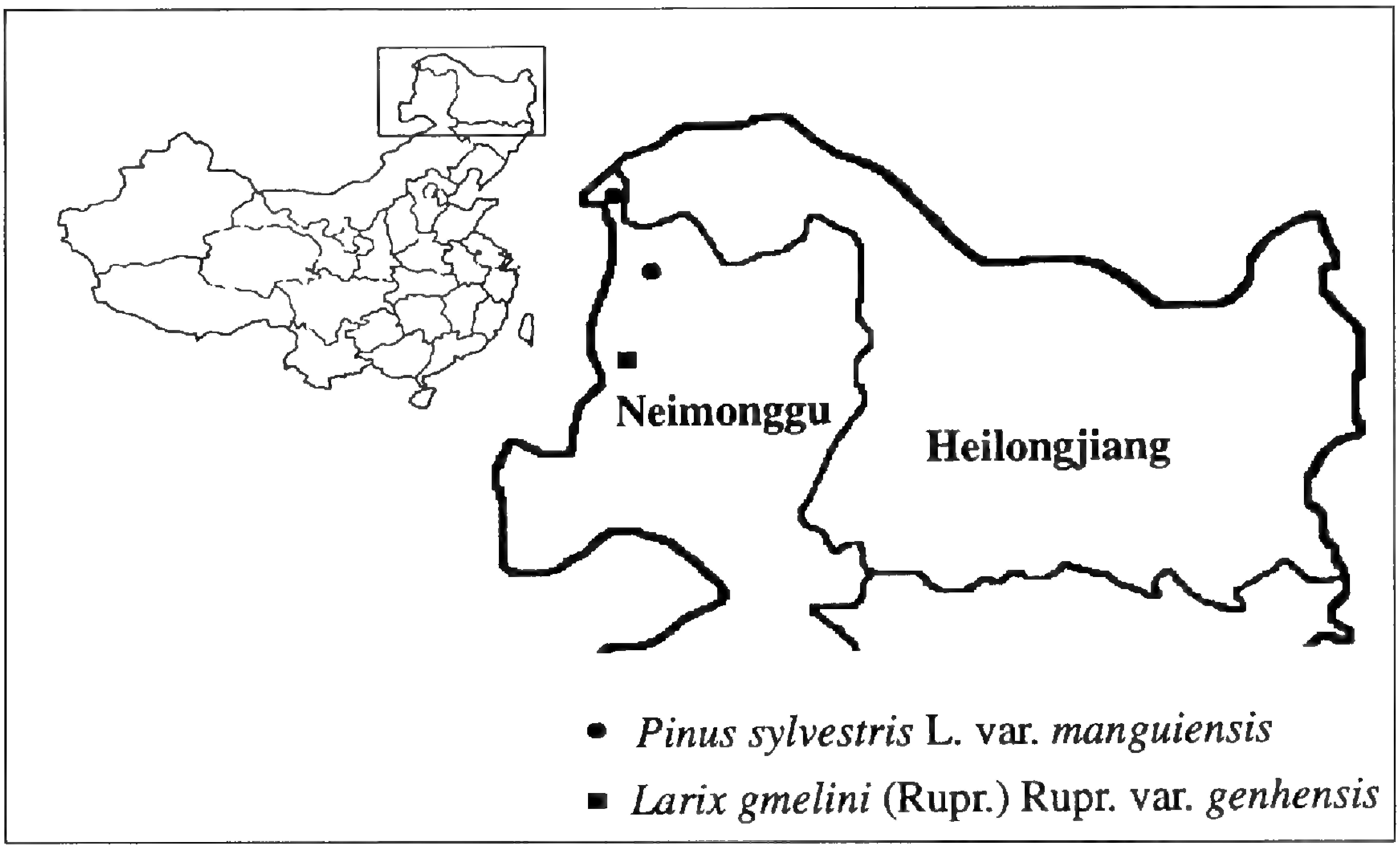

FIG. 3. Distribution of *Pinus sylvestris* L. var. *manguiensis* and *Larix gmelini* (Rupr.) Rupr. var. *genhensis*.

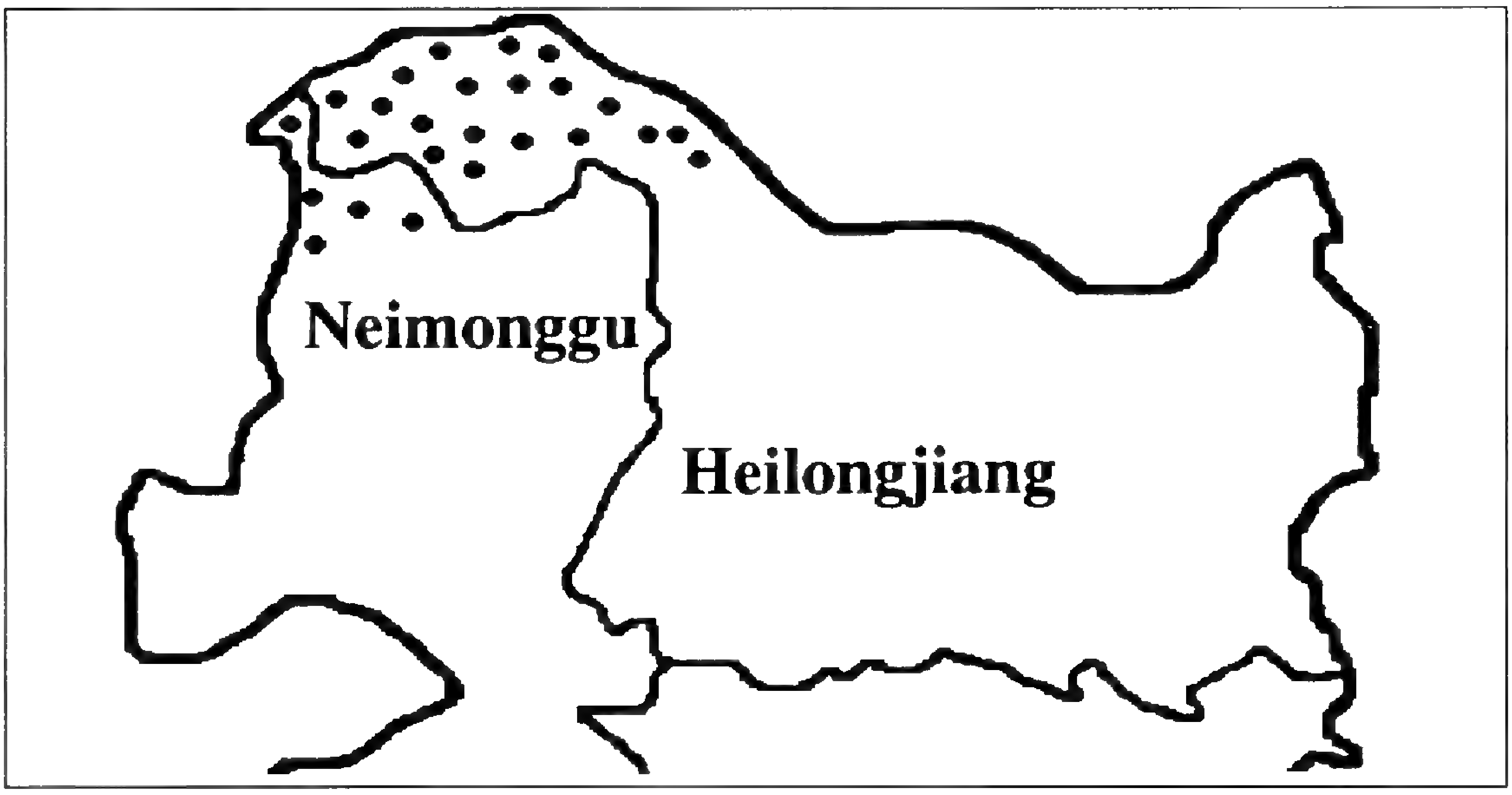

FIG. 4. Distribution of *Polemonium hingganicum*.

Huang & S.Y. Li, Bull. Bot. Res. 5:151–154. 1985. TYPE: CHINA. HEILONGJIANG: Da Xingan Ling, *S.Y. Li 841-372* (HOLOTYPE: NEFI!).

Polemonium hingganicum (XINGAN JACOBS-LADDER) was named by P.H. Huang and S.Y. Li in 1985 and treated as a subspecies of the circumboreal *P. boreale.* Recently, we reexamined this taxon with its closely related taxa. The data (Table 2) indicate that the taxon should be treated as a separate

TABLE 1. Gradient Analysis of needle length of *Pinus sylvestris* population with geographic location in China.

Location	Sample Size	Specimen Cited	Needle Length (cm) Range	Needle Length (cm) Mean±s.d.*	Taxon Name
Mohe, Heilongjiang	1030	NEFI 3589	3.1–7.1	5.35±0.94	var. *sylvestris*
Gulian, Heilongjiang	630	Wang 109	3.5–8.0	5.57±1.30	var. *sylvestris*
Mordaga, Neimonggu	760	Li 861–604	2.0–6.2	4.06±1.29	var. *sylvestris*
Nenjiang, Heilongjiang	160	Wang 105	3.4–8.4	6.08±0.93	var. *sylvestris*
Jixi, Heilongjiang	76	NEFI 0005	2.0–7.0	4.62±1.78	var. *sylvestris*
Mangui, Neimonggu	1078	Li 861–917	0.8–3.7	2.43±0.73	var. *manguiensis*
Jinhe, Neimonggu	950	Li 860–300	0.5–3.9	2.81±0.58	var. *manguiensis*
Hailar, Neimonggu	108	NEFI 630004	4.0–8.9	7.41±1.10	var. *mongolica*
Honghuarji, Neimonggu	240	NEFI 630087	4.6–7.0	5.76±1.10	var. *mongolica*
Yirsi, Neimonggu	85	NEFI 630082	3.1–7.3	5.09±0.83	var. *mongolica*
Guegang, Neimonggu	88	Dong 355, 357	2.1–7.9	5.24±1.21	var. *mongolica*
Antu, Jilin	350	NEFI 4001	3.4–7.7	4.98±0.80	var. *sylvestriformis*
Harbin, Heilongjiang	667	Li H-0086	7.3–11.0	9.48±0.73	var. *sylvestriformis*

* standard deviation

species because it can be distinguished by densely glandular pubescence in parts of the plant, large plant size, mostly stem leaves, a long pedicel, short corolla, and exposed stamens and stigma. *Polemonium hingganicum* is similar to *Polemonium pulchellum* in Siberia, but differs from the latter with large size, mostly stem leaves, campanulate corolla, and exposed stamens and stigma.

Penthorum sedoides L.

Penthorum is a perennial herbaceous genus with a disjunct distribution between eastern Asia and eastern North America. Although it is a small genus, the taxonomic treatment of species is in dispute. Gray (1846) once doubted that the Asian plants (*P. chinense* and *P. humile*) would be the same as the eastern North American *P. sedoides*. Maximowicz (1883) treated *P. chinense* as a variety of *P. sedoides*, and considered *P. humile* as possibly based on abnormal specimens. However, in this century, most scholars tend to recognize two species *P. sedoides* and *P. chinense* in the genus. Li (1952) clearly stated that *P. chinense* differs from *P. sedoides* in that stems are usually simple or few-branched, narrow leaves, has fewer flowered more corybose-like inflorescences and white flowers. In *P. sedoides*, as Li mentioned, the stems are usually many-branched, the leaves broader, the inflorescences more paniculate and the flowers greenish. Li's opinion is widely accepted by many scholars.

The natural range of *P. chinense* is the northeastern Asia, including Far East Russia, Northeast and North China, Korea, and Japan. We examined all available Chinese specimens of *Penthorum* and related literature and collected

TABLE 2. Morphological comparison of *Polemonium hingganicum* and its closely related species.

	P. acutiflorum	*P. boreale*	*P. hingganicum*	*P. pulcherrimum*	*P. pulchellum*
Distribution	Europe, Siberia, & western North America	circumboreal	boreal region of China	western North America	Siberia
Habitat	moist & grassy slopes	dry rocky slopes	moist & fertile sites	calcareous rocky slopes	rocky hills
Stature	10–80 cm	5–22 (40) cm	30–90 cm	10–40 (55) cm	8–25 cm
Stem	glabrous below & glandular pubescent above	glandular pubescent above	densely short glandular pubescent	spreading-hair to glandular pubescent	short glandular pubescent
Leaves	basal & stem	mostly basal	mostly stem	mostly basal	mostly basal
Leaflet	15–27 (23)	13–23	15–25	up to 31	11–25
Leaf surfaces	glabrous	viscid-pubescent	glandular pubescent	viscid-pubescent	glandular pubescent
Pedicel length	>calyx	<calyx	>calyx	>calyx	=calyx
Calyx Length	6–11 mm	5–10 mm	5–7 mm	4–7 mm	4–8 mm
Calyx lobe length	>tube	>tube	=tube	>tube	>tube
Calyx surfaces	glabrous	pubescent	pubescent	glabrous	pubescent
Corolla length	11–22 mm	14–25 mm	6–10 mm	8–13 mm	7–12 mm
Stamens	not exposed	not exposed	exposed	not exposed	not exposed
Stigma	not exposed	not exposed	exposed	not exposed	not exposed
Specimens Cited			Li 841-9008	Raines 1313	
References	Ohwi 1965, Polunin 1959	Polunin 1959, Welsh 1974	Huang & Li 1985	Polunin 1959, Welsh	Polunin 1959 1974

hundreds of accounts of specimens during 1985–1987. In 1989, we examined the American *P. sedoides* in both herbarium and field. Finally, we found the Asian and American plants to be almost the same in all characteristics in nature, with the exception of leaf shape. However, descriptions are often individual in flower color. Asian plant flowers have been observed and recorded as white, yellow white, and light green; American ones have been described as green or yellow-green in much of the literature (e.g. Correll and Johnston 1979). Some field notes of specimens are also different: e.g. *McCrary 1044* (Texas, 20 Jul 1984) recorded the flowers as yellow-green, and *Nixon 15992* (Texas, 10 Sep 1987) recorded flowers as white. According to our field observations in the last few years, the corollas of Chinese and American plants are both white in nature, but they are often inconspicuous and fall early while other parts of flowers are all green in color. In most cases, the white sepals do not remain or at most are restricted to the upper flowers in the inflorescences so that many observers recorded the flowers as green. Thus, flower color is not a character on which to distinguish between Asian and American plants.

Further, according to our observations, some Asian plants have simple or few-branched stems as Li (1952) described. Others have many-branched stems especially in dry and disturbed sites. Therefore, it seems there is no difference in stems between Asian and American populations. Also, Li's descriptions on the fewer flowered more corybose-like inflorescences (Asian plants) and more paniculate (American plants), seem a result of partial observations. According to our specimen examinations, there is no distinct difference in inflorescences between Asian and American taxa. In addition, anatomical data (Haskins and Hayden 1987) failed to show any significant difference between these two taxa.

Actually, the only morphological difference between Asian and American taxa is the former has narrow and long willow-like leaves, while the latter has wide and shorter glabrous leaves. Geographically, they occupy similar habitats on separate continents. Thus, we treat the Asian taxon as a geographic subspecies of the American species. As a result, *Penthorum* becomes one of five monospecific disjunct genera in eastern Asia and North America.

Penthorum sedoides L. subsp. **sedoides**

Distribution. Eastern United States.

Representative specimens examined. UNITED STATES. **Arkansas:** *D. Demaree 34302* (ASTC). **Iowa:** *H.B. Weyland 406* (ASTC). **Louisiana:** *C. Smith 1853* (ASTC). **Massachusetts:** *H.E. Ahles 90326* (ASTC). **Texas:** *L.E. Brown 3732* (ASTC); *M. McCrary 1044* (ASTC); *E.S. Nixon 7649, 10717, 15992* (ASTC); *E.S. Nixon and C. Burandt 7078* (ASTC); *E.S. Nixon and M. McCrary 3591* (ASTC); *E.S. Nixon and J.R. Ward 10863, 12390, 12422, 12434, 12547, 12922, 13043, 13136* (ASTC); *C. Waters 174* (ASTC).

Penthorum sedoides L. subsp. **chinense** (Pursh) S.Y. Li & K.T. Adair, comb. et stat. nov. BASIONYM: *Penthorum chinense* Pursh, Fl. Amer. Sept. 323. 1811; Koma-rov, Fl. Manshur. 2:403. 1903; Kitagawa, Lin. Fl. Manshur. 246. 1939; Liou, Key Pl. NE China 122. 1959. *Penthorum sedoides* L. var. *chinensis* (Pursh) Maxim., Mélanges Biol. Bull. Phys.-Math. Acad. Imp. Sci. Saint-Pétersbourg. 11:774. 1883.

Distribution. Korea, Japan, eastern China southward to Indochina.

Specimens examined. CHINA. **Heilongjiang:** *S.L. Dong 11040* (NEFI); *S.Y. Li 123, 84-103* (NEFI), *S.Q. Nie 964* (NEFI); *Y.L. Zhang 1926* (IFP). **Jilin:** *S.Y. Li 10043* (NEFI). **Liaoning:** *S.Y. Li 853007* (NEFI).

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A NEW SPECIES OF *ANEMONE* (RANUNCULACEAE) FROM CENTRAL TEXAS

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ABSTRACT

Five species of *Anemone* with tuberous rootstocks occur in Texas: *Anemone caroliniana* Walter, *A. berlandieri* Pritzel, *A. tuberosa* Rydberg, *A. edwardsiana* Tharp, and a new species, *A. okennonii* Keener & Dutton, endemic mainly to the Edwards Plateau in west-central Texas.

RESUMEN

Existen en Texas cinco especies de *Anemone* con rizomas tuberosos: *Anemone berlandieri* Pritzel, *A. caroliniana* Walter, *A. edwardsiana* Tharp, *A. tuberosa* Rydberg, y una nueva especie *A. okennonii* Keener & Dutton endémica principalmente de la Meseta Edwards en el centro-oeste de Texas

INTRODUCTION

The genus *Anemone* L. consists of ca. 150 species of perennial herbs featuring one or more radical leaves, involucrate peduncles, petaloid sepals, and achene fruits. In a recent preliminary reclassification based on restriction site variation and morphology of the subgeneric taxa of *Anemone*, Hoot et al. (1994) recognized two subgenera and seven sections. Section *Anemone* consists of four taxonomically unnamed groups, one of which (the *Coronaria* group) is characterized by distinctive tuberous rootstocks, typically heteromorphic 1–3 ternate radical leaves, simple or branched scapes with sessile involucral bracts positioned near the middle of the peduncle, numerous linear to obovate sepals, and numerous, usually densely woolly achenes borne in ellipsoidal to cylindroidal heads. According to Hoot et al. (1994), the ca. 18 species of the *Coronaria* group of section *Anemone* range from southern Europe to Mongolia, central and southern United States and adjacent Mexico, and South America below 10° south latitude (Hoot 1991; Joseph and Heimburger 1966).

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Texas has five species of anemones with tuberous rootstocks: *A. caroliniana* Walter, *A. berlandieri* Pritzel, *A. tuberosa* Rydberg, *A. edwardsiana* Tharp, and a new species, *A. okennonii* Keener & Dutton, herein described from the Edwards Plateau. The aim of our paper is to clarify the taxonomy of these species of *Anemone* in Texas, to provide keys to the taxa, and to describe the new species. Joseph and Heimburger (1966) reviewed the cytotaxonomic structure of these species (except *A. okennonii*), and provided (p. 908) a helpful comparative chart and distribution maps; the reader is referred to their paper for additional details. The five species treated herein are distinguished chiefly on the basis of leaf dissection, scape pubescence, relative similarity of involucral bracts to the basal leaves, style length, and sepal number and size (see Table 1 for additional details).

Until the species of *Anemone* with tuberous rootstocks are studied worldwide, it would be premature to speculate on phylogenetic relationships of the species treated in our paper (See Hoot et al. [1994] for further analysis of this problem). We believe, however, that *Anemone okennonii* is taxonomically closest to *A. edwardsiana*, but whether these two species are closest phylogenetically remains in question.

KEY TO TEXAS SPECIES OF *ANEMONE* WITH TUBEROUS ROOTSTOCKS

1. Involucre below middle of scape at anthesis; scape nearly glabrous below involucre; involucral bracts similar to at least some radical leaves; styles as long or longer than the ovoid achenes .... 1. *A. caroliniana*
1. Involucre above middle of scape at anthesis; scape glabrous to pubescent below involucre; involucral bracts dissimilar or similar to radical leaves; styles less than half as long as the orbicular, flat achenes.
    2. Scape simple, bearing 1 flower; involucral bracts distinctly dissimilar to radical leaves; scape densely pubescent below involucre .... 2. *A. berlandieri*
    2. Scape usually branched, bearing 2 or more flowers per stem; involucral bracts similar or dissimilar to radical leaves; scape nearly glabrous to glabrous below involucre.
        3. Involucral bracts similar to radical leaves; radical leaflets narrow, 1–2 cm wide; achenes 3–4 mm wide; rare in Texas (El Paso Co.) .... 3. *A. tuberosa*
        3. Involucral bracts dissimilar to radical leaves; radical leaflets broader, 1.5–2.5 cm wide; achenes 2–3(3.5) mm wide; uncommon, central to western Texas.
            4. Leaves 1(2) ternate; leaflets usually crenate-dentate; lateral flowering branches maturing usually at the same time as the central; sepals 10–20, oblanceolate, 2–3 mm wide .... 4. *A. edwardsiana*
            4. Leaves (2)3 ternate; leaflets usually incised with sharp teeth; lateral flowering branches maturing much later than the central; sepals 7–11, oblong, 3–4.5 mm wide .... 5. *A. okennonii*

1. **Anemone caroliniana** Walter, Fl. Carol. 157–158. 1788.

Slender, apically villous herbs; stems simple, 0.5–3.5 dm tall at anthesis, from rhizomes bearing a series of small, ±oblong to globose tuberous rootstocks 0.5–1 cm long and 0.5 cm thick. Radical leaves 1–2 ternate, to 3.5 cm wide; petioles 3–9 cm long. Leaflets 1–2 cm wide, glabrous, deeply 2–3-parted or divided, segments variously cleft, lobed or toothed, ultimate segments broad to narrow with crenate-dentate margins to variously linear with acute tips, sessile to long petiolulate. Involucral bracts usually similar to at least some radical leaves, reduced, opposite or whorled, sessile to subsessile, sparsely pilose, positioned below middle of scape at anthesis. Flowers solitary; scape villous above involucre, nearly glabrous below. Sepals 10–30, greenish white or pink to purplish blue, linear-oblong, 10–20 mm long and 1–6.5 mm wide; anthers yellow, 0.5–0.75 mm long. Fruiting heads ellipsoidal, to 2 cm long and 1.5 cm broad; achenes brownish, turgid, ±ovoid, ca. 2 mm wide, densely woolly; styles greenish (lavender-tipped), erect, filiform, as long as or longer than achenes, projecting beyond the woolly tomentum; $2n=16$ (Joseph and Heimburger 1966).

February to April. Prairies, moist sandy soils, calcareous dry grasslands, rocky hillsides, and alluvial flats, South Dakota to Texas, east to South Carolina and Georgia.

Anemone caroliniana is distinguished by its rhizomatous rootstocks bearing a series of small tubers, its heteromorphic radical leaves some of which resemble the involucral bracts, its simple scape bearing involucral bracts below the middle, its scape pubescent above the involucre but glabrous below, and its densely woolly ovoid achenes bearing relatively long styles (Table 1). In Texas, *A. caroliniana* occurs chiefly in the eastern third of the state, with some populations in the west-central and northern regions (see Joseph and Heimburger 1966, Fig. 3, for a distribution map of this species).

2. **Anemone berlandieri** Pritzel, Linnaea 15:628–629. 1841.

A. heterophylla Nuttall, nomen nudum in syn., Torrey & A. Gray, Fl. N. Amer. 1:12. 1838.
A. caroliniana Walter var. *heterophylla* Torrey & A. Gray, Fl. N. Amer. 1:12. 1838.
A. decapetala Arduino var. *heterophylla* (Torrey & A. Gray) Britton & Rusby, Trans. New York Acad. Sci. 7:7. 1887.

Similar to, though often larger than *A. caroliniana*. Stems simple, (1)3–5 dm tall at anthesis, from thick clavate to oblong, tuberous rootstocks 2–4 cm long and ca. 1 cm thick. Radical leaves 1(2) ternate; petioles 3–20 cm long. Leaflets 2–4 cm wide, pubescent, often 2–3 lobed or parted, the cuneate segments usually broad or rounded apically with dentate or serrate to crenate margins, sessile to long petiolulate. Involucral bracts dissimilar to radical leaves, ultimately dissected into linear segments with acute tips,

TABLE 1. Comparison of Texas *Anemone* species with tuberous rootstocks.

Anemone	*caroliniana*	*berlandieri*	*tuberosa*	*edwardsiana*	*okennonii*
STEM					
height (dm)	0.5–3.5	(1)3–5	1–3	3–5	2–3
branches	none	none	1 (rarely 2)	1–3	1–3
time of flowering			central before lateral	lateral with central	central before lateral
PUBESCENCE					
above involucre	villous	villous	villous	densely villous	villous
below involucre	±glabrous	villous	subglabrous	subglabrous	glabrous to subglabrous
TUBEROUS ROOTSTOCKS					
shape	±oblong to globose	clavate to oblong	oblong-obovate	oblong-obovate	oblong-obovate
length (cm)	0.5–1.0	2–4	1.5–2.0	2–4	1–3
thickness (cm)	0.5	1	1	1–2	1
RADICAL LVS					
divisions	1–2 ternate	1(2) ternate	1–2 ternate	1(2) ternate	(2)3 ternate
leaflet width (cm)	1–2	2–4	1–2	2–2.5	0.5–1.5(2.5)
pubescence	glabrous	pubescent	subglabrous	glabrous	subglabrous; marginally ciliate
petiole length (cm)	3–9	3–20	5–7	8–15	5–10
BRACTS					
position	below mid-scape	above mid-scape	above mid-scape	above mid-scape	above mid-scape
pubescence	sparsely pilose	pilose	thinly pilose	glabrous to sparsely pilose	appressed pilose
sessile/petiolate	±sessile	sessile	short-petiolate	sessile	short-petiolate
similar to basal leaves	yes (some)	no	yes	no	no
SEPALS					
number	10–30	7–17	8–10	10–20	7–11
shape	linear-oblong	linear-oblong	linear-oblong	oblanceolate	oblong
length (mm)	10–20	7–15(20)	10–14	10–16	6–12
color	various	various	greenish white to purplish	greenish white to bluish	greenish white
FRUITING HEAD					
shape	ellipsoidal	cylindroidal	±cylindroidal to ellipsoidal	ellipsoidal cylindroidal	oblong-ellipsoidal
length/width (cm)	1.5–2/0.5–1.5	2–3.5/0.5–1.3	1.5–3/1–1.5	1.5–3/0.6–0.8	1–3/0.5–1
ACHENES					
shape	turgid, ± ovoid	flat, orbicular	flat, orbicular	flat, orbicular	flat, ovate
width (mm)	ca. 2	2–3	3–4	2–3(3.5)	2–3
pubescence	densely woolly	densely woolly	densely villous	sparse	densely white

TABLE 1. continued

Anemone	*caroliniana*	*berlandieri*	*tuberosa*	*edwardsiana*	*okennonii*
STYLES					
shape	filiform	subulate	filiform	filiform	filiform
style/ach. length	≥1.0	ca. 1/3	<1/2	ca. 1/3	ca. 1/4
ANTHESIS	Feb. to Apr.	Feb. to Apr.	Apr. to May	Feb. to Apr.	Mar. to Apr.
HABITAT	moist acid soils and calcareous prairies	moist alkaline soils	high dry rocky slopes	canyons, in moist shaded alkaline soils	high dry open ledges and slopes

pilose, positioned above middle of scape at anthesis. Flowers solitary; scape villous throughout. Sepals 7–17, greenish white to pink or purplish blue, linear-oblong, to 7–15(20) mm long and 1.5–5 mm wide; anthers yellowish brown, 0.5–1 mm long. Fruiting heads cylindroidal, 2–3.5 cm long and 0.5–1.3 cm broad; achenes flat, orbicular, 2–3 mm wide, densely woolly; styles greenish (lavender-tipped), subulate with bent tips, ca. 1/3 length of achenes, not projecting beyond the dense woolly tomentum; $2n = 16$ (Joseph and Heimburger 1966).

February to April. Limestone hills, grassy knolls, and stony ground, Texas and Oklahoma eastward to (rarely) North and South Carolina.

Anemone berlandieri is distinguished by its ternate radical leaves with broad segments having typically crenately toothed margins, its simple scape bearing involucral bracts above the middle of the more or less uniformly pubescent scape, its bracts distinctly unlike the radical leaves, and its densely woolly orbicular, flat achenes bearing styles ca. 1/3 length of the achene (Table 1). In Texas, *A. berlandieri* occurs throughout the state except for the extreme western portions (i.e., High Plains and Trans-Pecos, Mountain and Basin regions; see Map 1, Correll and Johnston 1970).

The taxonomy of this species is complicated, owing largely to whether the North American plants are conspecific with the South American species recognized as *A. decapetala* Arduino (Britton 1891), and the adoption of the name *A. heterophylla*, which is listed by Torrey and A. Gray (Fl. N. Amer. 1:12. 1838) merely as a synonym for *A. caroliniana* Walter var. *heterophylla* Torrey & A. Gray. Joseph and Heimburger (1966) clarified distinctions between the North and South American species, and Keener (1975) reviewed the legitimacy of the name *A. heterophylla*.

3. **Anemone tuberosa** Rydberg, Bull. Torrey Bot. Club 29:151–152. 1902.

A. sphenophylla sensu Britton, Ann. New York Acad. Sci. 6:220. 1891, p.p., non Pöppig, Frag. syn. 27. 1833.

Robust, apically villous herbs; stems simple below, usually branched above involucre, 1–3 dm tall at anthesis, from brownish, oblong-obovate tuberous rootstocks 1.5–2 cm long and 1 cm thick. Radical leaves several, 1–2 ternate; petioles 5–7 cm long. Leaflets 1–2 cm wide, subglabrous, variously parted or cleft, with cuneate-obovate segments having acute tips, sessile to petiolulate. Involucral bracts 3, similar to radical leaves in dissection, reduced, short-petiolate, thinly pilose, positioned above middle of scape at anthesis; secondary branches 1 or more, 2-bracteate. Flowers 1-several per scape; lateral flowering branches maturing later than central flower; scape villous above involucre, subglabrous below. Sepals 8–10, greenish white to purplish, linear-oblong, 10–14 mm long, 3–6.5 mm wide; anthers yellowish brown, ca. 1 mm long. Fruiting heads cylindroidal to ellipsoidal, 1.5–3 cm long and 1–1.5 cm broad; achenes flat, orbicular, 3–4 mm wide, densely villous; styles lavender, ±erect, filiform, less than 1/2 length of achenes, not projecting beyond the dense woolly tomentum; $2n = 16$ (Joseph and Heimburger 1966).

April to May. High dry rocky slopes, southeastern California, southern Nevada, and southwestern Utah, southeastward to extreme western Texas (El Paso Co.), where it occurs on igneous rocky slopes (Joseph and Heimburger 1966).

Anemone tuberosa is distinguished by its ternate to biternate radical leaves with acute-tipped oblong-ovate segments, its relatively large involucral bracts similar in dissection to the radical leaves, its typically branched scape with an involucre above the middle at anthesis, its scape pubescent above the involucre but more or less glabrous below, and its densely villous, flat, orbicular, achenes having styles less than 1/2 the length of the achene (Table 1).

Britton (1891) regarded the North American populations conspecific (as *A. sphenophylla*) with similar populations in Chile, but Rydberg (1902) pointed out that in the Chilean plants "the whole scape is decidedly pubescent with ascending hairs and the segments of the involucral bases are narrower." However, Lourteig (1951: 564) regarded *A. sphenophylla* as a taxonomic synonym of *A. decapetala* Arduino.

4. **Anemone edwardsiana** Tharp, Amer. Midl. Naturalist 33:669. 1945.

Slender, apically villous herbs; stems simple below, usually branched above involucre, 3–5 dm tall at anthesis, from brownish, oblong-obovate tuberous rootstocks 2–4 cm long and 1–2 cm thick. Radical leaves several to many, 1(2) ternate; petioles 8–15 cm long. Leaflets reniform in outline, 2–2.5 cm wide, glabrous, variously 2–4 cleft, lobes crenate-dentate to sharply toothed, sessile to petiolulate. Involucral bracts 3, ±sessile, dissimilar to radical leaves, 2–5 cm long, ultimately dissected into oblanceolate segments with rounded to acute tips, glabrous to sparsely pilose, positioned above middle of scape at anthesis; secondary branches 1–3, 2-bracteate. Flowers 1-several per scape; lateral flowering branches usually maturing with central flower; scapes villous above involucre, subglabrous below. Sepals 10–20, greenish white to bluish, oblanceolate, 10–16 mm long, 1.5–3(4) mm wide; anthers bright yellow, 0.5–1 mm long. Fruiting heads ellipsoidal to cylindroidal, 1.5–3 cm long and 0.6–0.8 cm broad; achenes flat, orbicular, 2–3(3.5) mm wide, typically sparsely pubescent to glabrous; styles erect to horizontal, filiform, ca. 1/3 length of achenes, not projecting beyond the woolly tomentum; $2n=16$ (Joseph and Heimburger 1966).

February to April. Alkaline soils in moist shaded canyons; shaded, moist, rocky limestone bluffs and ledges along eastern edge of Edwards Plateau (R.J. O'Kennon, pers. comm.). Two varieties:

a. Achenes woolly, ±dull .... var. *edwardsiana*
a. Achenes glabrous, vernicose (polished) .... var. *petraea*

4a. **Anemone edwardsiana** var. **edwardsiana**

Range and habitat of the species.

4b. **Anemone edwardsiana** var. **petraea** Correll, Madroño 19:189. 1968.

Tall, spindly plants with glabrous, vernicose achenes endemic to moist rocky crevices along Curry Creek near Kendalia, Kendall Co., Texas. Additional population and cytotaxonomic studies are desirable to establish more clearly the range of this taxon as well as its phylogenetic relationships to other species in this complex.

The most polymorphic of Texas anemones, *A. edwardsiana* combines features of both *A. tuberosa* and *A. berlandieri* (cf. Table 1). It is like *A. tuberosa* in having a branched scape glabrous or slightly pubescent below the involucre, and like *A. berlandieri* in having involucral bracts with long, narrow, sharply toothed segments quite dissimilar from the radical leaves. Achene shape, style length, and position of the involucral bracts are similar to those character states in both *A. berlandieri* and *A. tuberosa*. The combination of branched scapes, involucral bracts dissimilar to the radical leaves, and relatively few sparsely woolly to glabrous achenes demarks *A. edwardsiana* from the other anemones in Texas.

Joseph and Heimburger (1966) pointed out that *A. edwardsiana* not only combines features of *A. tuberosa* and *A. berlandieri* (= *A. heterophylla* in their treatment), but also "shows an intermediate geographic range and altitude preference." They suggested that *A. edwardsiana* may be a hybrid derivative of *A. tuberosa* and *A. berlandieri*. However, based on restriction site analyses, Hoot et al. (1994) claimed that *A. edwardsiana* is a sister species to *A.*

berlandieri and possesses "no rDNA fragments in common with *A. tuberosa*." Additional biosystematic studies are desirable to clarify the phylogenetic relationships of this complex.

Because of glabrous, vernicose achenes, Correll (1968) segregated several populations occurring near Kendalia in Kendall Co., Texas, as *A. edwardsiana* var. *petraea* Correll. These populations appear to be an ecotypic phase of the polymorphic *A. edwardsiana*.

5. **Anemone okennonii** Keener & Dutton, sp. nov. (Figs. 1,2)

Herba perennis erecta e tuberibus brunneis; tubera oblongo-obovata, 1–3 cm longa, 1 cm crassa. Folia radicalia pluria, triternata, glabriuscula; petioli usque ad 10 cm longi. Foliola 0.5–1.5 (2.5) cm lata, profunde 2–4-fida; lobi cuneati-acuti; petioluli usque ad 2 cm longi. Scapi 2–3 dm alti, basibus glabratis, apicibus pubescentibus; bracteae primariae involucri 3, 2–5 cm longae; ramuli axillares (0)1–2(3), unusquisque involucro secundario bibracteato. Flores centrales 1.5–2.5 cm lati; ceteri parviores; sepala viridi-alba. Capitula fructificantia oblongo-elliptica, 1–3 cm longa. Achenia lata, ovata, marginata, brevirostria; rostra plus minusve erecta, pilis basibus sub-aequantibus corpora pubescentia.

Slender, apically villous herbs; stems simple below, usually 1–3 branched above involucre, 2–3 dm tall at anthesis, from brownish oblong-obovate tuberous rootstocks 1–3 cm long and 1 cm thick. *Radical leaves* several to many, *(2)3 ternate*; petioles 5–10 cm long. *Leaflets 0.5–1.5(2.5) cm wide*, subglabrous but marginally ciliate, deeply 2–4 cleft, *lobes cuneate-acute, reddish-glandular*; petiolules to 2 cm long. Primary involucral bracts 3, short-petiolate, dissimilar to radical leaves, 2–5 cm long, variously cleft into linear, acute-tipped segments, appressed pilose, positioned above middle of scape at anthesis; secondary branches (0)1–2(3), 2-bracteate. Flowers 2-several per scape; *lateral flowering branches maturing later than central flower*; scapes pubescent above involucre, glabrous or subglabrous below. *Sepals 7–11, greenish white, oblong, 6–12 mm long, (2)3–4.5 mm wide; anthers pale yellow, fading to creamy brown*, 0.75–1 mm long. Fruiting heads oblong-ellipsoidal, 1–3 cm long and 0.5–1 cm broad; *achenes* flat, ovate, 2–3 mm broad, *densely white villous*; *styles lavender-tinted*, ±erect to horizontal, filiform, *ca. 1/4 length of achenes*, not projecting beyond the wooly tomentum. Chromosome number unknown.

TYPE: U.S.A. TEXAS. Gillespie Co.: high on shallow roadcut in sandy loam, Fm 783, 2 mi S of Doss, 22 Apr 1993, *Robert J. O'Kennon 11390* (HOLOTYPE: BRIT; ISOTYPES, PAC, TEX; see Fig. 1). Named in honor of its discoverer, Robert J. O'Kennon, keen student of the flora of Texas.

Representative specimens examined: U.S.A.: TEXAS: **Brewster Co.**: Glass Mts., 21 Mar 1941, *Rose-Innes & Warnock 565* (SMU). **Crockett Co.**: 14.8 mi W of Ozona, 14 Mar 1949, *Turner & Warnock 273* (SMU). **Kimble Co.**: Hwy 385, 2.5 mi S of Llano River, 9 Mar 1992, *R.J. O'Kennon 8813* (PAC). **Mitchell Co.**: Lake Hollywood, 27 Mar 1945, *Pohl 4744* (SMU). **Pecos Co.**: 20 mi NE of Ft. Stockton toward McCamey, 27 Apr 1947, *Warnock 5199* (SMU).

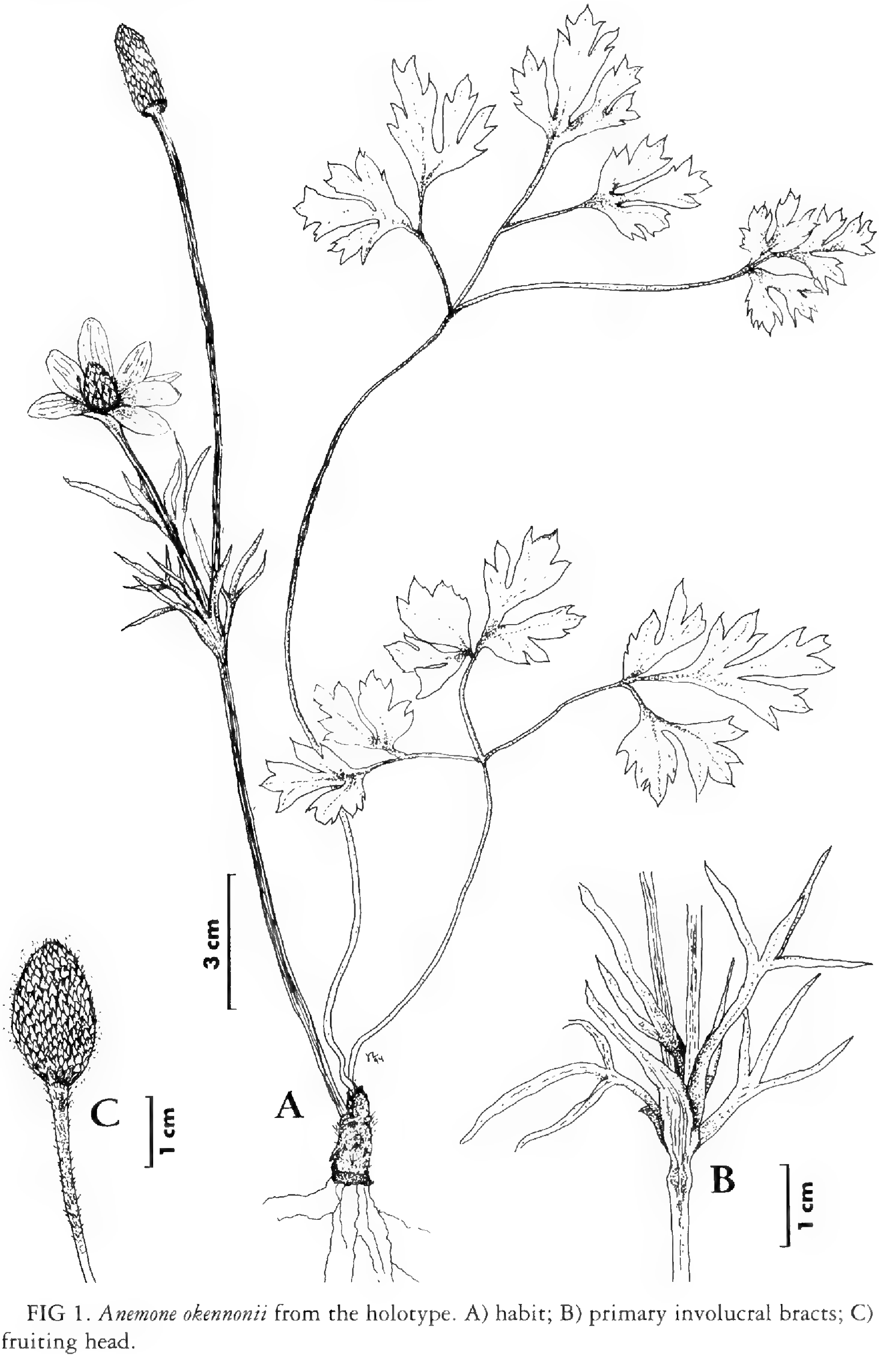

FIG 1. *Anemone okennonii* from the holotype. A) habit; B) primary involucral bracts; C) fruiting head.

FIG. 2. Habit of *Anemone okennonii*.

Terrell Co.: 31 mi S of Sheffield, 14 Mar 1949, *Turner & Warnock 307* (SMU); 4.2 mi W of Sanderson, 14 Mar 1949, *Turner & Warnock 319* (SMU). **Val Verde Co.:** 20 mi NNW of Del Rio, 31 Mar 1947, *McVaugh 7729* (SMU).

March to April. Dry sunny rocky limestone ledges, hills, and roadsides, in red sandy loam and igneous-based soils at an elevation of 490–530 m. Endemic from Gillespie and Mitchell cos., southwestward to Val Verde and Brewster cos., Texas, mainly in the Edwards Plateau vegetational area with outliers in the Rolling Plains and Trans Pecos, Mountain and Basin vegetational areas (see Map 1, Correll and Johnston 1970).

Anemone okennonii has been variously recognized as *A. caroliniana* Walter, *A. decapetala* Arduino, *A. edwardsiana* Tharp, *A. sphenophylla* Pöppig, *A. tuberosa* Rydberg, or possibly a hybrid between *A. tuberosa* and *A. heterophylla* Nuttall (= *A. berlandieri* Pritzel).

Anemone okennonii differs from its nearest presumed congener, *A. edwardsiana*, by its leaf dissection ([2]3 ternate vs. 1[2] ternate), its smaller leaflets (0.5–1.5 cm wide vs. 2–2.5 cm wide) with sharply cleft (rounded) lobes, its central flower maturing before (with) the lateral flowers, its sepal number (7–11 vs. 10–20), anther color (pale yellow vs. bright yellow), achene pubescence (densely white villous vs. sparse to glabrous), seedling leaves (similar to basal leaves vs. similar to bracts), relatively later blooming period (March to April vs. February to April), and habitat (drier, more exposed sites vs. more moist and shaded sites). The following chart summarizes differences between *A. okennonii* and other Texas species of *Anemone* with tuberous rootstocks:

1.	Radical leaves typically 3-ternate	Distinctive
2.	Leaves reddish-glandular on margins, tips	Distinctive
3.	Leaf divisions cuneate-acute	Like *A. tuberosa*
4.	Smaller flowers (cf. sepal length, below)	Distinctive
5.	Two or more flowers per stem	Like *A. edwardsiana* and *A. tuberosa*
6.	Central flower matures before lateral flowers	Like *A. tuberosa*
7.	Anthers pale yellow, fading to creamy brown	Distinctive
8.	Styles lavender-tinted	Distinctive
9.	Involucre with linear divisions	Like *A. berlandieri*
10.	Sepals 7–11	Like *A. tuberosa*
11.	Sepals oblong, 6–12 mm × (2)3–4.5 mm	Distinctive

Plant associates of *A. okennonii* include *Acacia roemeriana* Scheele, *Aristolochia coryi* I.M. Johnston, *Colubrina texensis* (Torrey & A. Gray) A. Gray, *Delphinium carolinianum* Walter, *Draba cuneifolia* Torrey & A. Gray, *Echinocereus enneacanthus* Engelmann, *Euphorbia acuta* Engelmann, *Ferocactus setispinus* (Engelmann) L. Benson, *Gilia rigidula* Bentham, *Haplopappus spinulosus* (Pursh) DC., *Melampodium leucanthum* Torrey & A. Gray, *Opuntia phaeacantha* Engelmann, *Prunus minutiflora* Engelmann, *Tetraclea coulteri* A. Gray, and *Thamnosma texana* (A. Gray) Torrey (R. J. O'Kennon, pers. comm.).

Anemone okennonii appears to have evolved from *A. edwardsiana* and may actually be a xeric form of it (R. J. O'Kennon, pers. comm.). O'Kennon has suggested (pers. comm.) that millions of years ago when western Texas was more mesic than at present a precursor form of *A. edwardsiana* was most likely the predominant species of *Anemone* in this area. As western Texas became hotter and drier (and this trend continues at present), xeric forms began to evolve. *Anemone tuberosa* probably evolved first farther west, and then *A. okennonii* evolved to fit into the niche between the two. The three species seem not to overlap anywhere in their ranges. The only species sympatric with *A. okennonii* is *A. berlandieri*, but there does not appear to be any intergradation between these two species. Critical biosystematic and population studies would be useful in establishing the most probable phylogenetic relationships among these five taxa of Texas anemones with tuberous rootstocks.

ACKNOWLEDGMENTS

Special thanks are due to Robert J. O'Kennon for pointing out the taxonomic problems in the Texas anemones and for providing specimens and data; to Dr. Sara Hoot and Dr. Ronald A. Pursell for reviewing an earlier manuscript; and to Robert F.C. Naczi for providing the Latin diagnosis of *Anemone okennonii*. Any errors of fact or interpretation are strictly our responsibility.

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DOCUMENTED CHROMOSOME NUMBERS 1994:1. KARYOTYPE OF *JAIMEHINTONIA GYPSOPHILA* (AMARYLLIDACEAE)

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ABSTRACT

A somatic chromosome count of the recently described *Jaimehintonia gypsophila* B.L. Turner (Amaryllidaceae) is presented, along with a photograph showing its karyotype. It has a diploid count of 2n=20 and is comprised of three pairs of large submetacentric chromosomes, three pairs of medium metacentric chromosomes and four pairs of small chromosomes, three of these metacentric and one acrocentric.

RESUMEN

Se presenta un recuento cromosómico somático de la recientemente descrita *Jaimehintonia gypsophila* B.L. Turner (Amaryllidaceae) junto con una fotografía que muestra su cariotipo. Presenta un recuento diploide de 2n=20 formado por tres pares de cromosomas grandes submetacéntricos, tres pares de cromosomas de tamaño medio metacéntricos y cuatro pares de cromosomas pequeños, tres de los cuales son metacéntricos y uno acrocéntrico.

INTRODUCTION

Jaimehintonia is a recently described monotypic genus of the Amaryllidaceae, tribe Allieae (Turner 1993). The single species, *J. gypsophila, i*s a relatively rare edaphic endemic in to gypseous soils of northeastern Mexico. Its generic relationships are moot, but its author thought the species to be most closely related to *Androstephium* and allies, in the sense of Moore (1953).

The present paper attempts to position the genus with more certainty using karyotypic data.

MATERIALS AND METHODS

Chromosome studies were made from root tips of seeds germinated on an agar nutrient medium in a petri dish. Seeds were collected at the type locality by George S. Hinton *(Hinton et al. 20560,* TEX*)*.

Root tips were placed in saturated 8-hydroxyquinoline solution for 4 hr, fixed in 3:1 (ethanol : acetic acid) about 4 hr, and transferred to 70% ethanol overnight. They were softened in 10% HCl at 60 C for 15 min, then squashed using standard procedures.

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RESULTS

The chromosome number of this species is 2n=20 (Fig. 1). Its karyotype can be described as follows (Fig. 2): three pairs of large submetacentric chromosomes, three pairs of medium metacentric chromosomes, three pairs of small metacentric chromosomes, and one pair of small acrocentric chromosome.

DISCUSSION

Jaimehintonia appears to have a distinctive karyotype that, along with its morphological features, supports its recognition as a distinct genus. Among the tribe Allieae, chromosome numbers of 2n=20 are found only in two species of the genus Muilla, but chromosomes of the latter differ in shape from those of *Jaimehintonia.* (Both *M. maritima* [Torr.] S. Wats. and *M. transmontana* Greene have five medium to long submetacentric chromosomes, four short submetacentric, and one short nearly metacentric chromosomes; Lenz 1975.) An anomalous count of n=20 pairs has been reported for *Brodiaea lutea* (Lindl.) Morton var. *anilina* (Greene) Munz (Niehaus 1965), but the chromosome numbers of most taxa of *Brodiaea* are based on x=6, 7, 8, and 9 (Federov 1969). This, along with differences in floral morphology, appears to rule out a close relationship between *Jaimehintonia* and *Brodiaea*. In contrast, the similarity between *Jaimehintonia* and taxa of the *Androstephium* group (within the Allieae), as noted by Turner (1993), indicate

FIG. 1. Microphotograph of root tip cell of *Jaimehintonia gypsophila* (×1000).

FIG.2. Karyotype of *Jaimehintonia gypsophila*, obtained from Fig.1.

that a close evolutionary relationship is probable. Unfortunately, there are no chromosome number reports for *Androstephium.*

ACKNOWLEDGMENTS

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BOOK REVIEW

BELOUSOVA, L.S. and L.V. DENISOVA. 1992. **Rare Plants of the World.** (ISBN 90-6191-482-5, hbk). A.A. Balkema Publishers, Rotterdam, Netherlands. $75 (hbk). 348 pp.

Translated from Russian, this book describes about 2000 rare and endangered plants of the world. The authors intended to provide a larger list and more information about each plant than is available from the Red Data Book of Plants published by the World Conservation Union (IUCN). Selections are based on regional publications as well as the Red Data Book of Plants, and it uses the IUCN rarity categories. It is easy to peruse, with brief botanical descriptions of each species and common names printed in bold type. It is organized by continent with plant families in alphabetical order. Notes on distributions, conservation status, endangerment listings, and causes of rarity are also included. There are sixty-four plates each with four taxa illustrated; eight of the plates are in color.

Treated in the book are about 118 taxa out of 818 listed as extinct or most probably extinct and endangered in North America (1342 additional taxa are in the vulnerable category for North America). When examining endangered, threatened, or protected native plants of Texas one finds a number of taxa, 17 to be exact, not included. Out of the 21 species listed for Texas, four are treated in the book. Two out of nine cactus species are listed for Texas, REICHENBACH'S ECHINOCEREUS (*Echinocereus reichenbachii*) and TOBUSCH'S ANCISTROCACTUS (*Ancistrocactus tobuschii*). HINCKLEY'S OAK (*Quercus hinckleyi*) and TEXAS WILD-RICE (*Zizania texana*) are the other two taxa listed.

The book would be improved by a discussion of rarity and endangerment in plants, for example a summation of plant characteristics and environmental conditions correlated with conservation status.—*Larry Ford.*

NOTES

VALIDATION OF *KARINIA* (CYPERACEAE)—It has been called to our attention that the name *Karinia* Reznicek & McVaugh, Flora Novo-Galiciana 13:386. 8 Dec 1993, may not be validly published because, even though monotypic, the sole species was not stated in the protologue also to be the holotype of the generic name.

It is difficult to understand how the generic name could have any other type, but for the peace of mind of those who would consider the name not validly published, the name is here explicitly typified to fulfil this requirement for valid publication, and the combination *Karinia mexicana* is remade now that the generic name is valid.

Karinia Reznicek & McVaugh

HOLOTYPE: *Karinia mexicana* (Britton) Reznicek & McVaugh, comb. nov. *Scirpus mexicanus* C.B. Clarke ex Britton, Trans. New York Acad. Sci. 11:77. 1892.

—A.A. Reznicek & R. McVaugh, University of Michigan Herbarium, North University Building, Ann Arbor, MI 48109, U.S.A.

PENSTEMON THURBERI (SCROPHULARIACEAE) NEW TO TEXAS—*Penstemon thurberi* Torr. (*P. scoparius* A. Nels., *Leiostemon thurberi* Greene, *P. ambiguus* var. *thurberi* Gray) is a woody perennial distributed from Southern California through Arizona to Southcentral New Mexico and Northern Mexico. In New Mexico, it is found in the southwestern counties east to Dona Ana and Lincoln counties (Martin and Hutchins 1981). This is the first report of *P. thurberi* in Texas, a range extension of approximately 320 km from the nearest known site in Dona Ana county, New Mexico, to the two populations on the slopes of Little Pinto Canyon and Cinco de Mayo Canyon in the Chinati Mountains of Presidio county, Texas. The two populations, approximately 2 km apart, one with about 150 specimens and the other with about 300, are in loose sandy shale, surrounded by plants typical of the Chihuahuan Desert grassland.

Collection data are: TEXAS. **Presidio Co.:** Little Pinto Canyon, *Warnock 121*, 9 Aug 1988 (Fig. 1).

—Barton H. Warnock, Professor Emeritus, Department of Biology, Sul Ross State University, P.O. Box 158, Alpine, TX 79831, U.S.A.; John Mac Carpenter, Native Plant Society of Texas, P.O. Drawer 430, Ft. Stockton, TX 79735-0430, U.S.A.

FIG. 1. *Penstemon thurberi.*

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EUPHORBIA GRAMINEA (EUPHORBIACEAE) NEW TO FLORIDA—*Euphorbia graminea* Jacq. apparently came into southern Florida during the late 1980s as a weed in horticultural stock. John Popenoe found plants without flowers in nurseries for several years (personal communication), but it was not until Jan-Feb 1993 that Popenoe and I independently found flowering populations of *E. graminea* separated by several miles. Plants of this species were found again, and in new areas, during the fall of 1993 so it seems fair to regard the species as established in southern Florida.

Euphorbia graminea is an erect annual reaching 35 cm in height with leaves well separated along the stem and branches. Stem leaves are 2-4 cm long, alternate and, on all Florida plants seen, are ovate with undulate margins. Leaves on the branches of the inflorescence are slightly shorter, opposite or nearly so and narrowly elliptic. Cyathia are terminal or solitary in the axes of dichasia and about 1 mm long. A variable number (1-4) of glands is produced along the upper edges of the cyathium, with many specimens having two glands on the cyathium. Glands have white appendages that are about equal in size to the glands. The capsule is held beneath the gland appendages until maturity and may not be apparent without close inspection. Mature capsules are about 3 mm long and wider than long.

Euphorbia graminea is widespread from southern Mexico to northern South America, and has weedy tendencies throughout this range. It shows considerable variation in leaf shape and pubescence, leading to the proposal of several subspecific groups. There is no consensus on the validity of these subspecific taxa (Webster and Burch 1968), so no attempt was made to identify the Florida plants below the specific level.

Within the genus *Euphorbia* (sens. lat.), *E. graminea* is the lectotype species of the section *Cyttarospermum* (Wheeler 1943). It has also been treated under the segregate genus *Eumecanthus*. This group is characterized by petiolate leaves and ecarunculate seeds with an areolate pattern of raised bumps covering the surface (Subils 1977).

All collections from Florida so far have been made in cultivated sites. Within these cultivated areas, the *Euphorbia* evidently prefers bare patches. Seeds are dispersed locally by the explosively dehiscent capsules, but the primary means of spread in southern Florida seems to be through human transport of ornamental plants, especially field grown trees.

Voucher specimens: FLORIDA. **Dade Co.:** weed in residential lawn, near Homestead, 28 Jan 1993, *Herndon 3338* (FTG); weed at the Dave Romney farm, Homestead, 5 Feb 1993, *Popenoe 2476* (FTG); growing in planted bed along the right-or-way of Old Cutler Road, ca. 1/4 mi S of Fairchild Tropical Garden, 20 Feb 1993, *Popenoe 2480* (FTG); weed in potted plant by residence, Perrine, 20 Aug 1993, *Herndon 3346* (FTG).

I am grateful to John Popenoe for sharing his knowledge of the early history of this species in Florida.—*Alan Herndon, Department of Biological Sciences, Florida International University, Miami, FL 33199, U.S.A.*

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MELICA SUBULATA (POACEAE: MELICEAE): THE FIRST REPORT FOR COLORADO—*Melica* L., a genus of ± 80 species, is found in temperate regions throughout the world, except Australia (Clayton and Renvoize 1986). Species of *Melica* are found in a variety of habitats, from woodland shade to dry stony slopes (Clayton and Renvoize 1986). There are 17 species of *Melica* in the United States. Boyle (1945) reported three taxa as occurring in Colorado, *M. bulbosa* Geyer *ex* Porter & J. M. Coulter, *M. porteri* Lamson-Scribner var. *porteri*, and *M. spectabilis* Lamson-Scribner. In the summer of 1992, Stanley and Gretchen Jones discovered a fourth taxon in the state, *M. subulata* (Grisebach) Lamson-Scribner. This represents a range extension of approximately 400 km (250 miles) from the closest previously known locality in Fremont County, Wyoming, as reported by Hallsten et al. (1987).

Melica subulata has not previously been reported as occurring in Colorado (Boyle 1945; Chase 1951; Harrington 1964; Weber 1987, 1990; Weber and Wittmann 1992). This species is found in mesic forests from Alaska south to Canada, Washington, Oregon, California, Idaho, Montana, Wyoming, and Colorado.

The following is a key to identify the species of *Melica* found in Colorado.

KEY TO *MELICA* OF COLORADO

1. Pedicels sharply bent; spikelets disarticulating below the glumes .... *M. porteri* var. *porteri*
1. Pedicels not sharply bent; spikelets disarticulating above the glumes 2
  2(1). Lemmas strigose over the veins; palea about 1/2 as long as the lemma; lemma apex acuminate to subattenuate .... *M. subulata*
  2. Lemmas glabrous or scabrous over the veins; palea about 2/3–3/4 as long as the lemma; lemma apex rounded to acute 3
    3(2). Second glumes less than 1/2 the length of the spikelet .... *M. spectabilis*
    3. Second glumes 2/3–3/4 the length of the spikelet .... *M. bulbosa*

Voucher specimen. COLORADO. **Gunnison** Co.: Gunnison National Forest, 0.6 mi S on USFR 898 from McClure Summit, hillside seep in aspen-spruce forest with gray silty clay loam soil, elev. 2660 m (8727 ft), 24 Jul 1992, *S. & G. Jones 9509* (jkw, sdj, TEX, UTC). Associates: *Veratrum californicum* Durand, *Zigadenus elegans* Pursh, *Carex stenoptila* F. Herm., *C. microptera* Mack., *Senecio bigelovii* A. Gray, *Rudbeckia occidentalis* Nutt., *Mertensia* sp., *Potentilla* spp., *Rosa* sp., *Delphinium* sp., *Geranium* sp., *Populus tremuloides* Michx., and *Picea* sp.

We would like to thank Mary E. Barkworth (UTC) for her review of this manuscript and Gretchen D. Jones (USDA) for her assistance with the field work.—*Joseph K. Wipff and Stanley D. Jones, S.M. Tracy Herbarium, Department of Rangeland Ecology and Management, Texas A&M University, College Station, TX 77843-2126, U.S.A.*

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EUSTACHYS GLAUCA AND *E. CARIBAEA* (POACEAE: CHLORIDEAE): THE FIRST REPORTS FOR MISSISSIPPI—*Eustachys* Desv. is a small tropical and subtropical genus of ten species, that is principally found in the New World (Clayton and Renvoize 1986). Three species are now known to occur in Mississippi: *Eustachys caribaea* (Sprengel) Herter, *E. glauca* Chapm. and *E. petraea* (Sw.) Desv. *Eustachys caribaea*, native to South America, has been reported from Louisiana (McKenzie et al. 1987) and Texas (Wipff and Hatch 1992). *Eustachys glauca*, native to North America, has been reported from Florida, Georgia and North Carolina and is found in brackish marshes, wet prairies and swamps (Chase 1951). *Eustachys petraea* is found in the SE U.S.A., eastern Mexico, Belize, Honduras, Costa Rica, and Panama (Pohl 1980). In the United States, *E. petraea* occurs in the Coastal Plain from North Carolina west to Texas on coastal sands, sandy fields and open pine woods (Chase 1951).

KEY TO *EUSTACHYS* OF MISSISSIPPI

1. Lower (fertile) floret glabrous, rarely sparsely pubescent on the midvein and margins; second glume apex is rounded or minutely notched; lower (fertile) lemma dark chocolate brown to black .... *E. glauca*
1. Lower (fertile) floret conspicuously pubescent on the midvein and margins; second glume apex is conspicuously bifid, the lobes are rounded to acute; lower (fertile) lemma dark chocolate brown to black or pale to golden brown 2

2(1). Lower (fertile) lemma dark chocolate brown to black; lower lemma margins glabrous on the lower 1/2–2/3; the upper portion of the lemma margins with short usually appressed trichomes 0.1–0.4 mm long; upper most (sterile) lemma 0.8–1.0 (1.2) mm long .... *E. petraea*

2. Lower (fertile) lemma pale to golden brown; lower lemma margins pubescent the entire length; trichomes on the lower lemma margins appressed to spreading and more than 0.5 mm long; uppermost (sterile) lemma 1.3–1.5 mm long .... *E. caribaea*

Eustachys caribaea (Sprengel) Herter

Voucher specimens. MISSISSIPPI: **Harrison** Co.: Gulfport, W jct. of Hwy 49 and 19th Street, T8S, R11W, S4; along edge of road and in a vacant lot, 11 Aug 1993, *C.T. Bryson 12661* (SWSL); Gulfport, W of Hwy 49, between 34th and Madison Street; vacant lot, open area, on sandy soil, 12 Aug 1993, *C.T. Bryson 12662* (SWSL).

Eustachys glauca Chapm.

Voucher specimens. MISSISSIPPI. **Hancock Co.:** 1 mi S jct. Hwys US 90 and MS 607; NW of US 90; open roadside on humic sandy soil, 17 Oct 1993, *C.T. Bryson 13181 & R. Carter* (IBE, SWSL, TAES). **Harrison Co.:** Gulfport, Mill Rd.; T7S, R11W, Sec. 25; old field adjacent to Bayou Bertrand, 11 Oct 1990; *T.C. Lockley s.n.* (SWSL).

—J.K. Wipff, Stanley D. Jones, S.M. Tracy Herbarium, Department of Rangeland Ecology and Management, Texas A&M University, College Station, TX 77843-2126, U.S.A. and Charles T. Bryson, USDA-ARS, Southern Weed Science Laboratory, Stoneville, MS 38776, U.S.A.

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SCHISANDRA GLABRA (SCHISANDRACEAE) NEW TO KENTUCKY—Field searches for rare native plants on the Daniel Boone National Forest in east central Kentucky are conducted yearly. During such a search in fall 1991, an unusual vine was found in McCreary County. The vine, growing with *Parthenocissus quinquefolia* and at first mistaken for an aberrant form of the latter, was eventually identified as *Schisandra glabra* (Brickell) Rehd., starvine. The plant was growing on a shale/sandstone talus slope at a break in a sandstone cliff. The species is typically a high climbing vine up to 3 cm in stem diameter, but the plants in this population were all creeping along the ground, some rooting at nodes. The site was partially shaded but did receive direct east sun. Overstory in the area consisted of *Acer rubrum*, *Liriodendron tulipifera*, *Tsuga canadensis*, and scattered *Quercus* species. Other species immediately adjacent to the site included *Clethra acuminata, Kalmia latifolia*, *Mitchella repens*, and *Solidago caesia.*

Schisandra glabra was not reported for McCreary County by Rogers (1941) or for Kentucky by Braun (1943). More recently, the taxon was not reported for Kentucky by Johnson and Nicely (1990) or Browne and Athey (1992). Medley (1993) referenced my collection in his dissertation. This new location is about 250 km disjunct from the nearest population of *S. glabra*, in Stephens County, Georgia (Jones and Coile 1988; Ettman 1980) and represents the first record for the northern Cumberland Plateau. Other sites are from the southern Cumberland Plateau (Alabama), the Piedmont Plateau, the Coastal Plain, and the Mississippi Embayment.

The leaves of starvine are alternate, typically pale green, somewhat fleshy, and coarsely and remotely serrate. Shorter branch stems have leaves crowded at the branch tip, almost appearing as palmately arranged leaflets. Leaves on trailing stems are widely spaced. Flowers are difficult to see as they are usually high above the ground. Fruits are scarlet and are arranged in loose racemes on pendulous peduncles. Illustrations may be found in Duncan (1967) and Stone (1968).

I thank Michael A. Vincent (MU) for providing helpful comments and suggestions.

Voucher specimen: KENTUCKY. McCreary Co.: single population on shale/sandstone talus slope at break in sandstone cliff on W side of Wolfpen Branch, ca. 1 mi S of White Oak Junction, ca. 1 mi E of Hickory Knob Church, Barthell Quadrangle, elev. ca. 1220 ft, 8 Oct 1991, *D.D. & L.A. Taylor 16351* (BEREA, KNK, MU, US).

—*David D. Taylor, USDA Forest Service, Daniel Boone National Forest, 1835 Bighill Road, Berea, KY 40403, U.S.A.*

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THLASPI MONTANUM (BRASSICACEAE) AND *OENOTHERA MISSOURIENSIS* (ONAGRACEAE) NEW TO COAHUILA—Recent collections in northern Cahuila, México, have included two species not previously reported for the state. Nesom (1992) found a similar situation for three species of *Aster* collected in the Serranías del Burro in Coahuila.

Thlaspi montanum L. var. **montanum** grows on moist or dry, open, rocky scree or talus slopes, alluvial fans or flats, limestone cliffs, and forest clearings. It has a wide distribution in the western United States, where it occurs from Washington, Oregon and southward along the Rocky Mountain Cordillera into New Mexico, Arizona, western-most Texas and in one locality in the La Bufa Mountains of northern Chihuahua, México. This new record extends its distribution to the northwestern Coahuila.

In addition to its wide geographical distribution, this variety of *Thlaspi montanum* has wide morphological variation (Holmgren 1971). The plants growing in Coahuila are 20–30 cm tall with racemes 8–10 cm long, peduncles 1 cm long and fruit 1 cm long and 5–6 mm wide. The habitat is semi-mesic submontane scrub.

Specimens examined: MÉXICO: **Coahuila:** Mpio. Muzquiz: Sierra del Carmen, Ranchos Morteros y San Isidro, Aprox. 178 km nw Muzquiz (Carr. 53) 28°47'N, 102°30'W, matorral rosetófilo de *Agave lechuguilla*, *Leucophyllum frutescens*, *Prosopis glandulosa* y *Larrea tridentata*, 1300 m, 27 Mar 1992, *M. A. Carranza 1385*, *J. Noriega*, y *L. García* (ANSM, MEXU). Mpio. Muzquiz: Sierra la Encantada, cuesta Malena, aporx. 170 km nw Muzquiz (Carr. 53) 28°54'N, 102°30'W, matorral de *Cercocarpus montanus*, *Garrya ovata*, *Juniperus flaccida*, *Fraxinus cuspidata*, *Ungnadia speciosa*, *Quercus gravesii* y *Q. invaginata*, 1600 m, 29 Mar 1992, *M. A. Carranza 1523*, *J. Noriega* y *L. García* (ANSM).

Oenothera missouriensis Sims.

Specimens examined: MÉXICO: **Coahuila:** Mpio. Muzquiz: Carr. Muzquiz-Boquillas (53), Rancho la Babia, área cercana al arroyo la Babia, 28°33'N, 102°05'W, matorral de *Leucophyllum Futescens*, *Acacia rigidula* con *Rhus virens*, *R. lanceolata* y *Ephedra*, 950 m, 17 Sep 1992, *J. A. Villarreal 6971*, *M. A. Carranza* y *R. Vasquez* A. (ANSM, MEXU).

Oenothera missouriensis is widely distributed in limestone knobs, prairies and dry hills in the High Plains through Oklahoma, west Arkansas, Missouri to Kansas and Nebraska and into northcentral Texas (the Edwards Plateau). The coahuilan population belongs to the var. *incana* gray and is located in an intermountain valley in central Coahuila disjunct from the closest Texan location. Numerous other species show a similar pattern of distribution as noted by Nesom (1992), considering that the two species here recorded have a primarily North American distribution extending into northern México.

I thank G. Nesom for comments on the manuscript.—*José A. Villarreal Q., Universidad Autónoma Agraria Antonio Narro, Departamento de Botánica, Buenavista, Saltillo, Coahuila 25315, México.*

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A STATE RECORD FOR *CYPERUS GRAYOIDES* (CYPERACEAE) IN ARKANSAS—*Cyperus grayoides* Mohlenbrock is an obscure member of *Cyperus* section *Laxiglumi*. It has previously been reported from Illinois, Missouri, Texas, and Louisiana. In Illinois its habitat is dry sand prairie located on the terraces of outwash plains of the Mississippi and the Illinois rivers (White & Madany 1978). In Missouri it is locally abun-dant on the Scotco sandridges of the southeastern lowlands (Carter & Bryson 1991). The Texas and Louisiana occurrences are described as located on pine barrens, xeric riparian sandhills, sandhill woodland, and deep sand savanna (Bridges & Orzell 1989). An Arkansas station was discovered as follows:

Voucher specimens: U.S.A. ARKANSAS. **Ouachita Co.:** ca. 2.5 km E of Chidester, NW1/4 of NE1/4 Section 6, T12N, R19W, on Agala soil, 11 Sep 1993, *Logan 1993–95* (ISU, UARK, VSC).

Approximately 100 plants were observed in a sunny opening of a pine sandhill community. Associate species include *Polygonella americana*, *Stylisma pickeringii*, *Quercus incana*, *Q. stellata* var. *margaretta*, *Polansia erosa*, *Haplopappus divaricatus*, and *Monarda punctata*. The site is undergoing active erosion. The presence of active disturbance to the site corresponds to descriptions given for sites in other states (Bridges & Orzell 1989; Carter & Bryson 1991; Herkert 1991). The pine sandhill community where the species was found corresponds more closely to the descriptions of *C. grayoides* locations in Texas and Louisiana (Bridges & Orzell 1989) than to those in Missouri or Illinois (Carter & Bryson 1991).

Discovery of *C. grayoides* in Arkansas indicates that this species should be looked for in other sandhill communities of southwestern Arkansas. Additionally, the presence in northeastern Arkansas of soils derived from sand deposits related to the sandy soils of southeastern Missouri (Saucier 1978) indicates that the species should also be searched for in that portion of the state.

I am grateful to the following individuals for their assistance: Dr. Richard Carter, Valdosta State College; Dr. Paul McKenzie, U.S. Fish and Wildlife Service; and Sherry Holmes, Missouri Department of Conservation.—*John M. Logan, Arkansas Natural Heritage Commission, 1500 Tower Building, 323 Center St., Little Rock, AR 72201,* U.S.A.

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BOOK REVIEWS

Horn, B., R. Kay and D. Abel. **A Guide to Kansas Mushrooms.** (ISBN 0-7006-0570-3, hbk; ISBN 0-7006-0571-1, pbk.). University Press of Kansas, 2501 West 15th Street, Lawrence, KS 66049-3904. (913)864-4154. $19.95 (pbk); $29.95 (hbk) 298 pp., 6 figures, 160 color photographs.

Kansas is famous for many things; wheat, cattle, oil, gas, aircraft manufacture, politicians, basketball, mile runners and now you can add mushrooms to the list. Most people not native to Kansas who plan a trip using Interstate 70 conjure up images of a monotonous, flat landscape dominated by endless fields of wheat. Nothing could be further from the truth for eastern and central Kansas. The westernmost extension of the broadleaf deciduous forest reaches into eastern Kansas, providing diverse habitats for mushrooms. The Flint Hills in the central part of the state also provide rolling terrain with glens and canyons that are heavily wooded with a mixture of deciduous trees and junipers. These diverse habitats provide for a much greater biodiversity of flowering plants, mushrooms, Myxomycetes, mosses, and liverworts than would normally be expected.

Bruce Horn, Richard Kay, and Dean Abel have given us a book that documents over 750 species of mushrooms with 150 species described and illustrated with color photographs. In the words of the authors "This book is a guide to the fungi of Kansas" and later, "Because this guide has grown out of our forays in Kansas, it is a personal document, written by experienced enthusiasts who want to impart their enthusiasm no less than their experience." It is that and much more.

The introduction contains topical sections on the naming of mushrooms, mushroom parts, microscopic features, substrates, sex and mushrooms, mycology in Kansas, first fungi, Kansas habitats, a Kansas calendar of fungal fruitings, collecting mushrooms, photographing mushrooms, mushrooms in the kitchen, Kansas edibles, the edibility issue, and identifying mushrooms. A bibliography follows each section. Some of the general non Kansas information is available in other mushroom books but some is not. The section on Kansas habitats destroys the myth that Kansas is a flat desert. First fungi informs the reader about the easy to recognize groups of fungi. A Kansas calendar of fruitings gives the frequency of occurrence and the months collected for 150 fungal species. There is a very informative section on techniques, equipment and tips on collecting mushrooms. There is a spoof on page 36 named *Gigantomyces kansensis,* depicted in color and located in Mushroom State Park near Kanopolis Lake. A Kansas historical marker along Interstate 70 reveals the true origin of these "mushroom rocks. "Formed through millions of years of erosion, and known geographically as the Smoky Hills, these Dakota sandstone mounds cover a wide area. Notice the natural rock outcroppings and toadstools" in this park. Here also are stone fence posts still used in this portion of Kansas."

There is an interesting chapter on the history of mycology in Kansas that highlights the activities of W.H. Kellerman at Kansas State University, Manhattan, who founded the *Journal of Mycology,* the forerunner of *Mycologia,* that today represents the official publication of the Mycological Society of America. Elam Bartholomew who was a farmer near Stockton in Rooks County and a self taught mycologist, "...became the greatest collector of American fungi in his generation." The numbers of fungi he collected are staggering: "...292,000 specimens of fungi, which he divided and distributed in 427,700 labeled packets", and the remainder represented the largest private herbarium in the United States. In the 1950s

Clark T. Rogerson and Robert L. Shaffer, currently distinguished mycologists, collected thousands of fungal specimens for the Kansas State University Herbarium and began an annotated checklist of Kansas fungi. But there is much more packed into these six pages.

An Anthology of Kansas Mushrooms is divided into the Basidiomycotina and Ascomycotina with keys to orders, to families, and to species. The dichotomous keys are based on macroscopic features and are easy to use. The authors are to be commended for giving numbers along with species names in the keys that guide the user to the species descriptions and photographs. Species are presented in systematic order and with the non technical species description and color habit photograph on the same page. The color habit photographs are excellent and of adequate size to demonstrate the appropriate field characters. Also included are very helpful notes that will aid in locating and identifying each species. There are 66 gilled Agaricales, 10 Boletaceae, 27 Aphyllophorales, 5 Tremellales, 13 Gasteromycetes, 2 Nidulariales, 3 Phallales, and 21 Ascomycetes. The nomenclature is current with scientific names given without author citations, some synonyms and common names are provided, and there are frequent references to related species. Each species is designated as being either edible, edibility unknown, not edible, caution, or poisonous. There are 3 appendixes and a four-page glossary. The first appendix is a summary of fungal classification of the fleshy Basidiomycotina and Ascomycotina and a listing of genera known from Kansas. The second appendix is entitled A Lifelist for the Kansas Mycophile and lists 548 Kansas species alphabetically by genus. The last appendix is an introduction to mycological Latin pronunciation. The Annotated Bibliography contains 26 references, mostly current and published after 1975, that will serve as field guides to identification.

The handy size of the book will facilitate its use in the field. The backside and outer edge of the book is divided into a 20 centimeter ruler that is an expedient way to measure specimens.

This book is well organized and easy to use for the beginner but has sufficient detail to satisfy the advanced student. There is a wealth of information not found in many regional mushroom books that warrants buying this book. It is the best of the regional books on mushrooms. It is modestly priced and worth every penny when one considers the number of color photographs. This book will help you enjoy and get the most out of hunting mushrooms in your neck of the woods. It should be on the bookshelf of every mushroom enthusiast wherever they live.—*Harold W. Keller.*

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DICK-PEDDIE, WILLIAM A. 1993. **New Mexico Vegetation, Past, Present, Future.** (ISBN 0-8263-1361-2, hbk) University of New Mexico Press, Albuquerque. $ 244 pp. + map and color photographs.

New Mexico has a richly diverse vegetation that is in a continual state of flux due to both human influences and long-term climatic changes. This theme pervades *New Mexico Vegetation* in which Dr. Dick-Peddie summarizes and synthesizes data from his long career at the University of New Mexico. Not only does this volume provide a detailed account of the present vegetation of New Mexico, but also gives an overview of the physical factors, vegetational history, and future concerns about rare species and fragmented natural areas.

The book is divided into twelve chapters which fall into three natural sets. Chapters One to Four, plus the Introduction, provide the reader with a general background on the vegetation. In particular, immediately preceding Chapter One there are a county map and 29 handsome, colored plates that depict the vegetation types and phenomena discussed. Chapter One, covering the physical environment, includes maps of the physiographic regions, land/water areas in geologic time, average frost-free days, average annual precipitation, and soils. Chapter Two provides a reconstruction of past vegetation since the Tertiary. The discussion and documentation of desertification over the last 100 years is important. Chapter Three presents general concepts of vegetation patterns in relation to the physical environment and to interspecies dynamics. Chapter Four discusses methods of classifying vegetation, conventions used in this book, and differences with other, earlier works.

The detailed descriptions of the vegetation types and their constituent habitat types (or vegetation units) in Chapters Five through Ten, make up the second section, the bulk of the book. Each chapter contains tables summarizing the hierarchy of these vegetation and habitat types and the major plant species in each vegetation type. Dick-Peddie recognizes the following vegetation types in New Mexico: Alpine Tundra, Subalpine Coniferous Forest, Upper Montane Coniferous (mixed conifer) Forest, Lower Montane Coniferous Forest, Aspen Disturbance Forest, Coniferous Woodland, Mixed Woodland, Savanna (extensive woodland-grassland ecotone), Montane Grassland, Plains-Mesa Grassland, Desert Grassland, Montane Scrub, Plains-Mesa Scrub, Great Basin Desert Scrub, Chihuahuan Desert Scrub, Successional Montane Scrub, and several riparian vegetation types. Chapter Ten discusses special types including aquatic, lava-flow, and gypsophilic vegetation. W.H. Moir contributed the chapter on alpine tundra and montane forests.

The final chapters shift the focus from the description of present vegetation types to concerns of and factors effecting the future of New Mexico vegetation. Richard Spellenberg contributed a lengthy discussion (Chapter 11) on species of special concern, i.e., endemics of limited distribution, and species in decline. Besides reviewing the problems, needs, and possible solutions, he gives detailed accounts of each of the types of threats and the plant species involved. In Chapter 12, Dick-Peddie advances a view of the future for the vegetation as a whole. In particular, his advocates a series of natural areas and a means to secure them.

When I first saw this book, I knew that it would be invaluable as a lecture and student reference for a field botany course in New Mexico that I am developing. Even so, I was somewhat disappointed when the book was evaluated against the rigorous demands that I placed upon it. I was happily composing charts of vegetation on a grid of mean annual rainfall vs. mean annual temperature, which can be gleaned from the descriptions in Chapter Five, when I discovered that there are no parallel presentations of that information in the remaining descriptions. Furthermore, an introductory map showing physical features such as mountain ranges, rivers, etc. would help one to quickly pinpoint examples given in the text.

Even with these short comings, the volume is sure to be of use to anyone interested in the biology and/or geography of the Southwest.—*Roger W. Sanders, Botanical Research Institute of Texas.*

NEUBERT, H., W. NOWOTNY and K. BAUMANN. 1993. **Die Myxomyceten Deutschlands und des angtenzenden Alpenraumes unter besonderer Beruchschtigung Osterreichs.** Band 1, Ceratiomyxales, Echinosteliales, Liceales, Trichiales. (ISBN 3-929822-00-8, hbk) Karlheinz Baumann Verlag, Gomaringen, Germany. DM190 (ca. $110.00). 344 pp., 158 line drawings, 96 SEM, 192 colored photographs.

English translation of the title, *The Myxomycetes of Germany* and its bordering Alpine Areas, with special attention to Austria. Volume 1 Ceratiomyxales, Echinosteliales, Liceales, Trichiales.

This is volume one of a three volume series. Volume two on the Physarales and volume three on the Stemonitales will follow in intervals of about two years. The volumes may be purchased separately. The acquisition of a volume does not obligate one to purchase later volumes. Volume I is 344 pages, bound in cloth with a color jacket, 190 German marks and about $110 at current exchange rates.

Introductory pages have photographs of colored plates taken from "Bulliard's Histoire des Champignons de la France" that illustrate *Stemonitis axifera, Comatricha typhoides,* and *Arcyria cinerea* and Ditmar's "Die Pilze Deutschlands" that illustrate *Enteridium lycoperdon, Trichia contorta, Trichia decipiens* and *Arcyria incarnata.* The first chapters treat in a general way the classification of the Myxomycetes, give their occurrence and distribution, describe and illustrate their life cycle, and discuss the general morphology of the fruiting bodies. The color photographs of the fruiting body habits are the highest quality I have ever seen. The book is worth the cost just for the excellent color photographs and scanning electron micrographs. Some of the color photographs are of fruiting bodies in an immature and freshly matured state. This is true of *Ceratiomyxa, Dictydiaethalium plumbeum, Hemitrichia clavata, Lycogala epidendrum, Trichia decipiens* var. *olivacea,* and *Tubifera ferruginosa.* The illustrations of color photographs and line drawings are conveniently included in the text on the same page as the species description. The SEM's are included as a group at the back of the book. The photographs and line drawing illustrations have a voucher specimen number cited as the source of the illustration. The authors are to be commended for following this practice.

A special feature of this book is the effective use of boldface headings that guide the reader through the genera, species and species descriptions. The high quality paper, double column format and accessibility of illustrations on the same page as the species description make this book very user friendly.

All three volumes are in German and represent the most comprehensive treatment of the Myxomycetes in German since the work of Schinz in 1920. According to the authors, their work will help fill the gap since that time. In a special section dichotomous keys lead the reader from the four orders to families, genera, and species with 145 species and varieties described in detail and 157 indexed. The keys are constructed so that the leads are reversible. There are also synoptic keys to some genera, for example, the very difficult and complex genus *Cribraria*, with line drawings of habits on side by side pages next to the key. This is a very user friendly key that should appeal to beginning students of the Myxomycetes. There are three species described as new: *Cribraria filiformis, C. macrospora,* and *C. stellifera.*

The authors prepared this work for professional botanists who may wish to identify Myxomycetes and also serve as an introduction for the lay botanist. The unique beauty of the Myxomycetes and largely unknown distribution in Germany are given as the additional reasons for publishing these volumes. There are sections on collecting and herbaria in Germany, on microscopic slide preparation, a glossary of 45 defined terms and the etymology is given for generic and species names. Commemorative peoples names listed for genera and species also have their birth and death dates, country of origin, and professional disciplines.

The author's classification system considers these organisms aligned with the fungi retaining the proper designated endings prescribed by the International Code of Botanical Nomenclature. The subordinal ranks follow closely the classification promoted by Nannenga-Bremekamp since many of her taxa, especially genera and families, are recognized. *Minakatella* has been transferred from the order Trichiales to a new family, the Minkatellaceae, in the order Liceales. The order Liceales was a heterogenous unnatural assemblage of unrelated taxa before the transfer of *Minakatella* and it is even more so now. There is no new convincing evidence to recognize two new families, the Minakatellaceae and Dictydiaethaliaceae, in the Liceales. In the case of *Minakatella,* the over emphasis of the property of birefringence of spores and capillitium, supposedly lacking in *Minakatella,* results in the tyranny of a single unproven character; a character that is variable within species but is used to move taxa from different orders and establish new families. Much of the name juggling that has gone on in the Myxomycetes should await state of the art DNA sequencing techniques to analyze genetic relationships within the Myxomycetes and to other taxa such as the protostelids and dictyostelids.

The literature cited section is especially valuable since it contains much of the published literature on the Myxomycetes since G.W. Martin and C.J. Alexopoulos published their world monograph, "The Myxomycetes," in 1969. This section is comprehensive with author citations from throughout the world.

This book should be on the bookshelf of every student of the Myxomycetes. The authors should consider an English translation to increase interest in the Myxomycetes on both sides of the Atlantic.—*Harold W. Keller.*

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CONTRIBUTIONS TO BOTANY

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MICONIA SKEANIANA (MELASTOMATACEAE: MICONIEAE), A NEW SPECIES FROM EASTERN CUBA

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ABSTRACT

Miconia skeaniana, which occurs in moist montane forests, cloud forests, and thickets from ca 750–1974 m in the Sierra Maestra, is described and illustrated. It is compared with the closely related *M. alternifolia*, of the mountains of northern "Oriente," a species with which it has been consistently confused.

RESUMEN

Se describe e ilustra *Miconia skeniana* que vive en los bosques montanos húmedos, bosques de nubes y matorrales entre los 750 y 1974 m en Sierra Maestra. Se compara con la cercanamente emparentada *M. alternifolia* de las montañas del norte de "Oriente," una especie con la que ha sido confundida frecuentemente.

In the course of taxonomic study of herbarium material in connection with a monograph of the Antillean members of *Miconia* section *Chaenopleura* Benth. & Hook.f., the following undescribed species of *Miconia* was recognized. Material representing this new species previously has been identified as *M. alternifolia* (Griseb.) Alain (=*Miconia grisebachii* Triana). The new species clearly is referable to *Miconia* sect. *Chaenopleura* (see Cogniaux 1891), a distinctive, diverse, and presumably monophyletic group (at least within the Antilles) possessing an actinomorphic androecium (i.e., stamens forming a radially symmetrical pattern around style) of glabrous, white stamens of which the obovate anthers open by longitudinal slit-like pores (Judd & Beaman 1988; Judd & Skean 1991). The group is also characterized by an indumentum of usually ferrugineous, ± irregularly stellate-branched hairs, globose fruits that turn from red to pale blue at maturity, and angular-obovoid seeds with a ± smooth testa (see Judd & Skean 1991, fig. 10B). The section is especially well developed in the Greater Antilles, where many narrow endemics occur. The new species is described and compared with *M. alternifolia*, a species with which it has been consistently confused. *Miconia alternifolia* occurs in the mountains of northern "Oriente"[1] from the Sierra de Cristal eastward, while *M. skeaniana* is restricted to the Sierra Maestra.

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[1] For convenience the four easternmost provinces of Cuba, i.e., Granma, Santiago de Cuba, Holguín, and Guantánamo, which were created in the post-1959 political reorganization of the island, are here referred to collectively as "Oriente," the pre-1959 name of the political unit comprising eastern Cuba.

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Miconia skeaniana Judd, sp. nov. (Fig. 1)

Miconiae alternifoliae (Griseb.) Alain affinis, sed foliorum nervationibus magis valde abaxiale elevatis, i.e., venis tertiariis leviter vel manifeste elevatis, et aliquot vel omnibus venis quaternariis leviter elevatis (vs. venis tertiariis leviter elevatis vel plus minusve planis, et venis quaternariis planis), foliorum apice acuminato (vs. apice late obtuso, acuto, vel acuminato), pilis irregulariter stellatis ca 0.09–0.2 mm latis in foliorum pagina abaxiali, interdum cum pilis minutis et globulosis (vs. pilis globulo-stellatis ca 0.04–0.09 mm latis), et antherae parte fertili 1.2–1.9 mm longa, i.e., 66–77% antherae, (vs. 0.9–1.4 mm longa, i.e., 39–58% antherae).

Shrub to 4 m tall. *Indumentum* of multicellular, ferrugineous, minute-globular, globular-stellate, or irregularly stellate-branched, to elongate-branched hairs. *Young twigs* not ridged, ± rectangular in cross-section, 1.7–4.5 mm wide, becoming ± terete with age, the indumentum of moderate to dense, irregularly stellate-branched to elongate-branched hairs, these ± persistent; internodes 1–4.5 cm long. *Leaves* opposite, with petiole 0.7–2.9(–3.2) cm long, the indumentum similar to that of the twigs; blade ovate to elliptic, 5–11.2(–16) × 1.7–4.1(–4.4) cm, flat, coriaceous, the apex acuminate, the base acute to rounded or very slightly cordate, the margin plane to revolute, obscurely serrulate to undulate-serrate, especially distally, proximal 0–40% of margin entire, but frequently appearing entire throughout (when revolute), the largest teeth to 0.2–0.4 mm (occasionally to 0.8 mm) long; venation acrodromous, slightly suprabasal to ± basal, with prominent midvein (primary vein) and 4 secondary veins, with 2 conspicuous secondary veins placed 2–6.5 mm in from margin, 2 inconspicuous secondary veins placed closer to margin, and numerous percurrent tertiary veins oriented subperpendicular to midvein, the tertiary veins sometimes partially separated by composite inter-tertiary veins but usually connected by 1 to numerous quaternary veins, higher order veins ± orthogonal-reticulate; adaxial surface very soon glabrescent, the midvein and major secondary veins impressed, minor secondary veins, tertiary veins, and some quaternary veins slightly impressed, and higher order veins flat, the surface appearing minutely wrinkled-papillose after drying, with sparsely to densely scattered druse crystals; abaxial surface with moderate to dense, persistent, irregularly stellate-branched or globular-stellate hairs, 0.09–0.2 mm across, on lamina and smaller veins, sometimes also with minute globular hairs, intergrading with slightly larger stellate-branched to elongate-branched hairs on midvein, the midvein and major secondary veins prominently raised, tertiary veins prominently to slightly raised, minor secondary veins, some to all quaternary veins, and sometimes even a few higher order veins slightly raised. *Inflorescences* terminal, many-flowered, broadly-rounded cymes of 3 or 4 branch-pairs, 3–8 cm long, 3–8 mm across; proximal segment of lowermost inflorescence branches 1–2.9 cm long, distal internodes shorter, ultimate branches 1–6.5 mm long, with ± moderate, irregularly stellate-branched to globular-stellate or elongate-branched hairs; peduncle 1.5–5 cm long, with similar indumentum; each branch associated with early caducous,

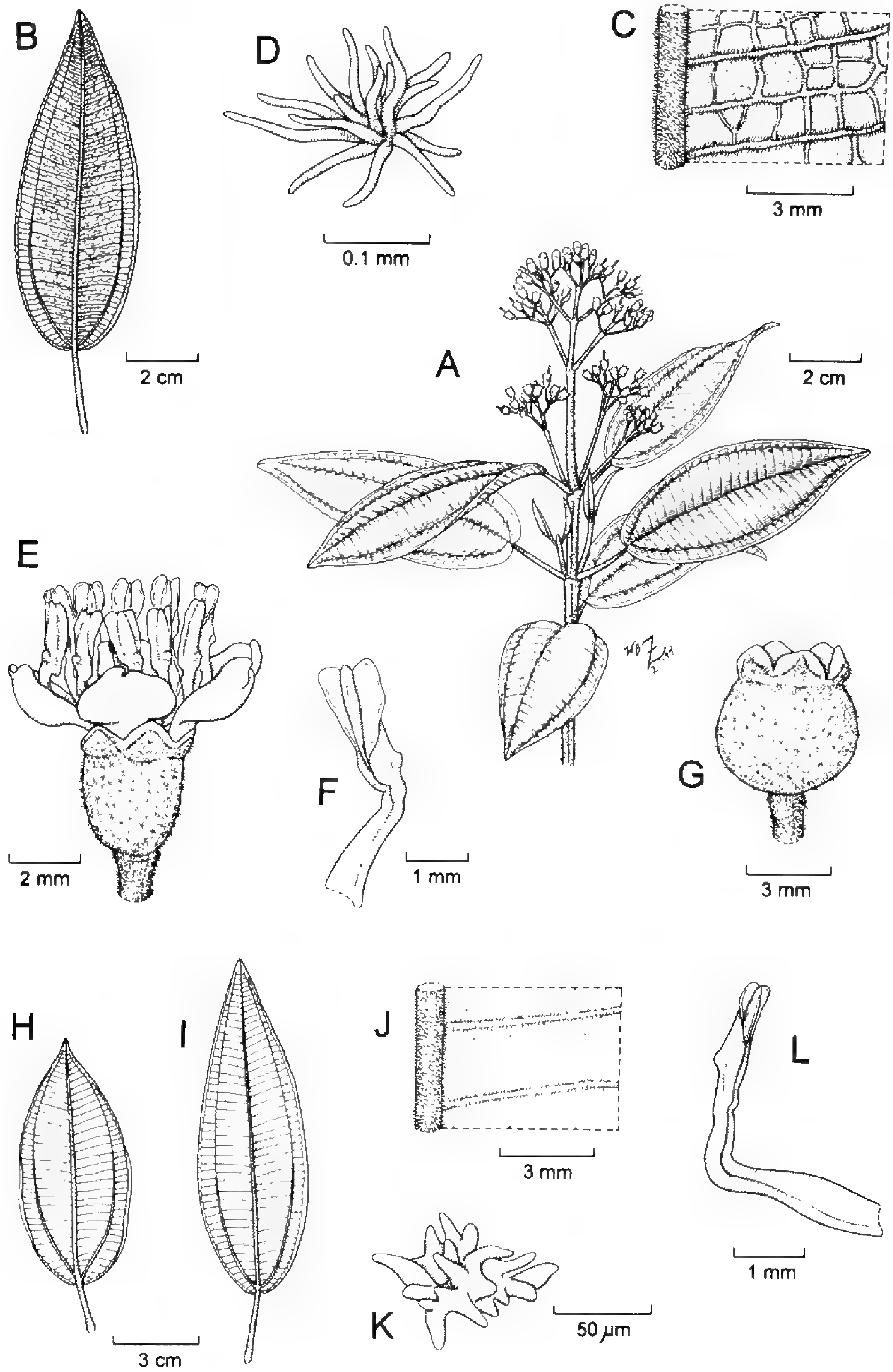

FIG. 1. Illustration of *Miconia skeaniana*, along with selected features of *M. alternifolia*. *Miconia skeaniana*: A. flowering branch (*Ekman 8855*); B. leaf, abaxial surface (*Ekman 6928*); C. detail of abaxial leaf surface (*Ekman 6928*); D. stellate hair from abaxial leaf surface (*Seifriz 1072*); E. flower (*Ekman 8855*); F. stamen (*Ekman 8855*); G. young berry (*Seifriz 1072*). *Miconia alternifolia*: H. leaf, abaxial surface (*Ekman 6833*); I. leaf, abaxial surface (*Wright 179*); J. detail of abaxial leaf surface (*Shafer 8198*); K. stellate hair from abaxial leaf surface (*Ekman 6833*); L. stamen, with elongate basal and sterile portion of the anther (*Ekman 6833*).

slightly ovate to obovate bract, ca 1.7–4 × 1–2 mm, the apex acute to rounded, the lowermost pair sometimes leaf-like; flowers in dichasia, usually distinctly separated from each other, each subtended by 2 caducous, ± ovate bracteoles, 1.5–2.2 × 0.8–1 mm, the apex acute to obtuse; pedicel 0–0.5 mm long. *Hypanthium* cylindrical, free portion 1.6–1.9 mm long, the outer surface with sparse to moderate, minute, stellate-branched hairs, the inner surface glabrous and strongly ridged, i.e., with 10 prominent ridges alternating with 10 weaker ridges, the apices of the stronger ridges projecting, 0.05–0.1 mm. *External calyx lobes* (=teeth) 5, 0.3–0.8 × 1.4–2.5 mm, broadly triangular, with acute to acuminate apex, indumentum as on hypanthium; *internal calyx lobes* 5, 0.5–1.5 × 1.4–2.5 mm, ± triangular to ovate-triangular, green, glabrous or with sparse stellate hairs, apex rounded, margin entire, sometimes minutely fringed; calyx tube 0.2–0.5 mm long. *Petals* 5, broadly ovate to obovate, 2.8–4.2 × 2.6–2.9 mm, glabrous, white to pink-tinged, imbricate and apically interlocking in bud, with apex emarginate, with an asymmetrically located notch; margin entire. *Stamens* 10, geniculate, glabrous; proximal segment (filament) 1.9–2.9 mm long; distal segment (anther and connective) 2.6–3.2 mm long, with minute dorsal projection (pointing ± toward anther apex), the anther 1.8–2.5 mm long, with fertile portion (anther sacs) 1.2–1.9 mm long, opening by 2 longitudinal slits, the connective extending 0.6–0.9 mm beyond the base of the anther. *Ovary* (2- or) 3-loculate (N=1, 10), ca 1/2-inferior (immature) to ca 2/3-inferior (mature), short-ovoid to subglobose, 2.1–3 × 2.4–3.5 mm, glabrous and strongly ridged, with fluted apical projection to ca 0.5 mm encircling the base of style; style 3.8–5 mm long, terete, glabrous; stigma truncate. *Berries* globose to subglobose, ca 4.5–7 × 5.5–7 mm, pale blue. *Seeds* angular-obovoid, ca 0.5–0.9 mm long; testa smooth.

TYPE: CUBA. PROV. SANTIAGO DE CUBA [=Oriente, p.p.]: Sierra Maestra, Cordillera de la Gran Piedra, La Gran Piedra, cloud forest, ca 1200 m alt., 10 Nov 1917, *E.L. Ekman 8855* (HOLOTYPE: S!; ISOTYPE: NY!).

Etymology: It is a pleasure to name this distinctive species after Dr. James Dan Skean, Jr. (b. 1958), plant systematist at the Department of Biology, Albion College, Michigan, who has assisted the author during fieldwork conducted in connection with a taxonomic revision of the Antillean species of *Miconia* sect. *Chaenopleura*.

Additional Specimens Examined: CUBA. PROV. GRANMA [=Oriente, p.p.]: Sierra Maestra, La Bayamesa, on the ridge between Río Oro and Río Yao, 1100–1400 m, *Ekman 7215* (F); peak of Punta de Palma Mocha, south of Yara, 1400 m, *Ekman 14317* (NY). PROV. SANTIAGO DE CUBA [=Oriente, p.p.]: Sierra Maestra, summit of Pico Turquino, 1960 m, *Acuña 6760* (NY); Pico Turquino, northern slopes, ca 1750 m, *Ekman 5275* (S); ibid., *Ekman 5389* (S); between Finca Reunion and peak of Loma del Gato, 750 m, *Ekman 6928* (NY); near summit of Pico Turquino, *León 10744* (GH, NY); between the arroyos Peladero and Indio, 3000–4500 ft, *López-Figueiras 406* (US); Gran Piedra, 1250 m, *López-Figueiras 2661* (IJ, US); Pico Turquino,

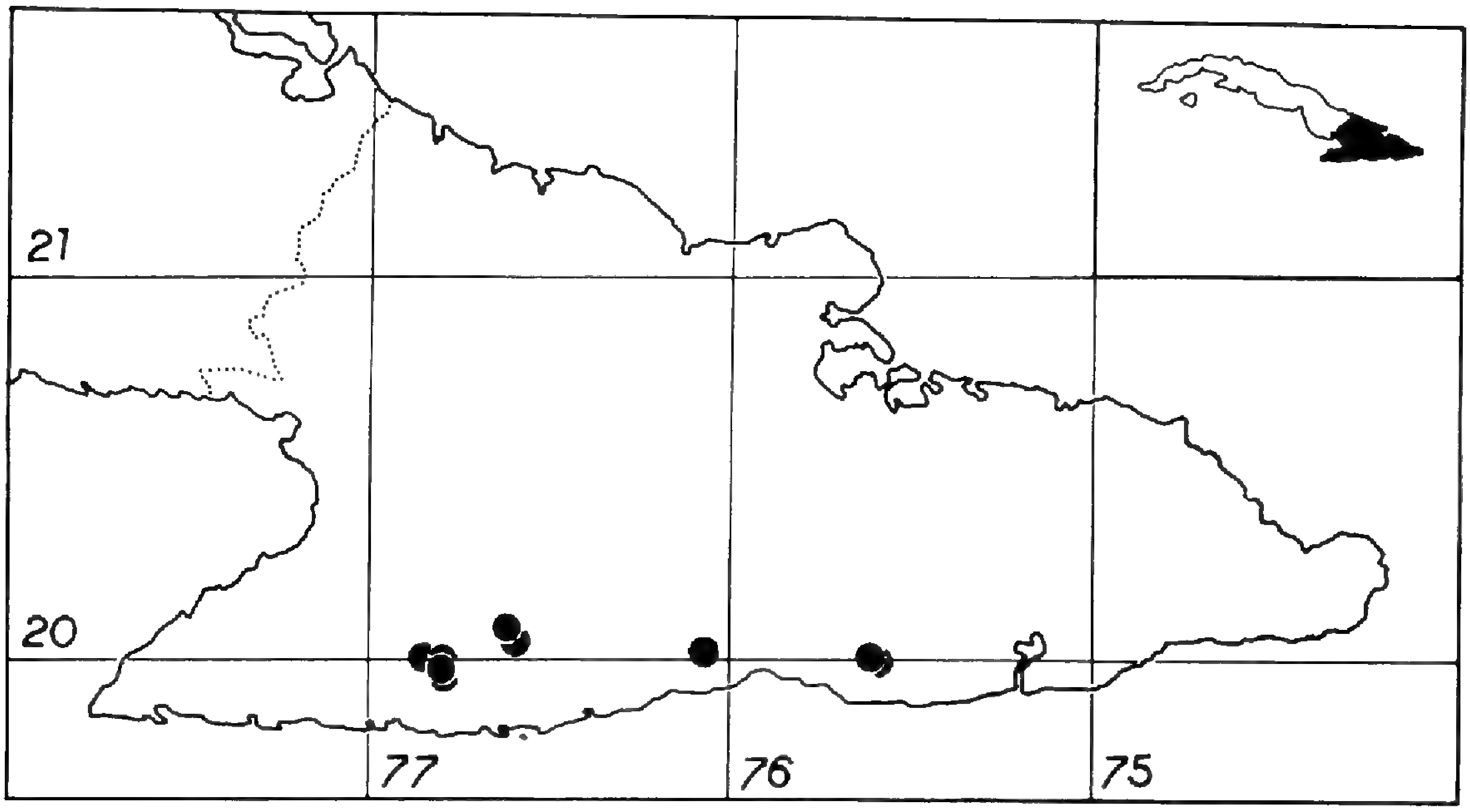

FIG. 2. Distribution of *Miconia skeaniana* in eastern Cuba.

south slopes, *Seifriz 1072* (US); Gran Piedra, ca 1500 m, *Shafer 9028* (NY); eastern Cuba, without definite locality, but probably collected at Loma del Gato, 1856–1857, *Wright 179* (GH, GOET, MO).

Miconia skeaniana is endemic to Cuba and known from several localities in the Sierra Maestra, both the Cordillera de Turquino and the Cordillera de la Gran Piedra, of southern "Oriente" [prov. Granma and Santiago de Cuba] (Fig. 2), where it occurs in moist montane forests, cloud forests and thickets from 750–1974 m elev. The vegetation of the higher elevations of the Sierra Maestra is summarized in León (1924, 1946), Seifriz (1943), and Borhidi (1991).

Miconia skeaniana is probably most closely related to *M. alternifolia*, with which it consistently has been confused. It can be readily distinguished from this species by its more strongly abaxially raised-reticulate leaf venation, i.e., midvein and major secondary veins prominently raised, *tertiary veins slightly to prominently raised*, minor secondary veins, *some to all quaternary veins*, *and sometimes even a few higher order veins slightly raised* (vs. midvein and major secondary veins prominently raised, minor secondary veins slightly raised, *tertiary veins slightly raised to ± flat, and higher order veins flat*). The leaves of *M. skeaniana* have consistently acuminate apices while those of *M. alternifolia* vary from broadly obtuse to acute or acuminate. *Miconia skeaniana* possesses a ferrugineous indumentum of irregularly stellate-branched to occasionally globular-stellate hairs, ca 0.09–0.2 mm across, on minor veins and lamina of the abaxial leaf surface. These hairs are sometimes intermixed with minute-globular hairs. In contrast, the hairs of *M. alternifolia* are more darkly ferrugineous, consistently globular-stellate, and smaller (i.e., 0.04–0.09 mm across). The basal and sterile portion of the anthers of *M. skeaniana* is shorter than that in *M. alternifolia*, i.e., anther with fertile portion 1.2–1.9 mm long and occupying 66–77% of anther length in *M. skeaniana* (vs. 0.9–1.4 mm long and occupying 39–58% of anther length in *M. alternifolia*). Additionally, the tertiary veins of *M. skeaniana* are frequently more closely spaced than those of *M. alternifolia*, i.e., 5–12 (avg. 9) veins vs. 4–11 (avg. 7) per 2 cm in middle portion of leaf. The two species are completely allopatric and are, thus, geographically isolated.

The type of *Miconia alternifolia*, collected by Charles Wright (no. *179*), is actually a mixed collection composed of material collected at Monte Verde (Prov. Guantánamo) on March 2nd, 1859 (see original label on isotype at GH and label on holotype at GOET) and presumably at Loma del Gato in the Sierra Maestra (Prov. Santiago de Cuba) in 1856–1857. The exact locality of the 1856–1857 collections is not known because no original label is present; however, plants matching these specimens occur only in the Sierra Maestra and it is known that Wright did collect in the Loma del Gato area of the Sierra Maestra in 1856–1857 (Underwood 1905; Howard 1988). These collections of Charles Wright were all assigned the same number by Asa Gray (Howard, 1988). The holotype of *Miconia alternifolia* (at GOET) represents the "Monte Verde element" (collected on March 2, 1859), which is considered to be conspecific with phenetically similar collections from other localities in northern "Oriente," i.e., prov. Holguin and Guantánamo; isotypes representing this collection are found at BM, GH, NY, and S (all with printed labels giving the incorrect date of 1860–1864). Collections of *Wright 179* at GH, GOET, and M (collected in 1856–1857, probably at Loma del Gato) actually represent the taxon here considered to be *M. skeaniana*. As discussed above, this species is restricted to the Sierra Maestra. The name *M. alternifolia* is, of course, linked to the holotype specimen of *Wright 179* (which represents the northern "Oriente" taxon). Thus, the plants of the Sierra Maestra, if considered specifically distinct from *M. alternifolia*, are left without a name, and herein are described as *M. skeaniana*.

The specimens of *Wright 179* collected in 1856–1857 have sometimes been considered as a distinct variety, i.e., *M. grisebachii* var. *reticulata* Cogn., but the type of this name actually is a Puerto Rican plant of the Sierra de Luquillo (and this name is a synonym of *M. pychoneura* Urb.).

The recognition of *Miconia skeaniana* brings the number of Antillean species of *Miconia* sect. *Chaenopleura* to 43 (Judd, unpublished data). Other members of this section occurring in Cuba include: *M. alternifolia*, *M. cubensis* (Griseb.) C. Wright, *M. rufa* (Griseb.) Triana (probably conspecific with *M. plumeriaefolia* Britton & P. Wilson), and *M. subcorymbosa* Britton (probably conspecific with *M. calycina* Cogn.).

ACKNOWLEDGMENTS

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BOOK NOTICE

KARTESZ, JOHN. T. 1994. **A Synonymized Checklist of the Vascular Flora of the United States,Canada and Greenland.** Second Edition. (ISBN 0-88192-204-8, hbk, 2 volumes); Timber Press Inc., 9999 S. W. Wilshire, Suite 124, Portland, OR 97225. (800) 327-5680. $159.00. Vol. 1, 622, vol 2, 816 pp.

The long awaited second edition of John Kartesz' *A Synonymized Checklist of the Vascular Flora of the United States, Canada and Greenland* is finally available, and it was well worth the wait! This is officially a second edition, but it is more than just a new edition, it is rather a much expanded major rework which includes a new format and a second volume. This is a significant improvement over his 1980 work, which has been the standard for fourteen years.

As monographic research continues the taxonomic and nomenclatural process is in constant flux, and will be for many years to come. Also, much of the classification of our flora is a tangle of individual taxonomic opinion. This work does not attempt to solve all these problems, but it is a quantum leap forward, and is a solid new foundation on which to build the next cycle. With Kartesz' new *Checklist* we now have an incredibly valuable and comprehensive effort that sets a new standard.

The new edition has two volumes. The first is the familiar checklist that is alphabetical by families, genus, species, etc., and the synonyms of each of these taxa. The second volume is a new thesaurus that is a quick reference source with all names and authors used following exactly those in the body of the checklist with each name listed alphabetically by genus. Accepted names appear in Roman print and stand alone, whereas synonyms appear in italics and are followed by their accepted names. The thesaurus differs from the checklist by offering a rapid location system for all names, save those names above the genus level. The thesaurus and the checklist are together intended to provide a comprehensive summary of accepted names and their synonyms of the North American vascular flora north of Mexico: the continental United States, Hawaii, Puerto Rico, and the U. S. Virgin Islands; Canada; the French islands of St. Pierre and Miquelon; and Greenland.

This is a major work which is used many times a day in my work of compiling floras, manuals, articles, books, and plant checklists of Texas and its many regions. This definitive *Checklist* on plant nomenclature and its synonymy is an indispensable tool of immense reference value, and is a must on the desk and bookshelf of taxonomists and systematists, botanists and horticulturists who must know the latest correct nomenclature of our flora.—*Robert J. O'Kennon.*

CYTOLOGICAL STUDIES ON NORTH AMERICAN SPECIES OF *SACCHARUM* (POACEAE: ANDROPOGONEAE)

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ABSTRACT

Cytology of the *Saccharum* L. (including *Erianthus* Michx.) species native to North America has not been well characterized. Our objectives were to determine chromosome numbers of 60 clones representative of the eight native species and varieties and attempt crosses with elite sugarcane (*Saccharum* spp. hybrids). Counts are reported for the first time for *S. brevibarbe* var. *brevibarbe* (2n = 60), *S. coarctatum* (2n = 60), and *S. giganteum* (2n = 30, 60, and 90). The latter represents the first report of a polyploid series within *S. giganteum* and the first count of 2n – 90 for the *Erianthus* group. Counts also were made for *S. alopecuroideum* (2n = 30), *S. baldwinii* (2n = 30), and *S. brevibarbe* var. *contortum* (2n = 60). Five putative crosses were made between sugarcane hybrids and native *Saccharum*, yielding 4 to 448 seeds per cross.

RESUMEN

La citología de las especies de *Saccharum* L. (incluyendo *Erianthus* Michx.) nativas de Norte América no ha sido bien caracterizada. Nuestros objetivos fueron determinar el número cromosómico de 60 clones representativos de ocho especies y variedades nativas e intentar cruces con caña de azúcar de élite (híbridos de *Saccharum* spp.). Se ofrecen por primera vez recuentos de *S. brevibarbe* var. *brevibarbe* (2n = 60), y *S. coarctatum* (2n = 60), y *S. giganteum* (2n = 30, 60, y 90). Este último representa la primera cita de una serie poliploide en *S. giganteum* y el primer recuento de 2n = 90 para el grupo *Erianthus*. Se hicieron también recuentos de *S. alopecuroideum* (2n = 30), *S. baldwinii* (2n = 30), y *S. brevibarbe* var. *contortum* (2n = 60). Se hicieron cinco cruces putativos entre híbridos de caña de azúcar y *Saccharum* silvestres, produciendo de 4 a 448 semillas por cruce.

INTRODUCTION

There has been disagreement among taxonomists concerning the treatment and placement of *Saccharum* L. and *Erianthus* Michx. A brief history of the vari-

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ous concepts of these genera is presented in Webster & Shaw (1995). North American taxonomists have followed the concepts of Hitchcock (1951) and have recognized both genera. European agrostologists have placed *Erianthus* within *Saccharum*. Characteristics used to distinguish the genera are difficult to apply when the full range of variation is considered. Therefore, we are following the concept presented in Clayton & Renvoize (1986) that recognizes *Erianthus* as a synonym of *Saccharum*.

Sugarcane breeders recognize separate genera and generally include five to six species within *Saccharum*: *S. edule* Hassk. (2n = 60 to 80), *S. officinarum* L. (2n = 80), *S. robustum* Brandes & Jesw. ex Grassl (2n = 60, 80, to about 200), *S. sinense* Roxb. (2n = 111 to 120), and *S. spontaneum* L. (2n = 40 to 128). A sixth species, *S. barberi* Jesw. (2n = 81 to 124), is sometimes included in *S. sinense*. Chromosome counts (Daniels et al. 1975) for closely related taxa called the "*Saccharum* complex" by Mukerjee (1957) include Old World *Erianthus* Michx. sect. *Ripidium* Henrard (2n = 20, 30, 40, 60); *Miscanthus* Anderss. sect. *Diandra* Keng (2n = 40); *Narenga* Bor (2n = 30); and *Sclerostachya* (Hack.) A. Camus (2n = 30). These and a few other genera have at times been placed in *Saccharum* (Daniels and Roach 1987; Whalen 1991). The basic genomes within *Saccharum* (s. str.) appear to be x = 8, 10, and 12 (Sreenivasan et al. 1987), and that of *Erianthus* may be x = 5, typical of the Andropogoneae (Celarier 1956a).

Harlan and de Wet (1975) noted that *Saccharum* had an "oversplit taxonomy," implying that many taxonomic divisions may be artificial. As evidence of this, interspecific and intergeneric crosses within the *Saccharum* complex are usually successful (Gill and Grassl 1986; Grassl 1980; Daniels and Roach 1987). The taxonomic relationships among the taxa of the *Saccharum* complex have been neither carefully studied nor well-defined (Webster and Shaw 1995) and they conclude that *Erianthus* is best treated as a synonym of *Saccharum*. Five species and one variety of *Saccharum* L. were recognized by Webster and Shaw (1995) as being native to North America. They are *S. alopecuroideum* (L.) Nutt. [= *Erianthus alopecuroides* (L.) Ell.], *S. baldwinii* Spreng. (= *E. strictus* Baldw.), *S. brevibarbe* (Michx.) Pers. var. *brevibarbe*, *S. brevibarbe* (Michx.) Pers. var. *contortum* (Nutt.) R. Webster (= *E. contortus* Ell.), *S. coarctatum* Fern. (= *E. coarctatus* Fern.), and *S. giganteum* (Walt.) Pers. [= *E. giganteus* (Walt.) C.E. Hubb.].

Old World species previously treated in *Erianthus* (sect. Ripidium) are used in sugarcane breeding (Heinz 1991), particularly for its disease resistance (Burner et al. 1993; Grisham et al. 1992) and freeze tolerance (Moore 1987). Chromosome numbers of many clones have been reported (Babu and Srinivasan 1960; Mohan and Sreenivasan 1983). Hybrids between *Saccharum* spp. and North American species placed in *Erianthus* have not been reported, although Gill and Grassl (1986) reported hybrids between *Sclerostachya fusca* (Roxb.) A. Camus and *E. brevibarbis* Michx. (= S. *brevibarbe*), *E. tracyi* Nash. (= *S. alopecuroideum*), *E.*

contortus Baldw., and between *Miscanthus* sp. and *E. brevibarbis* Michx. (= *S. brevibarbe*).

Except for the few clones (five clones in four species) reported by Celarier (1956b) and Gill and Grassl (1986), there have been no cytological studies of the North American species traditionally placed in *Erianthus*. The objectives of this research were to determine chromosome numbers and characteristics in a complete collection of North American species of these taxa and attempt hybridization with elite sugarcane hybrids (interspecific and intergeneric *Saccharum* spp. hybrids).

MATERIALS AND METHODS

Clones were collected as rhizomes from natural populations in the mid-Atlantic and southeastern U.S.A. (Fall 1992) and southcentral U.S.A. (Fall 1993) and were grown at Houma, Louisiana (29° 35'N 90° 44'W) in 18.9 L cans filled with a soil mix of 3:2:2 (soil:sand:peat moss). Taxonomy was verified according to the concepts presented in Webster and Shaw (1995). Voucher specimens are deposited at TAES.

Inflorescences were collected at early boot stage and fixed in Carnoy's B: ethanol, acetic acid, and chloroform (6:3:1 mixture by volume) (Smith 1947) and a few drops of saturated ferric chloride. Anthers were squashed in 5 g L^{-1} propionocarmine. Chromosome number was determined from pairing configurations at diakinesis or metaphase I (MI) in 5 to 25 microsporocytes per plant. Chromosome number for some plants was determined or verified in squashes of root tip cells using standard procedures. Pollen stainability, an estimate of pollen viability, was measured by staining mature anthers in 10 g L^{-1} I_2-KI.

The cross-sectional area of individual bivalent chromosomes was measured at MI for each of nine clones (range 1 to 15 cells $clone^{-1}$, mean 6 cells $clone^{-1}$) using a Cue-2[1] image analyzer (Galai 1990). Area (μm^2) was determined from the number of pixels in the bivalent chromosome.

About 100 completely filled pollen grains from mature anthers of 25 plants were collected in Fall 1993, stained in 10 g L^{-1} I_2-KI, and imaged at 400x. Cross-sectional area was calculated as described above. Average cross-sectional radius (μm) of each pollen grain was the mean of eight Martin's radii measured at 0, 45, 90, 135, 180, 225, 270, and 315° (Galai 1990). Volume (μm^3) was calcu-lated from average radius assuming that pollen grains were perfect spheres.

Analysis of variance of pollen area and volume was done by the general linear models procedure (SAS Institute 1990). Sources of variation were species (7 df),

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[1] Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture and does not imply its approval to the exclusion of other products that may also be suitable.

clone within species (16 df), and residual (2,773 df). The effect of species was tested using clone within species as error; clone within species was tested using residual as error. Means were compared using least significant difference at the 5% level of significance (Steel and Torrie 1980). The cluster procedure (SAS Institute 1990) was used to assign clones to non-overlapping hierarchical groups based on multivariate analysis of chromosome number, pollen area, and pollen volume. Prior to conducting the cluster analysis, data were standardized to a mean of 0 and standard deviation of 1 using procedure "standard" (SAS Institute 1990).

Crosses between the native North American taxa of *Saccharum* and elite sugarcane clones, cytoplasmically male-sterile (cms) *Sorghum bicolor* (L.) Moench, and *Vetiveria zizanioides* (L.) Nash (used as females) were attempted in Fall 1993. Flowering of sugarcane clones was induced using standard photoperiod treatment (Dunckelman and Legendre 1982). Flowering of *Sorghum*, North American *Saccharum*, and *V. zizanioides* occurred under natural photoperiod. Conventional methods of crossing, seed maturation, seed germination, and seedling establishment were used (Dunckelman and Legendre 1982).

RESULTS AND DISCUSSION

Chromosome number varied among and within the North America *Saccharum* species (Table 1). *Saccharum alopecuroideum* and *S. baldwinii* were 2n = 30. Counts of 2n = 30 in *E. strictus* from Texas (Celarier 1956b) and *E. tracyi* (Gill and Grassl 1986) are consistent with our data. A count of 2n = 60 in *S. alopecuroideum* (Celarier 1956b) is inconsistent with our data. However, two clones of *S. giganteum* (2602 and 2603) with 2n = 60 and characteristics similar to *S. alopecuroideum* were collected in Tennessee and Arkansas. It seems probable that Celarier's count of 2n = 60 may be based on *S. giganteum* according to present taxonomic concepts. Clones with 2n = 30 and 2n = 60 are probably 6*x* and 12*x*, respectively.

Saccharum giganteum consisted of clones with 2n = 30, 60, and 90 chromosomes. These are the first counts for the species, the first indication that the species is a polyploid series, and the first report of 2n = 90 (18x) in the taxa traditionally placed in *Erianthus*. The 2n = 30 types were collected from Maryland south to Alabama and in southern Louisiana; the 2n = 60 types were collected in Alabama, Arkansas, Georgia, Louisiana, and Tennessee; and the 2n = 90 types were collected in southern Georgia and Florida. This indicates a geographic effect on distribution of cytotypes. Future studies are planned to define the relationship between chromosome number and morphology within this species. *Saccharum bengalense* Retz. [= *E. bengalense* (Retz.) Bharadw.] has also been shown to be a polyploid series with 2n = 20, 40, and 60 chromosomes (Mehra et al. 1968).

TABLE 1. Chromosome numbers and collection sites of native North American species of *Saccharum*.

S. alopecuroideum

2n = 30: ALABAMA. **Blount Co.:** Hwy 278, 32 km W of Gadsden, 6 Nov 1992, *Webster 2551* (TAES). **Lamar Co.:** Hwy. 18, 24 km E of Fayettsville, 6 Nov 1992, *Webster 2548* (TAES). GEORGIA. **Banks Co.:** Interstate 85, 3 km E of Commerce, 7 Nov 1992, *Webster 2553* (TAES). **Brooks Co.:** Hwy 84, 8 km E of county road 219, 27 Oct 1992, *Webster 2533* (TAES). **Forsyth Co.:** Hwy 9, 6 km S of Cummings, 7 Nov 1992, *Webster 2552* (TAES). MISSISSIPPI. **Choctaw Co.:** Natchez Trace Pkwy., 13 km S of Hwy 9, 28 Oct 1992 *Webster 2544* (TAES). TENNESSEE. **Putnam Co.:** Interstate 40, just E of mile marker 293, 8 Nov 1993, *Webster 2600* (TAES).

S. baldwinii

2n = 30: ALABAMA. **Tuscaloosa Co.:** Hwy 82, 8 km N of Tuscaloosa, 28 Oct 1992, *Webster 2541* (TAES). GEORGIA. **Charlton Co.:** Hwy 23 & 121, 8 km S of Folson, 26 Oct 1992, *Webster 2525* (TAES). **Lowndes Co.:** Hwy 84, 8 km W of Valdosta, 27 Oct 1992, *Webster 2532* (TAES).

S. brevibarbe* var. *brevibarbe

2n = 60: ARKANSAS. **Perry Co.:** Hwy 10, 2 km E of Hwy 324 jct, 10 Nov 1993, *Webster 2607* (TAES). **White Co.:** Hwy 367, within Garner city limits, 9 Nov 1993, *Webster 2605* (TAES).

S. brevibarbe* var. *contortum

2n = 60: ALABAMA. **Autauga Co.:** Hwy 82, 2 km E of county road 29, 28 Oct 1992, *Webster 2538* (TAES). **Chilton Co.:** Hwy 82, 7 km S of county road 65, 28 Oct 1992, *Webster 2539* (TAES). **Houston Co.:** Hwy 84, at AL state line, 27 Oct 1992, *Webster 2536* (TAES). **Lamar Co.:** Hwy 96, 8 km from MS state line, 6 Nov 1992, *Webster 2547* (TAES). **Pickens Co.:** Hwy 82, 13 km from MS state line, 28 Oct 1992, *Webster 2542* (TAES). ARKANSAS. **White Co.:** Hwy 64, 6 km W of Beebe, 10 Nov 1993, *Webster 2606* (TAES). **Yell Co.:** Hwy 10, 2 km W of Birta, 10 Nov 1993, *Webster 2608* (TAES). GEORGIA. **Decatur Co.:** Hwy 84, 1 km from jct 285, 14 km E of Donaldsonville, 27 Oct 1992, *Webster 2535* (TAES). MARYLAND. **Somerset Co.:** Hwy 13, S of Salisbury, 23 Oct 1992, *Webster 2502* (TAES); Hwy 13, 11 km N of Pocomoke, 23 Oct 1992, *Webster 2503* (TAES). MISSISSIPPI. **Choctaw Co.:** Natchez Trace Pkwy., 2 km S of Hwy 9, 28 Oct 1992, *Webster 2543* (TAES). NORTH CAROLINA. **Greene Co.:** Hwy 13, 16 km S of Greenville, 24 Oct 1992, *Webster 2509* (TAES). **Halifax Co.:** Hwy 258, 2 km N of Hwy 97, 24 Oct 1992, *Webster 2508* (TAES). SOUTH CAROLINA. **Florence Co.:** Hwy 301, 3 km N of Langston Rd, 25 Oct 1992, *Webster 2514* (TAES). TEXAS. **Angelina Co.:** Hwy 69, 6 km N of 7 jct., 13 Nov 93, *Webster 2611* (TAES). **Cherokee Co.:** Hwy 175, 6 km W of Jacksonville, 13 Nov 93, *Webster 2609* (TAES). VIRGINIA. **Accomack Co.:** Hwy 13, 91 m off of Parkway, 2 km N of Keller, 23 Oct 1992, *Webster 2504* (TAES).

S. coarctatum

2n = 60: ALABAMA. **Henry Co.:** Hwy 95, 29 km N of state line, 27 Oct 1992, *Webster 2537* (TAES). FLORIDA. **Clay Co.:** Hwy 301, 27 km N of Starke, 26 Oct 1992, *Webster 2527* (TAES). GEORGIA. **Brantley Co.:** Hwy 301, 14 km N of Nahunta, 26 Oct 1992, *Webster 2523* (TAES). **Evans Co.:** Hwy 301, 8 km N of Canoochee River, 25 Oct 1992, *Webster 2520* (TAES). **Grady Co.:** Hwy 84 & Steward Road, 27 Oct 1992, *Webster 2534* (TAES). **Screven Co.:** Hwy 301, 8 km S of state line, 25 Oct 1992, *Webster 2519* (TAES). **Wayne Co.:** Hwy 301, 3 km N of Jones Creek, Bethel Church, 25 Oct 1992, *Webster 2522* (TAES). SOUTH CAROLINA. **Dillon Co.:** Hwy 301, Little Pee Dee River, 8 km S of the state line, 24 Oct 1992, *Webster 2513* (TAES). **Clarendon Co.:** Hwy 301, 1 km N of Fox Tindal Road, 25 Oct 1992, *Webster 2516* (TAES). **Orangeburg Co.:** Hwy 301, 11 km E of Orangeburg, 25 Oct 1992, *Webster 2517* (TAES).

S. giganteum

2n = 30: ALABAMA. **Bibb Co.:** Hwy 82, 2 km from jct Hwy 91, 28 Oct 1992, *Webster 2540* (TAES). FLORIDA. **Gilchrist Co.:** Hwy 26, 13 km E of Trenton, 26 Oct 1992, *Webster 2528* (TAES).

Table 1. Continued

LOUISIANA. **Terrebonne Parish:** Spanish Trail Farm, Chacahoula, *Burner 2554* (TAES). NORTH CAROLINA. **Robeson Co.:** Hwy 301, 5 km N of Little Marsh Swamp, 24 Oct 1992, *Webster 2512* (TAES). **Wayne Co.:** Hwy 13, 2 km N of Rachel Jackson Hwy, 24 Oct 1992, *Webster 2510* (TAES). MARYLAND. **Wicomico Co.:** Hwy 50, just W of exit 331, 23 Oct 1992, *Webster 2501* (TAES). SOUTH CAROLINA. **Bamberg Co.:** Hwy 301, 11 km S of Bamberg, 25 Oct 1992, *Webster 2518* (TAES). **Clarendon Co.:** Hwy 301, 2 km N of Manning, 25 Oct 1992, *Webster 2515* (TAES). VIRGINIA. **Accomack Co.:** Hwy 13, 3 km N of Hwy 704, 23 Oct 1992, *Webster 2505* (TAES). **Southampton Co.:** Hwy 258, 3 km N of NC state line, 24 Oct 1992, *Webster 2506* (TAES).

$2n = 60$: ALABAMA. **Cullman Co.:** Hwy 91, at 4 mile marker, 6 Nov 1992, *Webster 2550* (TAES). **Lamar Co.:** Hwy 50, at AL state line, 6 Nov 1992, *Webster 2546* (TAES). **Walker Co.:** Hwy 69, 3 km S of Jasper, 6 Nov 1992, *Webster 2549* (TAES). ARKANSAS. **White Co.:** Hwy 367, 91 m E of Bradford city limits, 9 Nov 1993, *Webster 2603* (TAES). GEORGIA. **Evans Co.:** Hwy 301, 8 km N of Canoochee River, 25 Oct 1992, *Webster 2521* (TAES). LOUISIANA. **St. Landry Parish:** Hwy 49, 53 km N of Opelousas, 30 Oct 1992, *Webster 2545* (TAES). TENNESSEE. **Carroll Co.:** Hwy 70A bypass, N of Huntington, 8 Nov 1993, *Webster 2602* (TAES).

$2n = 90$: FLORIDA. **Dixie Co.:** Hwy 19 & 98, 2 km S of county road S358, 26 Oct 1992, *Webster 2529* (TAES). **Taylor Co.:** Hwy 51, 10 km from the Gulf of Mexico, 26 Oct 1992, *Webster 2530* (TAES); Hwy 221, 6 km N of Perry, 27 Oct 1992, *Webster 2531* (TAES). GEORGIA. **Charlton Co.:** Hwy 23 & 121, 2 km N of the FL line, 26 Oct 1992, *Webster 2526* (TAES).

Saccharum brevibarbe vars. *brevibarbe* and *contortum* and *S. coarctatum* were $2n = 60$. Gill and Grassl (1986) reported that a clone of *E. brevibarbis* was $2n = 60$, which confirmed our finding for the species. However, they reported that a clone of *E. contortus* was $2n = 30$, which may be the result of misidentification. *Saccharum brevibarbe* var. *contortum* is characterized as having callus hairs equal to or shorter than the spikelet, while callus hairs are either absent (*S. baldwinii*) or longer (*S. giganteum* and *S. alopecuroideum*) than the spikelet in $2n = 30$ types (Webster and Shaw 1995).

Meiosis was normal in all clones and univalents and quadrivalents were extremely rare (Fig. 1). Celarier (1956b) noted bivalent size polymorphism in North American *Saccharum*. Mean bivalent area of 4.43 μm^2 (range 1.58 to 8.94 μm^2), 3.25 μm^2 (range 1.10 to 8.77 μm^2), and 4.43 μm^2 (range 1.86 to 7.61 μm^2) in $2n = 30$, 60, and 90 biotypes, respectively, differed little among cytotypes. Bivalent area was not normally distributed; the distribution was generally shifted toward the smaller size classes. Bivalents of an Old World clone (*E. rufipilus*, $2n = 20$) averaged 3.89 μm^2 (range 3.25 to 5.28 μm^2), and those of an elite sugarcane clone LCP 81-30 ($2n = 105, 108$) averaged 3.42 μm^2 (range 1.55 to 6.99 μm^2) (Burner and Legendre 1994; Burner unpublished data). Thus, North American *Saccharum* tends to have wider ranges of bivalent area than Old World *Saccharum*, but there is little difference in area or range between New World *Saccharum* and sugarcane. The data support the observation by Gould (1956) that there is no obvious correlation between chromosome number and chromosome size in the Andropogoneae.

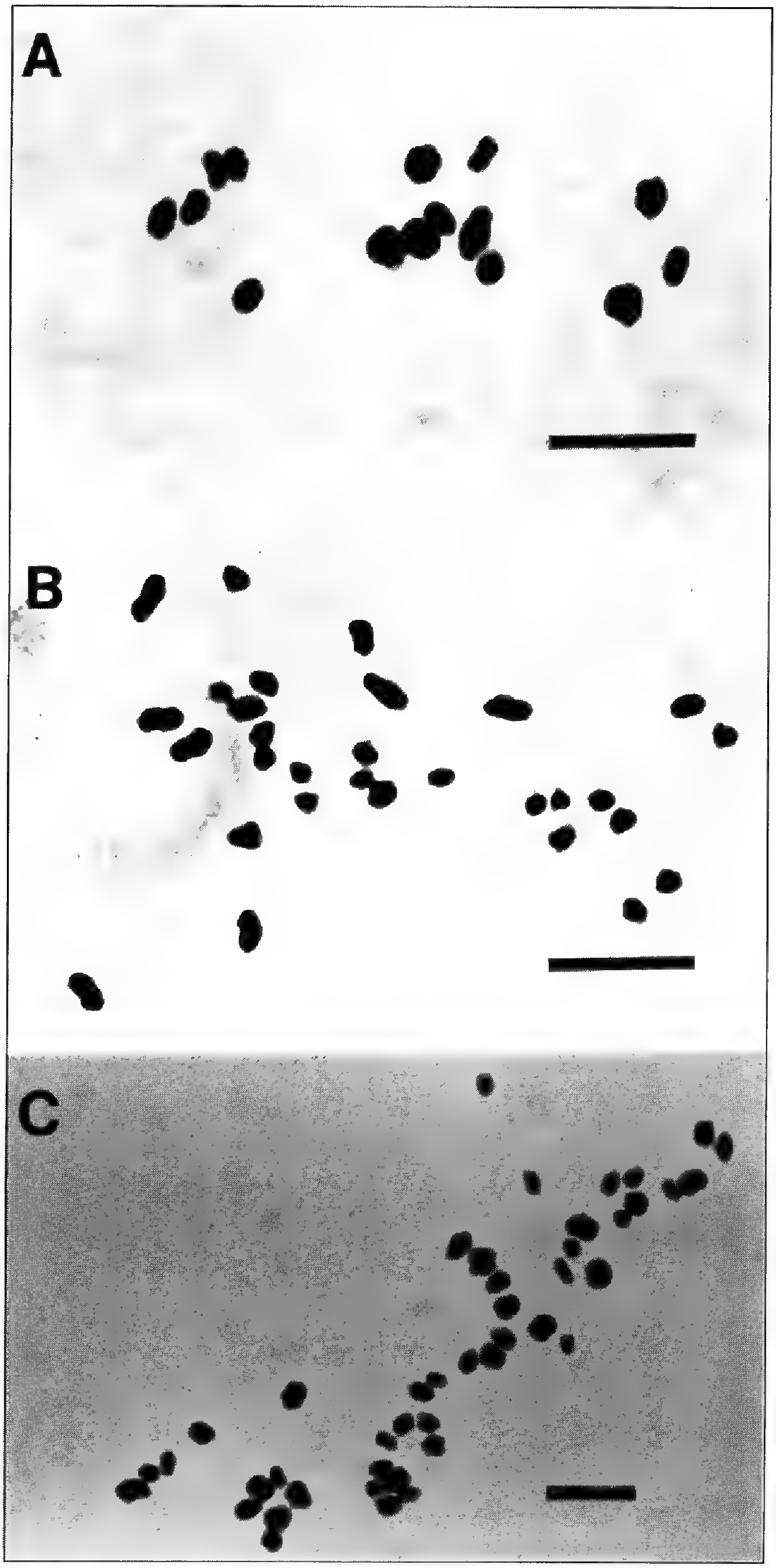

FIG. 1. Meiotic metaphase I chromosomes of North American *Saccharum*. Bar in each figure represents 10 µm. (A) *S. giganteum* (n = 15 bivalents) [×1600]. (B) *S. brevibarbe* var. *contortum* (n = 30 bivalents) [×1600]. (C) *S. giganteum* (n = 45 bivalents) [×1000].

Pollen area and volume differed significantly among species and clones within species (Table 2). As expected, species with 2n = 30 had smaller pollen than those with 2n = 60 or 2n = 90 (Gould 1957). Pollen size has been used as a taxo-nomic character to separate closely related taxa differing in chromosome number (Gould 1953 & 1957). However, variation in pollen size among clones within species indicates that pollen size would be an unreliable predictor of species.

Clones were assigned to clusters based on chromosome number, pollen area, and pollen volume. The dendrogram beginning with seven clusters (R^2 = 0.97) and ending with one cluster (R^2 = 0.00) is shown in Fig. 2. There was a

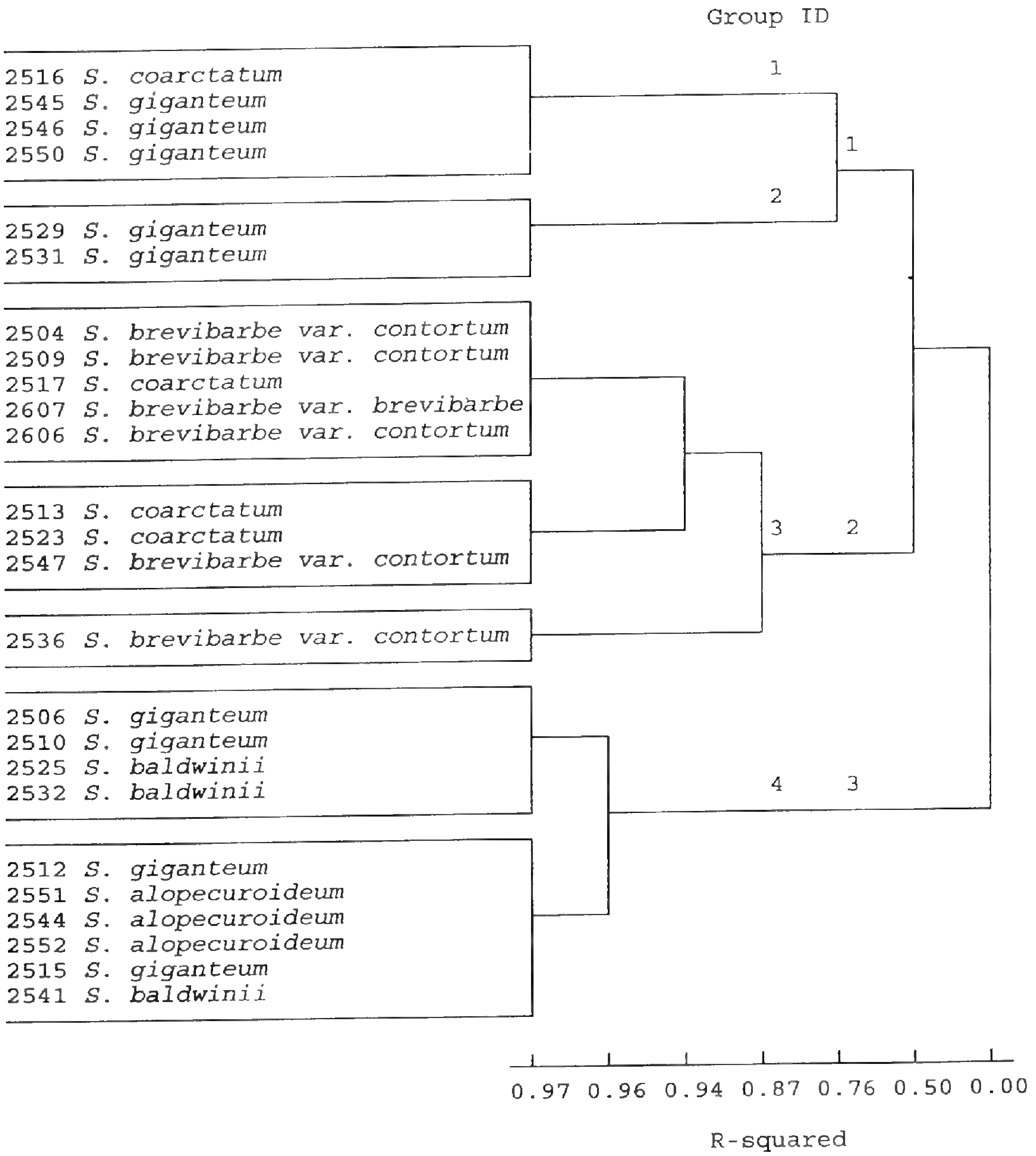

FIG. 2. Dendrogram of relationships among 25 North American *Saccharum* clones based on pollen area, pollen volume, and chromosome number.

TABLE 2. Mean pollen area and pollen volume of North American *Saccharum* clones.

Species/clone	Pollen Area (μm^2)	Pollen Volume (μm^3)
S. alopecuroideum	1052	25761
2544	1028	24840
2551	1044	25421
2552	1084	27022
S. baldwinii	1218	32146
2525	1282	34478
2532	1243	33248
2541	1129	28712
S. brevibarbe var. ***brevibarbe***	1926	63635
2607	1926	63635
S. brevibarbe var. ***contortum***	2020	68814
2504	1854	59960
2509	1914	63254
2536	2476	92818
2547	1752	55298
2606	2106	72741
S. coarctatum	1751	55459
2513	1711	53577
2516	1603	48565
2517	1924	63544
2523	1765	56152
S. giganteum 2n = 30	1184	30987
2506	1271	34365
2510	1277	34685
2512	1045	25494
2515	1144	29405
S. giganteum 2n = 60	1447	41065
2545	1529	45172
2546	1417	40494
2550	1394	39148
S. giganteum 2n = 90	1478	43090
2529	1447	41883
2531	1510	44297
Mean	1511	45366
CV (%)	12.3	18.9
LSD (0.05) - Species	207	10324
LSD (0.05) - Clone within species	52	2397

TABLE 3. Seed yield of crosses with North American *Saccharum*.

Cross no.	Parents		Viable
	Female	Male	seeds (no.)
3003	A4692[1]	2508	0
3004	A$_3$TX7000[1]	2535	0
3006	A$_2$TX632[1]	2504	2
3007	A83E[1]	2551	1
3008	ATX 623[1]	2525	0
3011	POJ 2222[3]	2543	26
3031	IND 81-53[2]	2532	0
3144	CP 65-357[3]	2531	448
3145	CP 91-534[3]	2531	92
3206	CP 92-670[3]	2530	12
3209	CP 65-357[3]	2533	4
3210	CP 88-755[3]	2533	0

[1] CMS *Sorghum*.

[2] *Vetiveria zizanioides* 2n = 20 (D.M. Burner, unpublished data).

[3] Elite sugarcane clone.

10% loss in explained variance when seven clusters were combined to four clusters. Four-cluster analysis ($R^2 = 0.87$) seemed to be most informative. Clones of *S. giganteum* (2n = 60) and *Webster 2516* (*S. coarctatum*, 2n = 60) were assigned to cluster group 1. Morphology of *Webster 2516* is otherwise typical of *S. coarctatum*. Clones of *S. giganteum* with 2n = 90 chromosomes were assigned to cluster group 2. Clones of *S. brevibarbe* vars. *brevibarbe* and *contortum* and *S. coarctatum*, except for *Webster 2516* were assigned to cluster group 3. Clones with 2n = 30 were assigned to cluster group 4. Thus, the four-cluster analysis was generally consistent with present taxonomic concepts (Webster and Shaw 1995) and provided evidence of diversity between the cytotypes of *S. giganteum*. There was a further loss of 11% of explained variance when the 2n = 60 and 2n = 90 cytotypes of *S. giganteum* were joined to form three clusters. The three-cluster analysis explained 76% of variance. Only 50% of total variance was explained by two clusters.

Crosses were successful between elite sugarcane and North American *Saccharum* (Table 3). A cross with *Webster 2531* (2n = 90) yielded 448 seeds, and other crosses yielded 0 to 92 seeds. The potential agronomic value of these F_1 hybrids will be evaluated in subsequent tests. Two crosses of cms *Sorghum* × North American *Saccharum* (five crosses attempted) yielded some seed, but grow-out evaluation showed that the F_1 progeny were not hybrid. Crosses of cms *Sorghum* × elite sugarcane also failed to yield hybrid progeny (Burner unpublished data). *Vetiveria zizanioides* (2n = 20) × *Webster 2532* (2n = 30) was also unsuccessful. Pistillate sterility is frequently observed in *V. zizanioides* (Ramanujam and Kumar

1963), and despite several attempts we have never obtained viable seeds from this species.

Löve (1951) noted that differing chromosome numbers within a species, as we found in *S. giganteum*, indicates the species may include more than one distinguishable taxon and needs closer taxonomic inspection. Löve (1951) and Nannfeldt (1938) further argue that intraspecific difference in ploidy level has fundamental systematic value sufficient to justify the recognition of their respec-tive members as species. Cytomorphological study of *S. giganteum* should be conducted and crosses between 6*x* and 18*x* forms, to attempt synthesis of the intermediate 12*x* form, would further our understanding of the evolution of the genus.

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SYSTEMATIC STUDY OF TEXAS POPULATIONS OF *PHACELIA PATULIFLORA* (HYDROPHYLLACEAE)

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ABSTRACT

Populations of *Phacelia patuliflora*, a species of the southeastern United States and closely adjacent Mexico, were investigated in Texas. The species was formerly treated as having two varieties, *P. patulifora* var. *patuliflora* and *P. patuliflora* var. *teucriifolia*. The present investigation suggests that an additional regional variety from south Texas be recognized for which the name ***P. patuliflora*** var. ***austrotexana*** J.A. Moyer, var. nov. is proposed. A key to the varieties of this complex along with a map showing their distribution is included.

RESUMEN

Se investigaron en Texas poblaciones *Phacelia patuliflora*, una especie del sureste de los Estados Unidos y partes adyacentes de México. Se reconocían anteriormente dos variedades, *P. patulifora* var. *patuliflora* y *P. patuliflora* var. *teucriifolia*. La presente investigación sugiere que puede ser reconocida una variedad regional adicional del sur de Texas, para la que se propone el nombre *P. patuliflora* var. *austrotexana* J.A. Moyer, var. nov. Se incluye una clave para las variedades de este complejo junto con un mapa que muestra su distribución.

KEY WORDS: Hydrophyllaceae, *Phacelia*, Texas

Phacelia patuliflora belongs to section *Cosmanthus* Brand of the Hydrophyllaceae. This section is characterized by the presence of a gland or nectary on the principal vein of the corolla (Constance 1949). *Cosmanthus* consists of 14 species with a south to north distribution starting in the Guatemalan and the Mexican highlands and extending northwards into Texas and Oklahoma and eastward through the Ozarks to the Appalachians. Other species of *Phacelia* do not overlap the distribution of the subgenus *Cosmanthus*, with the exception of *P. congesta* Hook. and its few relatives, which are not morphologically or cytologically similar to *Cosmanthus* (Constance 1949). Gillett (1968), in his cytological work on *Cosmanthus*, also recognized 14 species in the section. Turner (1991) has recently added three additional new species, *P. altotonga*, *P. carmenensis,* and *P. neffii*, to the *Cosmanthus* complex.

The *Phacelia patuliflora* complex is most commonly aligned with *P. strictiflora* and *P. laxa* (Constance 1949, 1950; Gillett 1968). As indicated in Fig. 1 and in the taxonomic treatment that follows, we recognize three infraspecific elements

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in the group, all of which are distinctly allopatric and show little or no tendency to intergrade when observed in the field. The var. *austrotexana*, a segregate from var. *patuliflora* as treated by Constance, is probably closer to *P. laxa* Small than it is to *P. patuliflora* var. *patuliflora* [which appears equally close to *P. strictiflora* (Engelm. & Gray) A. Gray, according to Constance (1949)]. Indeed, Constance in his discussion of *P. laxa*, states that the species is:

> ... exceedingly difficult to separate from *P. patuliflora* in the herbarium ... since all the character of *P. laxa*, except perhaps the low number of ovules, have been diffused into *P. patuliflora*, its distinctness rests solely upon a combination of characters, none of which is clearly distinguishing in itself.

He goes on to note, however, that in the field it is easily recognized by its small, pale flowers, petiolate cauline leaves, sparse pubescence and preference for shaded alluvial situations, all of which the senior author also observed in her field excursions. Nevertheless, Constance opined that *P. laxa* has been very nearly "swamped out" by the competition from its own recombinational products with *P. patuliflora* var. *teucriifolia*. Our field observations and examination of distributional ranges, make it difficult to accept that *P. laxa* has, to any considerable extent, hybridized with *P. patuliflora* var. *teucriifolia*. Rather, the distribution pattern and morphological data strongly suggest that *P. patuliflora* var. *austrotexana* is a regionally differentiated taxon little affected by hybridization from *P. laxa* or other taxa. Whatever its origin, it would appear on both morphological and geographical grounds that *P. laxa* is much closer to *P. patuliflora* var. *austrotexana* than it is to *P. patuliflora* var. *teucriifolia*.

BIOGEOGRAPHY

The three varieties of *Phacelia patuliflora* in Texas are distinctly separated geographically (Fig. 1). Interestingly, the collective distribution of the subgenus *Cosmanthus* indicates a migration northward from Mexico (Constance 1950; Turner 1991). Within Texas this migration presumably allowed for geographical diversification and habitat specialization for each variety.

Phacelia patuliflora is characterized by hard-to-locate but often relatively dense populations which appear to be thriving. The species is not present in many apparently suitable areas near the known populations. Frequent human disturbance or overgrazing at the sites where *P. patuliflora* does occur might explain the difficulty in locating sizeable colonies.

TAXONOMIC TREATMENT

Phacelia patuliflora (Engelm. & A. Gray) A. Gray, Proc. Amer. Acad. Arts 10:321. 1875. *Eucota patuliflora* Engelm. & A. Gray, Boston J. Nat. Hist. 5:45. 1845. TYPE: U.S.A: TEXAS: Austin Co.: in a woods near San Felipe, Mar 1843, *Lindheimer* II-280 (HOLOTYPE: GH; ISOTYPES: NY, MO).

Phacelia hispida Buckl., Proc. Acad. Nat. Sci. Philadelphia 13:463. 1862. non A. Gray 1878. TYPE: U.S.A.: TEXAS: Travis Co.: Austin, 1860, *Buckley s.n.* (HOLOTYPE: PA; ISOTYPES: GH, MO).

KEY TO THE VARIETIES OF *PHACELIA PATULIFLORA*

1. Peduncles with small, well-defined, glandular hairs, these ca 0.1 mm in length and dispersed among a rather even vestiture of mostly short, non-glandular hairs 0.5 mm in length or less .... var. *patuliflora*
1. Peduncles without glandular hairs, the vestiture various but not as described in the above .... (2)
    2. Calyx lobes markedly acute, elongating in fruit to twice the length of the invested capsules; calcareous soils of west-central Texas and adjacent Mexico var. .... *teucriifolia*
    2. Calyx lobes rounded or rather abruptly obtuse; mostly sandy soils of southern Texas .... var. *austrotexana*

Phacelia patuliflora (Engelm. & A. Gray) A. Gray var. **patuliflora**

Annual herbs, 8–60 cm high, branching at the base with branches stiffly ascending to decumbent. Leaves rarely rosulate or persistent, petiolate, truncate at base, oblong to oval, 2–10 cm long, 1–4 cm broad, pinnately lobed to pinnatifid with 1–7 pairs of smaller lobes or remote leaflets at base and a larger terminal lobe, all coarsely dentate or lobed with obtuse or acute teeth, strigulose to hirsute on both surfaces, the cauline leaves reduced, mainly sessile, oblong and coarsely dentate, distinctly lobed. Inflorescence a scorpoid cyme of 5–30 flowers, loosely hirsute to strigulose or canescent; the peduncles with small, well-defined glandular hairs, the latter about 0.1 mm in length; the mature pedicels weakly ascending to widely spreading or decumbent, 3–15 mm long. Corolla, purplish-violet to lavender, commonly with white centers, broadly campanulate to rotate-campanulate, 8–16 mm broad, the lobes finely crenulate, moderately to sparsely pilose on back. Stamens 5–8 mm long, included, the anthers 1.0–1.5 mm long. Style included, cleft to midpoint, hirsute below. Capsule globose, 4–6 mm across, the seeds 10–15, about 2 mm in length, ovoid-angled, brown, areolate and finely alveolate. Chromosome number, n = 9 pairs.

Distribution and Ecology: Central and eastern Texas (Fig. 1) mainly in sandy soils of roadsides, railroad embankments and alluvial soils of stream and river beds. The plants occur in disturbed areas in full sun or in partial shade of deciduous roadside thickets. Often grazed, plants begin to flower in mid-March, peak in early April and have set seed by the middle of May.

Population Site Descriptions: (Fig. 1) Three populations, 5–15 individuals each, of var. *patuliflora* were found in Burnet County on April 13, 1991. Populations 1, 2 and 3 were located on sandy, well-drained roadside banks in the Buchanan Dam area. These sites were situated on large sandstone outcrops with smaller flags present on the surface. Some of the plants in all of the sites had been grazed.

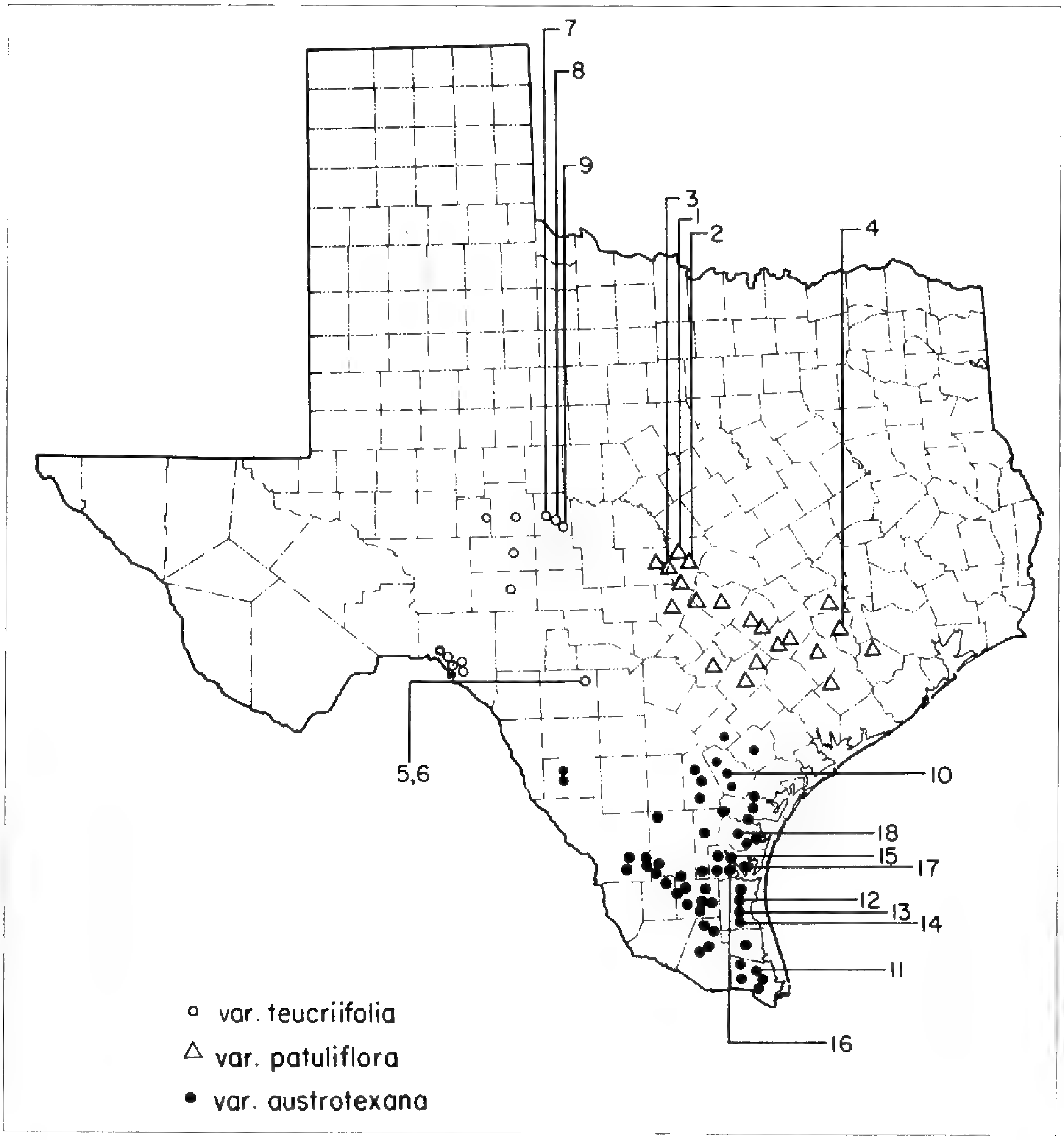

Fig. 1. Distribution of *Phacelia patuliflora* in Texas based upon specimens at LL, TEX. Populations examined in the field and discussed in the text are labeled accordingly.

Interestingly, plants were confined to the sandy areas, although tracts with abundant humus were in close proximity. Grasses and occasional plants of *Opuntia macrorhiza* characterized the area.

Population 4 of var. *patuliflora* was observed at or near the type locality in San Felipe, Texas on April 3, 1992. This population was rather dense, with 1000–1500 plants covering approximately half an acre. The plants were growing in very sandy loam with a few sandstone outcrops and were located in full sun. Other plants growing in this area were *Lupinus texensis*, *Pyrrhopappus pauciflorus*, *Gaillardia pulchella*, *Cirsium texanum* and *Castilleja indivisa*.

Phacelia patuliflora var. **teucriifolia** (I.M. Johnst.) Constance. TYPE: MEXICO. COAHUILA: Muzquiz, 12 Apr 1936, *Marsh 2120* (HOLOTYPE: GH; ISOTYPE: TEX!).

Annual herbs, 10–60 cm high, branching at the base with branches stiffly ascending. Leaves rarely rosulate or persistent, petiolate, truncate at base, oblong to oval, 2–10 cm long, 1–4 cm broad, pinnately lobed to pinnatifid with 1–7 pairs of smaller lobes or remote leaflets at base and a large terminal lobe, all coarsely dentate or lobed with obtuse or acute teeth, strigulose to hirsute on both surfaces, the cauline leaves reduced, mainly sessile, oblong and coarsely dentate, distinctly lobed. Inflorescence a scorpoid cyme of 5–30 flowers, loosely hirsute to strigulose or canescent, the mature pedicels weakly to stiffly ascending, 3–15 mm long. Corolla, purplish-violet to deep bluish-purple, commonly with white centers, broadly campanulate to rotate-campanulate, 12–20 mm broad, the lobes finely crenulate, moderately to sparsely pilose on back. Stamens 5–8 mm long, included, the anthers 1.0–1.5 mm long. Style included, cleft to midpoint, hirsute below. Capsule globose, 4–6 mm across, the seeds 10–15, about 2 mm in length, ovoid-angled, brown, areolate and finely alveolate. Chromosome number, n=9 pairs.

Distribution and Ecology: Edwards Plateau region of Texas southward to Mexico (Figure 1). Plants commonly occur in calcareous soils in draws and river beds as well as along roadsides. Populations are frequently located in the partial shade of deciduous trees and in the full sun of disturbed roadside ditches. Flowering begins in late March with its peak in mid-April. Seeds are set and plants die back by late May.

Population Site Descriptions: (Fig. 1) Populations 5 and 6 occurred in Montell, Uvalde County and were sampled in mid-April of 1991. Both were located on highway embankments. Populations were comprised of 20–50 plants which were widely scattered, located in full sun and on the naturally calcareous soil of the western Edwards Plateau region. Associated species included, *Delphinium carolinianum, Callirhoe involucrata, Verbena bipinnatifida* and *Phlox drummondii*, as well as assorted grasses.

Populations 7, 8 and 9 were all located along the San Saba River in Menard County. These sites were characterized by calcareous soils of a grainy nature that seemed well drained. Populations 7, located at a picnic area on highway 83, two miles south of Menard, and population 8, located in the town of Menard, were situated in the partial shade of pecan bottoms. Both populations were dense, comprised of 500–1500 individuals. Other species in these areas included *Oenothera speciosa, Gaura coccinea* and *Penstemon triflorus*.

Population 9 was located on the banks of a road cut along FM 1311 where it crosses the San Saba River and was comprised of 24 individuals. The soil at this site was sand that appeared to have been recently deposited. It was also in partial shade. Associated species were grasses and abundant individuals of *Clematis pitcheri.*

Phacelia patuliflora var. **austrotexana** J.A. Moyer, var. nov.

Differt a *Phacelia patuliflora* (Engelm. & A. Gray) A. Gray var. *patuliflora* trichomatibus glandulosis carentibus.

Annual herbs, 8–60 cm high, branching at the base with branches stiffly ascending to decumbent. Leaves rarely rosulate or persistent, petiolate, truncate at base, oblong to oval, 2–10 cm long, 1–4 cm broad, pinnately lobed to pinnatifid with 1–7 pairs of smaller lobes or remote leaflets at base and a large terminal lobe, all coarsely dentate or lobed with obtuse or acute teeth, strigulose to hirsute on both surfaces, the cauline leaves reduced, mainly sessile, oblong and coarsely dentate, distinctly lobed. Inflorescence a scorpoid cyme of 5–30 flowers, loosely hirsute to strigulose or canescent; the mature pedicels weakly ascending to widely spreading or decumbent, 3–15 mm long. Corolla, purplish-violet to lavender, commonly with white centers, broadly campanulate to rotate-campanulate, 7–16 mm broad, the lobes finely crenulate, moderately to sparsely pilose on back. Stamens 5–8 mm long, included, the anthers oblong 1.0–1.5 mm long. Style included, cleft to midpoint, hirsute below. Capsule globose, 4–6 mm across, the seeds 10–15, about 2 mm in length, ovoid-angled, brown, areolate and finely alveolate. Chromosome number, n=9 pairs.

TYPE: U.S.A.: TEXAS: San Patricio Co.: along railroad ca. 2.5 mi. SW of Sinton, 22 Mar 1969, *D.S. Correll 36834* (HOLOTYPE: LL!; ISOTYPE: TEX!).

Representative specimens: TEXAS. **Bee Co.**: just south of Pettus, 2 Mar 1968, *Correll 35511*. **Brooks Co.**: King Ranch, Encino Division, 26 Apr 1949, *Lundell 14975*. **Cameron Co.**: Arroyo Colorado, Harlingen, 13 Mar 1964, *Correll 28973*. **Dimmit Co.**: Carrizo Springs, 12 Mar 1964, *Cuellar 43*. **Duval Co.**: 7 mi W of Hebbronville, 5 Mar 1962, *Trivino 4*. **Goliad Co.**: open places, Mar 1927, *C.B. Williams 45*. **Hidalgo Co.**: S of Encino, 19 Mar 1942, *Lundell 10829*. **Jim Hogg Co.**: Hebbronville, 14 Mar 1931, *Tharp s.n.* **Jim Wells Co.**: field at Alfred, 30 Mar 1970, *Correll 38310*. **Kenedy Co.**: Sarita along Hwy 96, 14 Mar 1941, *Runyon 2469*. **Kleberg Co.**: 10 mi S of Kingsville, 6 Mar 1959, *Turner 4467*. **Live Oak Co.**: along US Hwy. 59, 20 SW of Georgewest, 14 Mar 1964 *Fowler & Vergara 99*. **Nueces Co.**: Petronila Creek, between Bishop and Chapman Ranch, 12 Mar 1964, *Correll 28925*. **San Patricio Co.**: near Mathis, 29 Mar 1941, *Lundell 10081*. **Webb Co.**: 8.3 mi S of Mirando City, 16 Mar 1966, *Correll 32259*.

Distribution and Ecology: South and southeastern Texas in the sandy, well-drained soils of roadsides and alluvial stream beds (Fig. 1). Found in the following counties: Bee, Brooks, Cameron, Dimmit, Duval, Goliad, Hidalgo, Jim Hogg, Jim Wells, Kenedy, Kleberg, Live Oak, Nueces, San Patricio, Webb. Populations were found most frequently in full sun and often comprised the only vegetation in highly disturbed areas. Flowering begins in March with maximum anthesis in early April.

Population Site Descriptions: (Fig. 1) Population 10, located in Bee County, was sampled on 12 March 1991. It was comprised of approximately 500–700 plants which were found growing on the banks of a roadside drainage area in downtown Beeville. The drainage ditch walls and associated bank were comprised of sand with gravel and was located in the full sun. The population extended to a railroad embankment located approximately 20 meters from the roadside area. This embankment, also comprised of sand and gravel, was located in full sun and was well-drained. Individuals were not found in the 20 meter swath of loamy sand that lay between the drainage area and the embankment. Associated species found growing in the sand and gravel included *Corydalis micrantha* and isolated individuals of *Opuntia macrorhiza*.

Population 11 was collected in Cameron County on 14 March 1991. The site was in an abandoned commercial area off of the access road to Highway 77. Approximately 100–150 individuals were growing in what appeared to have been a sand and gravel parking lot in direct sun. No plants were found in a nearby (20 meters distance) overgrown garden area of rich loam.

Kenedy County was visited on 14 March 1991 and three populations were located. Population 12 was located along Highway 77 on the sandy berm of a drainage area. The berm, located in full sun, appeared to have been deposited some years prior and was comprised entirely of sand. Approximately 50 individuals were growing in association with *Sisyrinchium ensigerum* and varied grasses.

Population 13 was the only partially cultivated population found. Several thousand individuals were growing in the sandy loam of Sarita Square in the center of Sarita. These plants were being watered daily. All individuals were located in full sun in association with *Gaillardia pulchella, Castilleja indivisa, Sisyrinchium ensigerum, Gaura coccinea, Argemone albiflora* and varied herbs and grasses.

Population 14 was located along a roadside and the railroad embankment running parallel to and approximately 15 meters from Highway 77 near Ytturia. This site was characterized by extremely dry, well-drained sand and gravel. Approximately 100–200 individuals were present with only sparse grasses.

Three populations were found in Kleberg County on 14 March 1991. Population 15 was comprised of 15 plants and was located on the alluvial sand of Escondido Creek just south of Kingsville. Individuals were found only in the sand of the banks, and not in the surrounding grassy field. All individuals were located in full sun. Associated species included *Buchnera floridana* and *Phlox drummondii*.

Population 16 occurred on a railroad embankment along Highway 77 at its junction with FM 1118 in alluvial sand and gravel. The 22 plants observed were in full sun and were widely separated. Associated vegetation was comprised of *Corydalis micrantha, Cirsium texanum, Opuntia macrorhiza*, and *Sisyrinchium ensigerum*.

Population 17 was also growing on a railroad embankment running parallel to Highway 77 just south of its junction with FM 628, in gravelly sand.

This population was widely scattered and was comprised of approximately 50–60 individuals. However, this group was in the partial shade of a large *Acacia* grove. *Corydalis micrantha* and *Sisyrinchium ensigerum* were the only other species found on the embankment.

Population 18 was located in Nueces County and was sampled on 13 March 1991. It was comprised of 25–50 individuals growing in sand at the foundation of a roadside warehouse off of the Padre Island Expressway in Flour Bluff. The individuals were restricted to the sandy soils that appeared to have been placed at the foundation for the purpose of creating a drainage bank. The site was located in full sun; grasses were the only other species present.

ACKNOWLEDGMENTS

The present study represents part of a Master's thesis by the senior author. It is based upon field work, as indicated, and examination of approximately 300 specimens of the taxa concerned on file in the Plant Resources Center at the University of Texas at Austin (LL, TEX). We are grateful to Guy Nesom for the Latin diagnosis and to the McLean Family, Red Stoner and Marky Miles for their generous donation of time and effort in locating populations.

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ASHICAULIS, A NEW GENUS FOR SOME SPECIES OF *MILLEROCAULIS* (OSMUNDACEAE)

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ABSTRACT

Millerocaulis Erasmus ex Tidwell was established as a new genus for Miller's "*Osmundacaulis herbstii* group." *Australosmunda* Hill, Forsyth & Green was proposed subsequently for osmundaceous stems anatomically similar to *Millerocaulis*, but without leaf gaps. However, a few species of *Millerocaulis*, including its type, *M. dunlopii*, lack or have occasional leaf gaps. Therefore, *Australosmunda* is placed in the synonymy of *Millerocaulis*. *Millerocaulis* is emended to include those osmundaceous species without or having only an occasional leaf gap. Under the new arrangement, *Millerocaulis* includes four species *M. dunlopii*, *M. indica*, *M. indentata*, and *M. chubutensis*. A new genus, *Ashicaulis*, is proposed for species formerly in *Millerocaulis* having numerous leaf gaps. It contains 22 species, all of which are recognized nomenclaturally by new combinations.

RESUMEN

Millerocaulis Erasmus ex Tidwell se estableció como un nuevo género para el grupo de Miller "*Osmundacaulis herbstii*". Se propuso por ello *Australosmunda* Hill, Forsyth & Green para los tallos osmundáceos anatómicamente similares a *Millerocaulis*, pero sin lagunas foliares. Sin embargo, unas pocas especies de *Millerocaulis*, incluyendo su tipo, *M. dunlopii*, carecen de o tienen ocasionalmente lagunas foliares. Por ello, *Australosmunda* se pasa a la sinonimia de *Millerocaulis*. Se enmienda *Millerocaulis* para incluir aquellas especies osmundáceas que no tienen laguna foliar o que la tienen sólo ocasionalmente. En la clasificación nueva, *Millerocaulis* incluye cuatro especies *M. dunlopii*, *M. indica*, *M. indentata*, y *M. chubutensis*. Se propone un género nuevo, *Ashicaulis*, para las especies con numerosas lagunas foliares que se incluían anteriormente en *Millerocaulis*. Contiene 22 especies que se reconocen nomenclaturalmente con nuevas combinaciones.

INTRODUCTION

The genus *Millerocaulis* was established as a new taxon based upon the informal "*Osmundacaulis herbstii* group" that was originally discussed by Miller (1967). The "*Osmundacaulis herbstii* group" was ineffectively published (Art. 29) as a new genus *Millerocaulis* by Erasmus in his unpublished doctoral dissertation (1978). Herbst (1981:37) accepted Erasmus' *Millerocaulis* but failed to validate it with a description (Art. 32.1)" (Tidwell 1986:402). *Millerocaulis* was validated by Tidwell (1986).

Australosmunda was proposed for osmundaceous stems similar to *Millerocaulis*, but without leaf gaps (Hill et al. 1989; Fig. 1A). However, there are a few species in *Millerocaulis*, including its type, *M. dunlopii* (Kidston and Gwynne-Vaughan

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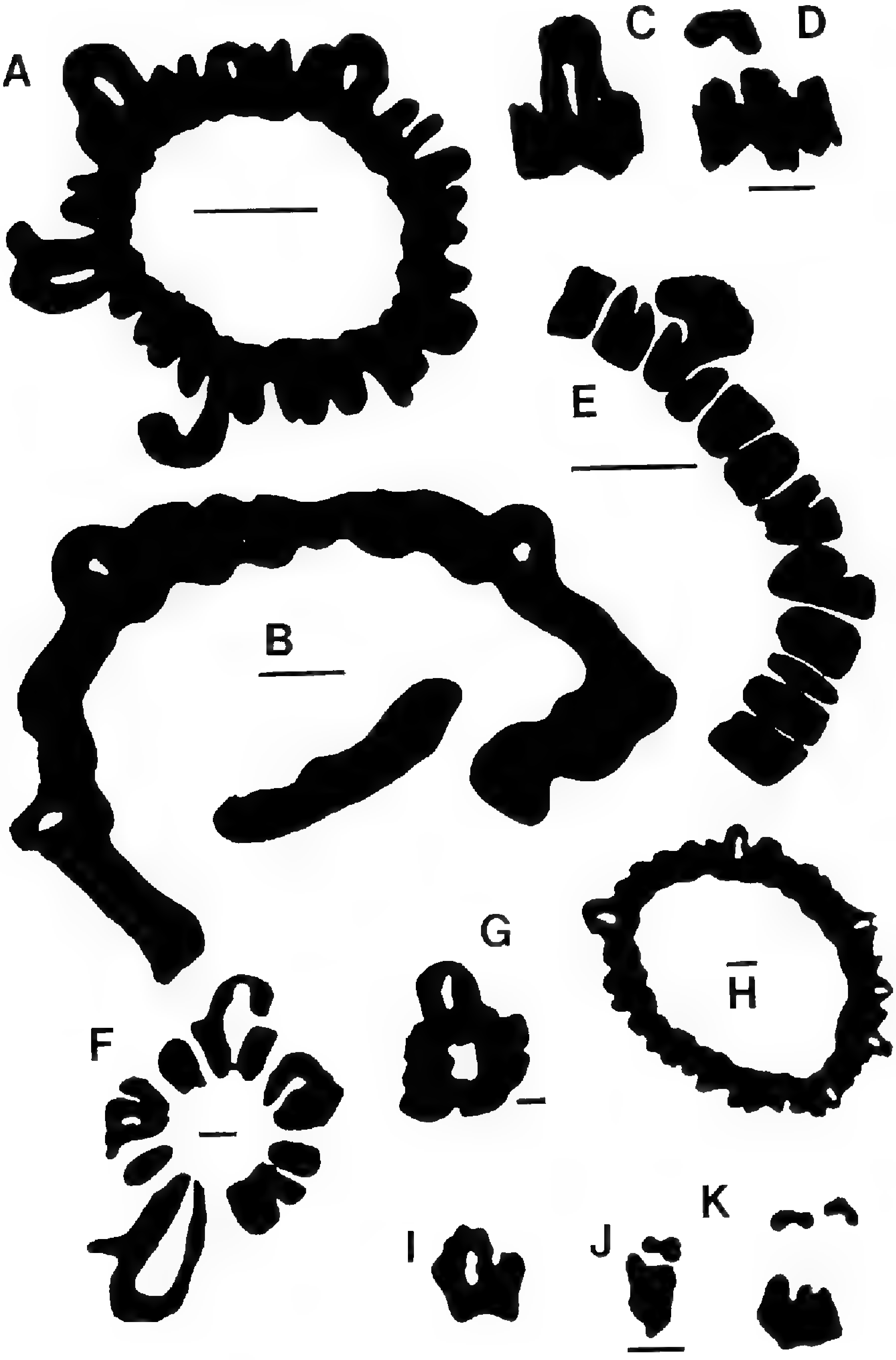

FIG. 1. Xylem cylinders and part of xylem cylinders of four species of *Millerocaulis* and two species of *Ashicaulis* gen. nov. A. *Millerocaulis indentata* (*Australosmunda indentata*), illustrating lack of leaf gaps. B, C, D. *Millerocaulis dunlopii* B, Part of continuous xylem cylinder, C, D, stages of leaf trace formation and departure. E. *Ashicaulis herbstii* and F. *Ashicaulis wadei* showing many leaf gaps in their xylem cylinders. G. *Millerocaulis indica* with continuous xylem cylinder and forming leaf trace. H, I, J, K, *Millerocaulis chubutensis*, H. xylem cylinder without leaf gaps, I, J, K, leaf trace formation and departure without leaving gaps. (Bars = 1mm). (A. Drawn from holotype of *Austalosmunda* (=*M.*) *indentata*, Hill et al. 1989; B, C, D, Drawn from holotype of *M. dunlopii*, Kidston & Gwynne-Vaughan 1907; E. Redrawn from Archangelsky & de la Sota 1963; F. Drawn from holotype of *Ashicaulis wadei*, Tidwell & Rushforth 1968; G. Redrawn from Sharma 1973; H. Drawn from holotype of *M. chubutensis*, Herbst 1977, I,J,K. Redrawn from Herbst 1977).

1907; Figs. 1B, C, D), that also lack or have an occasional leaf gap. Since the type of *Millerocaulis* essentially lacks leaf gaps, *Australosmunda* is placed in the synonymy of *Millerocaulis*, and *Millerocaulis* is restricted to fossil osmundaceous axes lacking or having very rare or only an occasional ill-defined leaf gap. *Ashicaulis* is proposed for those species formerly in *Millerocaulis* that have numerous definite leaf gaps (Figs. 1E, F).

TAXONOMY

Millerocaulis Erasmus ex Tidwell emend. Tidwell

Fossil osmundaceous rhizomes or arborescent axes containing stem or branching stems surrounded by a mantle of leaf bases and roots. Stele an ectophloic siphonostele, with xylem cylinder usually continuous, generally 3–15, sometimes up to 20, tracheids thick radially, with leaf gaps either totally lacking, incomplete, or very rare. Incomplete leaf gaps extending up to three-quarters through the metaxylem cylinder. Leaf trace separating from the xylem cylinder with only one protoxylem cluster and often, but not always, lacking axillary sclerenchyma. Scelerotic outer cortex of stem usually much wider than parenchymatous inner cortex. Petiole bases stipulate, and adventitious roots arising either singly or in pairs.

TYPE: *M. dunlopii* (Kidston & Gwynne-Vaughan) Tidwell (Basionym: *Osmundites dunlopii* Kidston & Gwynne-Vaughan "*dunlopi*").

Millerocaulis chubutensis (Herbst) Tidwell, comb. nov. BASIONYM: *Osmundacaulis chubutensis* Herbst, Facena 1:25. 1977.

Millerocaulis dunlopii (Kidston & Gwynne-Vaughan) Tidwell, comb. nov. BASIONYM: *Osmundites dunlopii* Kidston & Gwynne-Vaughan, Trans. Roy. Soc. Edinburgh 45:759. 1907 ("*dunlopi*"). *Osmundacaulis dunlopii* (Kidston & Gwynne-Vaughan) Miller, Contr. Mus. Paleo. Univ. Michigan [21:146. 1967 ("*dunlopi*"), nom. invalid. under Art. 33.2 — no page reference to basionym] 23:135. 1971. *Osmundites aucklandicus* Marshall, Trans. & Proc. New Zealand Inst. 56:210. 1924.

Millerocaulis indentata (Hill, Forsyth & Green) Tidwell, comb. nov. BASIONYM: *Australosmunda indentata* Hill, Forsyth & Green, Palaeontology 32:292. 1989.

Millerocaulis indica (Sharma) Tidwell, comb. nov. BASIONYM: *Osmundacaulis indica* Sharma, Palaeontographica 140B:157. 1973.

Ashicaulis Tidwell, gen. nov.

Fossil osmundaceous rhizomes, rarely arborescent axes, containing stem or branching stems surrounded by a mantle of leaf bases and roots. Stele an ectophloic-dictyoxylic-siphonostele (Miller 1971), with a xylem cylinder up to 20 tracheids thick, with many definite leaf gaps. Leaf trace separating from the xylem cylinder with only one protoxylem cluster and often, but not always, lacking axillary sclerenchyma. Commonly, the outer sclerenchymatous cortex is wider than the parenchymatous inner, rarely the same width. Petiole bases stipular and adventitious roots arising either singly or in pairs.

TYPE: *Ashicaulis herbstii* (Archangelsky & de la Sota) Tidwell (*Osmundites herbstii* Archangelsky & de la Sota).

The generic name honors my good friend and colleague Professor Sidney R. Ash of Weber State University of Ogden, Utah, in recognition of his numerous significant contributions to paleobotany. The list of species assigned to *Ashicaulis* and their synonyms are as follows:

Ashicaulis amajolensis (Sharma) Tidwell, comb. nov. BASIONYM: *Osmundacaulis amajolensis* Sharma, Palaeontographica 140B:156. 1973. *Millerocaulis amajolensis* (Sharma) Tidwell, Sida 11:402. 1987.

Ashicaulis beardmorensis (Schopf) Tidwell, comb. nov. BASIONYM: *Osmundacaulis beardmorensis* Schopf, Can. J. Bot. 56:3034. 1978. *Millerocaulis beardmorensis* (Schopf) Tidwell, Sida 11:402. 1987.

Ashicaulis broganii (Tidwell, Munzing & Banks) Tidwell, comb. nov. BASIONYM: *Millerocaulis broganii* Tidwell, Munzing & Banks, Palaeontographica 223B:98. 1991.

Ashicaulis estipularis (Sharma, Bohr & Singh) Tidwell, comb. nov. BASIONYM: *Osmundacaulis estipularis* Sharma, Bohra & Singh, Phytomorphology 8:61. 1979 ("estipulare"). *Millerocaulis estipularis* (Sharma, Bohra & Singh) Tidwell, Sida 11:403. 1987.

Ashicaulis gibbiana (Kidston & Gwynne-Vaughan) Tidwell, comb. nov. BASIONYM: *Osmundites gibbiana* Kidston & Gwynne-Vaughan, Trans. Roy. Soc. Edinburgh 45:763. 1907. *Osmundacaulis gibbiana* (Kidston & Gwynne-Vaughan) Miller, Contr. Mus. Paleontol. Univ. Michigan [21:146. 1967, nom. invalid. under Art. 33.2 — no page reference to basionym] 23:136. 1971. *Millerocaulis gibbiana* (Kidston & Gwynne-Vaughan) Tidwell, Sida 11:403. 1987.

Ashicaulis guptai (Sharma) Tidwell, comb. nov. BASIONYM: *Osmundacaulis guptai* Sharma, Palaeontographica 140B:154. 1973. *Millerocaulis guptai* (Sharma) Tidwell, Sida 11:403. 1987.

Ashicaulis hebeiensis (Wang) Tidwell, comb. nov. BASIONYM: *Osmundacaulis hebeiensis* Wang, Rev. Palaeobot. Palynol. 39:93. 1983. *Millerocaulis hebeiensis* (Wang) Tidwell, Sida 11:403. 1987.

Ashicaulis herbstii (Archangelsky & de la Sota) Tidwell, comb. nov. BASIONYM: *Osmundites herbstii* Archangelsky & de la Sota, Ameghiniana 3:135. 1963. *Osmundacaulis herbstii* (Archangelsky & de la Sota) Miller, Contr. Mus. Paleontol. Univ. Michigan (21:146. 1967, nom. invalid. under Art. 33.2 — no page reference to basionym) 23:134. 1971. *Millerocaulis herbstii* (Archangelsky & de la Sota) Tidwell, Sida 11:403. 1987.

Ashicaulis johnstonii (Tidwell, Munzing & Banks) Tidwell, comb. nov. BASIONYM: *Millerocaulis johnstonii* Tidwell, Munzing & Banks, Palaeontographica 223B:94. 1991.

Ashicaulis kidstonii (Stopes) Tidwell, comb. nov. BASIONYM: *Osmundites kidstonii* Stopes, Ann. Bot. 35:55. 1921 ("*kidstoni*"). *Osmundacaulis kidstonii* (Stopes) Miller, Contr. Mus. Paleontol. Univ. Michigan (21:146. 1967 ("*kidstoni*"), nom. invalid. under Art. 33.2 — no page reference to basionym) 23:136. 1971. *Millerocaulis kidstonii* (Stopes) Tidwell, Sida 11:403. 1987.

Ashicaulis kolbei (Seward) Tidwell, comb. nov. BASIONYM: *Osmundites kolbei* Seward, Geol. Mag., NS. 4:482. 1907. *Osmundacaulis kolbei* (Seward) Miller, Contr. Mus. Paleontol. Univ. Michigan (21:146. 1967, nom invalid. under Art. 33.2 — no page reference to basionym) 23:136. 1971. *Millerocaulis kolbei* (Seward) Tidwell, Sida 11:403. 1987.

Ashicaulis liaoningensis (Wu & Shao-lin) Tidwell, comb. nov. BASIONYM: *Millerocaulis liaoningensis* Wu & Shao-lin, Acta Palaeontol. Sinca 30:717. 1991.

Ashicaulis patagonica (Archangelsky & de la Sota) Tidwell, comb. nov. BASIONYM: *Osmundites patagonica* Archangelsky & de la Sota, Ameghiniana 2:153. 1962. *Osmundacaulis patagonica* (Archangelsky & de la Sota) Miller, Contr. Mus. Paleotol. Univ. Michigan [21:146. 1967, nom. invalid. under Art. 33.2 — no page reference to basionym] 23:136. 1971. *Millerocaulis patagonica* (Archangelsky & de la Sota) Tidwell, Sida 11:403. 1987.

Ashicaulis rajmahalensis (Gupta) Tidwell, comb. nov. BASIONYM: *Osmundites rajmahalensis* Gupta, Proc. Ind. Sci. Congr. Varanasi 55:428. 1968. *Osmundites rajmahalensis* Gupta, Palaeontographica 130B:174. 1970. *Osmundacaulis rajmahalensis* (Gupta) Sharma, Palaeontographica 140B:152. 1973. *Millerocaulis rajmahalensis* (Gupta) Tidwell, Sida 11:403. 1987.

Ashicaulis richmondii (Tidwell) Tidwell, comb. nov. BASIONYM: *Millerocaulis richmondii* Tidwell, Pap. & Proc. Roy. Soc. Tasmania 126:1–2. 1992.

Ashicaulis sahnii (Mittre) Tidwell, comb. nov. BASIONYM: *Osmundites sahnii* Mittre, Paleobotanist 4:113. 1955. *Osmundacaulis sahnii* (Mittre) Miller, Contr. Mus. Palaeontol. Univ. Michigan [21:146. 1967, nom. invalid. under Art. 33.2 — no page reference to basionym] 23:135. 1971. *Millerocaulis sahnii* (Mittre) Tidwell, Sida 11:403. 1987.

Ashicaulis santaecrusis (Herbst) Tidwell, comb. nov. BASIONYM: *Osmundacaulis santaecrusis* Herbst, Facena 1:21. 1977.

Ashicaulis spinksii (Tidwell, Munzing & Banks) Tidwell, comb. nov. BASIONYM: *Millerocaulis spinksii* Tidwell, Munzing & Banks, Palaeontographica 223B:96. 1991.

Ashicaulis swanensis (Tidwell, Munzing & Banks) Tidwell, comb. nov. BASIONYM: *Millerocaulis swanensis* Tidwell, Munzing & Banks, Palaeontographica 223B:99. 1991.

Ashicaulis wadei (Tidwell & Rushforth) Tidwell, comb. nov. BASIONYM: *Osmundacaulis wadei* Tidwell & Rushforth, Bull. Torrey Bot. Club 97:137. 1970. *Millerocaulis wadei* (Tidwell & Rushforth), Tidwell, Sida 11:403. 1987.

Ashicaulis websterii (Tidwell, Munzing & Banks) Tidwell, comb. nov. BASIONYM: *Millerocaulis websterii* Tidwell, Munzing & Banks, Palaeontographica 223B: 97. 1991.

Ashicaulis wrightii (Tidwell, Munzing & Banks) Tidwell, comb. nov. BASIONYM: *Millerocaulis wrightii* Tidwell, Munzing & Banks, Palaeontographica 223B:93. 1991.

DISCUSSION

Hill et al. (1989) considered *Australosmunda indentata* the first fossil osmundaceous rhizome described with a simple siphonostele and a parenchymatous pith without realizing that the holotype of *Millerocaulis*, *M. dunlopii*, also has a simple siphonostele. The reason is the considerable confusion surrounding the presence or absence of leaf gaps in *M. dunlopii*. As pointed out by Kidston and Gwynne-Vaughan (1907) in describing the holotype, "The most important anatomical character of this species is the almost complete absence of leaf gaps in the xylem ring of the stem. The fact that most of the leaf traces, *if not all*, depart without in any way interrupting the continuity of the xylem ring, so that the "medullary rays" characteristic of the osmundaceous stele in general are almost or completely absent. Most of these breaks in the xylem ring are clearly due to accident, but it is just possible that some of them may have been occupied by thin-walled cells which decayed before fossilization. Even if such medullary rays actually were present in the living plant, they must have been extremely narrow and very rare." "... and reference to the longitudinal sections will make it clear that no medullary ray is caused by the departure of the xylem of the leaf-trace and that the continuity of the deeper portion of the xylem ring is undisturbed." (p. 760–761). Thus, this species lacks leaf gaps.

Sinnott (1910), however, attributed the apparent lack of leaf gaps in the holotype of *M. dunlopii* to its having very short and narrow gaps that were obliterated by the process of fossilization, an intriguing explanation but without any real evidence. It is interesting to note that Sinnott also illustrated a diverging leaf trace for *Osmunda regalis* in an "apparently gapless fashion" and one for *O. cinnamomea* and others for *Todea superba* and *T. hymenophylloides* that had not formed complete gaps. The lack of leaf gaps in extant Osmundaceae is rare. Miller (pers. comm. 1993) mentioned that stems of modern osmundaceous taxa may be without complete leaf gaps near branches.

Several osmundaceous specimens with leaf gaps have been reported as *Osmundites* (= *Millerocaulis*) *dunlopii* from the Jurassic of New Zealand (Sinnott 1914) and the Jurassic near Purga, Queensland (Sahni 1920). However, none appear to be that species. One of Sinnott's specimens, for example, is most likely *Ashicaulis wrightii* described from Tasmania (Tidwell et al. 1991). His other specimens also belong to *Ashicaulis* but are too poorly preserved to be identifiable to species. Of the five leaf gaps Sahni (1920) noted in the transverse section of the stem of one of the four incomplete specimens he attributed to *O.*(=M.) *dunlopii*, two very narrow gaps may be valid, but even these, could be due to fracturing prior to preservation. None of his alleged gaps have traces opposite them. Sahni further stated, "In the only longitudinal section that was made, three leaf-traces are seen arising, but while it is impossible to say whether all of these have been cut medially, in no case is the cauline strand interrupted opposite an off-coming leaf trace" (p.13). Furthermore, it is doubtful if the specimen (#140) Sahni (1920) illustrated as text – fig. 2 is *M. dunlopii*, but more likely represents a species of *Ashicaulis*. He founded much of his identification on the curved leaf traces, sclerotic rings, and "the two large sclerotic strands inside the curved ends of the leaf-trace, which is characteristic of *O. dunlopii*." He used these criteria based on the limited knowledge of the Osmundaceae in Australia at the time. It is now known that the first two characters occur in essentially all the extant and extinct species of the Osmundaceae (Hewitson 1962; Miller 1967, 1971) and the last feature in nearly all described species of *Millerocaulis* and *Ashicaulis* from that continent (Tidwell et al. 1991).

The distribution of sclerenchyma in the stipular wings, which has proven to be useful in species determination (Hewitson 1962; Miller 1967), was largely ignored in the specimens reported by Sahni (1920) and Sinnott (1910, 1914) as

Osmundites(=*M.*) *dunlopii*. The distribution in the wings of one petiole figured by Sahni (pl. I, fig.4) was noted to be like that described for *M. dunlopii*, but that particular petiole was not attached to any stem. The stem Sahni (1920) figured (pl. I, fig.3) had attached petiole bases, but none was figured or described. Consequently, it is doubtful whether any were really *M. dunlopii*.

Edwards (1933) pointed out in discussing his fossil osmundaceous specimen from central Australia that it had a continuous or almost continuous xylem cylinder that was not broken into separate strands similar to the Jurassic species of *Osmundites* (=*Millerocaulis*) *dunlopii*. Medwell (1954), Sharma (1973), and Andrews (1961) all stated or implied that *O.* (=*M.*) *dunlopii* possessed a continuous xylem ring, meaning no leaf gaps.

Miller (1967, 1971) in his papers on the *Osmundaceae* accepted the fossils of Sinnott (1910, 1914) and Sahni (1920) as specimens of *O.* (=*M.*) *dunlopii* and concluded that the species had very narrow, some immediate, some delayed and some incomplete leaf gaps. In addition, he mentioned that the near absence of gaps in the type specimen of this species is not typical for the species. More recently, however, Miller (pers. comm. 1993) commented that in reviewing his notes he had not observed any evidence of leaf gaps when examining slides (#1242–1247) of the holotype of *M. dunlopii* from Gore (Otago), New Zealand at the British Museum of Natural History. He further stated that the holotype of *M. dunlopii* does not have leaf gaps, and that there was never any indication of the short narrow leaf gaps that might have been obliterated in the process of fossilization as per Sinnott's (1910) explanation. Furthermore, Miller noted that Kidston and Gwynne-Vaughan's (1907) photos (pl. I, fig. 3; pl. II, figs. 4–5) do not show any 'obliteration' of the xylem tracheids either. In conclusion, the only definite specimen of *M. dunlopii* known, is its holotype, and it lacks leaf gaps. Consequently, *Australosmunda indentata* is reassigned to *Millerocaulis*. *Millerocaulis dunlopii*, the type, and *M. indica*, which also lacks leaf gaps (Sharma 1973; Fig. 1G), are retained in this genus. Based on photographs of *Osmundacaulis chubutensis* from Argentina (Herbst 1977), this species also appears to be without leaf gaps (Figs. 1H, I, J, K) and is placed in *Millerocaulis* as well.

Millerocaulis, as now defined, with a Triassic species (*M. indentata*) and three Jurassic species illustrates another phylogenetic line in the Osmundaceae that is presently known only from the Southern Hemisphere. Osmundaceous taxa of this phylogenetic line in lacking gaps and having parenchymatous piths lend support to the hypothesis that evolution of the parenchymatous pith and evolution of the leaf gap in the xylem cylinder were independent (Hill et al. 1989).

The other species previously assigned to *Millerocaulis* have numerous definite leaf gaps are hereby transferred to the new genus *Ashicaulis*. *Ashicaulis*, presently composed of 22 species, is known from both the Northern and Southern Hemispheres and is currently known from the Triassic to Early Cretaceous.

ACKNOWLEDGMENTS

I am grateful to Dr. Dan H. Nicolson of the Smithsonian Institution, Dr. Charles N. Miller, Jr. of the University of Montana, Dr. Alfred Traverse of Penn State University, and Dr. Sidney R. Ash of Weber State University for their assistance with nomenclatural problems as well as reviewing earlier versions of this paper.

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BOOK NOTICES

EVERITT, JAMES H. and D. LYNN DRAWE. 1993. Trees, Shrubs & Cacti of South Texas. Texas Tech University Press, Lubbock, TX 79409-1037 (1-800-832-4042). ISBN 0-89672-252X; ISBN 0-89672-253-8 (pbk). $18.95 pbk. Text of colored photographs.

Contents include the preface, introduction with colored vegetational map, text with 204 colored photographs, bibliography, glossary, list of vertebrates, and index.

The text "contains a color photograph, the family name, scientific name, common name, general description, geographical range, and ecological characteristics for each species of the majority of trees, shrubs, and cacti occurring in the 14 southernmost counties of Texas."

The photographs are good and the photos are large enough, mostly two per page to provide a nice aspect. Only one word was found to be mispelled in browsing through the book ("*Baccharis*," p. 47)

This is an exellent pictorial book for the south Texas area and should be on your bookshelf or with you daily.—*Wm. F. Mahler.*

BURT, PAGE. 1991. **Barrenland Beauties.** (ISBN 0-919315-25-9, pbk). Outcrop Ltd., The Northern Publishers, Box 1350, Yellowknife, N.W.T., Canada X1A 2N9. $25.00 (Canadian; includes postage). 246 pp.

This is a guide to some 100 species of "showy plants" of the Canadian arctic coast. The color photos—about 200 of them, a few full-page but most grouped two to four per page—are excellent. Notes on habitat, ecology, and uses are included (with summaries in Inuinaktun, the written form of the dialect commonly spoken in the central arctic). Described, too, are the setting, history, and botany of seven major coastal communities. The book has a glossary, a bibliography, and an index to common and scientific names. Page Burt is a naturalist at Bathurst Inlet Lodge, to which every summer come guests to learn about arctic natural history (I recommend the lodge highly). Although her fine book was written to fill the need for a guide to the marvelous, low-arctic flora of the inlet, its usefulness extends from there to Ellesmere Island. Enjoy this book in your living room (bonus: no mosquitoes); it is the next-best thing to going north.—*John W. Thieret.*

NEW AND NOTEWORTHY MALESIAN MYRSINACEAE, VIII[1]

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ABSTRACT

New taxa of paleotropical Myrsinaceae are described from the Philippines and New Guinea in the genera *Ardisia, Fittingia*, and *Tapeinosperma. Ardisia anceps* var. *borneensis* is shown to be a species of Theaceae, probably *Adinandra*, which is not a myrsinaceous plant. The subgeneric position of *Ardisia mystica* is established. *Ardisia brassii* Stone (non Sleumer) is renamed *A. brassiella*.

RESUMEN

Se describen nuevos taxa de *Myrsinaceae* paleotropicales, que pertenecen a los géneros *Ardisia, Fitingia*, y *Tapeinosperma*, procedentes de las Filipinas y Nueva Guinea. Se descubre que *Ardisia anceps* var. *borneensis* es en realidad, una especie de la familia *Theaceae*, posiblemente un miembro del género *Ardinandra*. Se ubica *Ardisia mystica* en el subgénero *Pimelandra*. *Ardisia brassi* Stone (non Sleumer) se renombra como *A. brassiella*.

INTRODUCTION

This paper is a continuation of a series of studies of paleotropical Myrsinaceae from the Malesian region. Earlier papers in the series are included in the references. This paper is also Contribution no. 2 in the Precursors series for the Flora of the Philippines project.

In the course of revising the Myrsinaceae in the Malesian region and in collecting intensively in the Philippines under the Philippine Plant Inventory project (PPI), new taxa, new biological and distributional data necessitate taxonomic and nomenclatural changes. New taxa are described in *Ardisia, Fittingia,* and *Tapeinosperma.* Also, one purported variety of *Ardisia* is in fact theaceous and some further notes on species of *Ardisia* are included.

A new species of *Ardisia* Swartz

Ardisia reynosoi B.C. Stone, sp. nov. (Fig. 1).

Frutex glaber humilis usque ad 150 cm altus, ramulis 2.5–3 mm diametro adscendentibus,

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[1] Flora of the Philippines Project, Precursors, Contribution no. 2. Preceding paper: see Pacific Sci. 47(3): 276–294, 1993. This study was partly supported by NSF Grant DEB-9007742.

[†] Benjamin C. Stone died 19 March 1994 in Manila, Philippines.

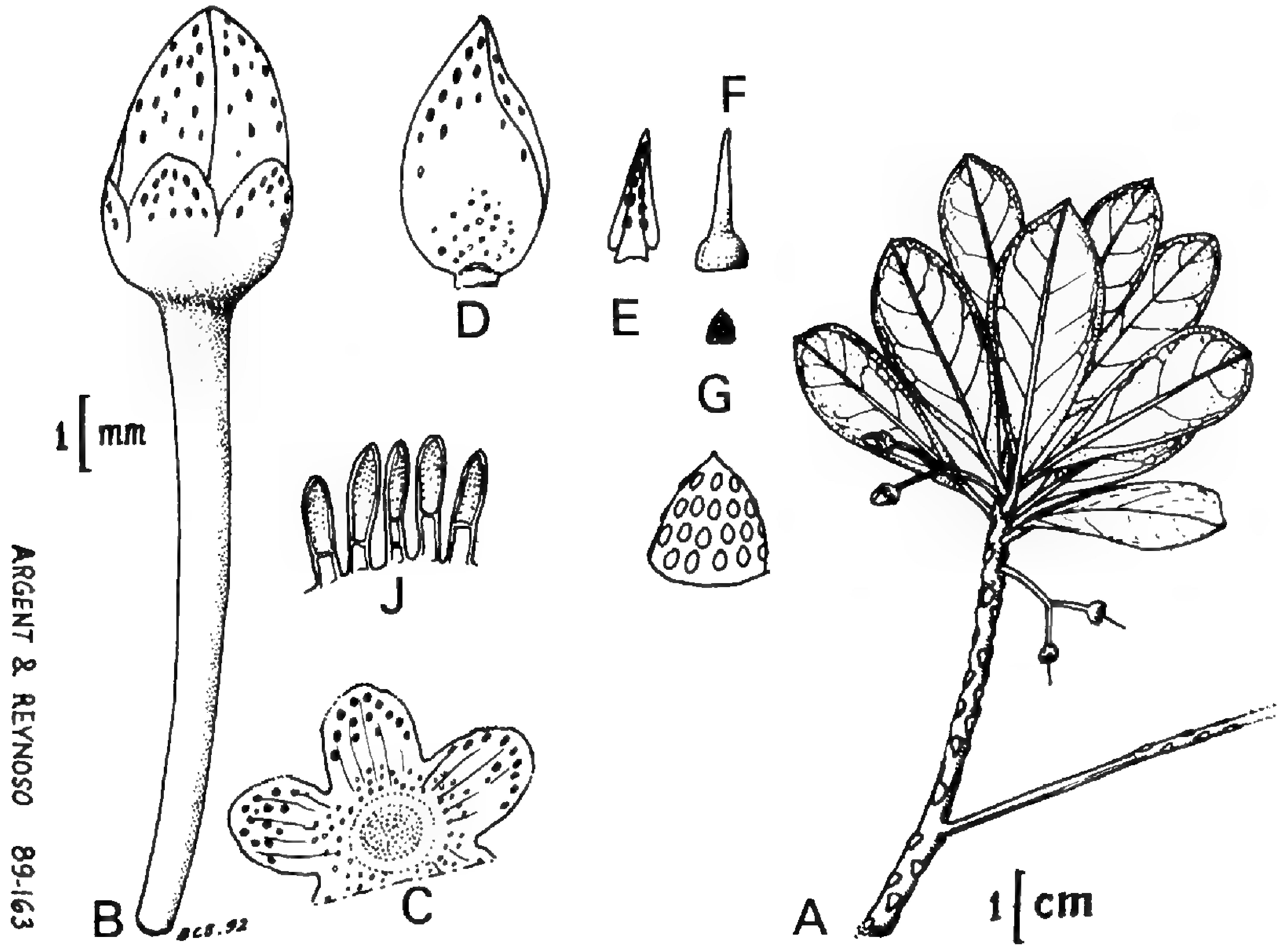

FIG. 1. *Ardisia reynosoi* Stone (drawn from holotype). A. Leafy flowering branchlet. B. Single flower. C. Detached calyx (2 lobes cut off), adaxial view. D. Corolla lobe, interior view; glands toward apex, papillae above small staminal attachment. E. Stamen, abaxial view, with glandular connective. F. Ovary and style. G. Placenta, the lower figure much enlarged to show rows of ovules. J. Trichomes from calyx margin.

apicem versus copiose foliatis. Folia congestae, parvae, petiolis 3–6 (raro ad 15) mm longis, laminis subanguste obovatis, subrigide coriaceis, ad 45(–65) mm longis, 17.5(–25) mm latis, apice subacuti vel obtusi vel rotundati, marginibus integris revolutis; costa infra elevato; venis secundariis 6–9-paribus infra parce elevatis, tertiariis submanifestis vel subobscuris; glandulis minime pustulatis dispersis. Inflorescentia axillaris, brevis, 2–3-floriferis, pedunculo 9–11 (–20) mm longis, glabris, alabastris ovoideis 2–3 mm longis; calycis lobis 1–1.2(–1.8) mm longis subrotundatis, glanduloso-punctatis, marginibus minime ciliatis, basi perbreviter imbricatis; corollae lobis ovatis usque ad 4 mm longis, glabris, glandulosis, intus basin versus sparse papillosis (papillis rotundatis adnatis compressibus); staminibus perbreviter filamentatis, antheris deltatis acutis, connectivo dorso bilinealiter glandulosis, thecis indivisis; ovario hemiovoideo, 1 mm alto, in stylo 1.5–2(–4) mm longo producto, stigmate acuto punctiforme; placenta hemiovoideo, ovulis ca. 35 tetraseriatis. Fructus *(PPI 6925)* oblatus 5 × 7 mm ultime atropurpureus.

TYPE: PHILIPPINES. SIBUYAN (Romblon Province): Magdiwang, western extremity of Mt. Giting-giting, ridge to Mayos Peak, steep slope in open grassy area at 1400 m alt., 29 Aug 1989, G. *Argent & E. Reynoso 89-163* (HOLOTYPE: PNH; ISOTYPE: E).

PARATYPES: SIBUYAN: ridge to Mayos Peak, 1300 m alt., submontane forest, 24 Aug 1989, *Argent & Reynoso 89-87* (E, PNH); same locality, 1400 m alt., dwarf shrub, 5 Jun 1992, *B.C. Stone & E. Reynoso PPI 6925* (L, PNH, US).

Etymology: Named for the collector Ernesto Reynoso whose extensive experience in the Philippines qualified him as a team leader in the Philippine Plant Inventory Project. Many botanists and other collectors have been guided by "Estong" over the years, so this dedication is well deserved.

Notes: This small, shrubby *Ardisia* occurs in elfin forest and partly open areas on the steep upper ridges of Mt. Giting-giting; so far it is only known from there and is apparently endemic. The side-branches (usually 15–20 cm long) are ascending and bear small crowded ascending leaves. These may reach 8 cm but are usually shorter; the midrib beneath is tawny brown. The inflorescences are axillary and terminal, umbelliform, with umbels usually few (2–3) flowered; in fruit the calyx lobes attain a length of almost 2 mm and are slightly imbricate at base. Ripe fruits are dark purple, conspicuously obloid, and are about 5 mm long and 7 mm wide. In general appearance this species is very similar to *A. gitingensis* Elmer.

The infrageneric position of *Ardisia mystica*

Ardisia mystica Stone, Malayan Forester 45:114, fig. 5. 1982.

This species was described from imperfect material and there was doubt as to which of the subgenera it pertains to. After examining type material of *Ardisia chrysophyllifolia* King & Gamble (K) it was evident that the two species were closely related and that A.mystica had to belong in the same subgenus. Both in fact belong to Subg. *Pimelandra.*

The ovary of *Ardisia mystica* is minutely tomentellous and the flowering pedicels are about 10 mm long; while in *A. chrysophyllifolia* the ovary is glabrous and the flowering pedicels are 5 mm long.

The identity of *Ardisia anceps var. borneensis* Scheff.

Ardisia anceps var. *borneenis* Scheff., Myrs. Archip. Ind. 79. 1865. "Folia sessilia denticulata longiuscule abrupte acuminata, in sicco rubescentia." (Fig. 2).

The type specimen bearing this name (*Korthals s.n.* from Gunong Rantau, South Borneo, in L!) is not myrsinaceous, but appears to be theaceous, probably a species of *Adinandra*. It has acicular pellucid stramineous unicellular trichomes; the crenate-denticulate leaf margins with the distinct teeth are extensions of the veinlets. The habit of the leafy branchlets somewhat resembles an *Ardisia* with slight ridges (alulae) as prolongations of the petiole bases, and a pattern of glands on the leaf lamina. In several herbria, specimens of *Adinandra* and other similar genera of Theaceae have been found lodged among undetermined material of Myrsinaceae, showing that there is a possibility of confusion among specimens of these families. The trichomes of Myrsinaceae are often ferrugineous or brown, seldom pale tawny, and the species with denticulate leaves have

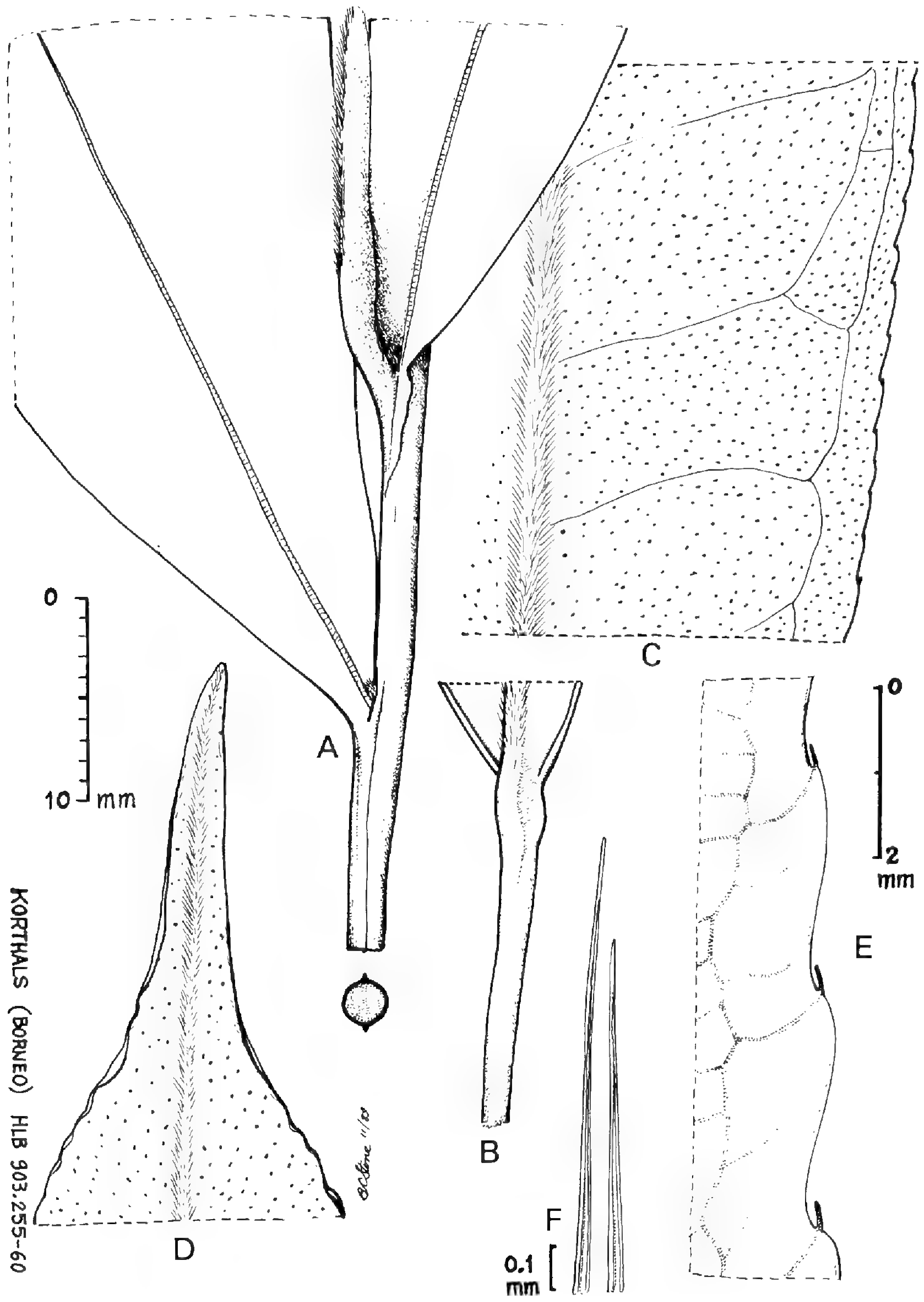

FIG. 2. "*Ardisia anceps* var. *borneensis* Scheffer" = Theaceae sp. Details of the type specimen. A. Stem with leaf bases and cross-section view (showing pair of ridges on stem). B–D. Views of leaf undersurface (base with petiole, part of middle, and apex) with strigose midrib, laminar glands, and margin. E. Leaf margin with spinulose crenations, shown enlarged. F. Spinule-like trichomes from midrib.

more delicate teeth with a different relationship to the veins. Scheffer himself was doubtful as to the affinity of this specimen, stating "*An Ardisia?* Nec fructiferam nec floriferam vidi.—Rami ancipites sunt.—*Myrsinea* ex Korthals."

A new name for *Ardisia brassii* Stone

Ardisia brassiella B.C. Stone, nom. nov. *A. brassii* Stone, Proc. Natl. Acad. Sci. U.S.A. 142: 52. 1990 (non Sleumer, Blumea 33:130. 1988). TYPE: PAPUA NEW GUINEA: Sudest Island; Mt. Riu, W slopes, 300 m, 31 Aug 1956 (fl, fr), *Brass 27954* (HOLOTYPE: US).

The name *A. brassii* Stone was inadvertently used in my 1990 study for the species represented by *Brass 27954* and *27825,* an error for *A. brassiella* which was intended, as Sleumer's earlier use of *A. brassii* (for a New Guinea species) preempts that epithet.

Fittingia Mez

This genus is endemic to New Guinea. The following new species is the sixth known; Sleumer (1988) recognized five species.

Fittingia mariae B.C. Stone, sp. nov. (Figs. 3, 4).

Fruticulus tenuis, stipite erecto ad 4 mm diam., atrobrunneo, glabro, apicem versus foliatis, ramulis lateralibus tenuioribus 1–2 mm diam., 10–15 cm longis, teretibus, apice excepto haud foliatis, novellis subglabris vel sparsiter lepidotis. Folia anguste elliptico-lanceolatae, usque ad 19 cm longae, 4 cm latae, integerrimae, chartacea, utrinque sensim acuminato-acutatae, infra pallidiora et dissite minuteque atropunctatae, in sicco leviter reticulatae; petiolis 10–15 mm longis, subteretibus, supra canaliculatis, peranguste marginatis; costa media supra anguste impresso, infra bene elevato basin verus carinato; venis lateralibus 10–14-paribus, ad ca. 60 emittis, prominulentibus, distaliter antrorse curvtis et anastomosantibus, rete nervarum tenue submanifesto. Inflorescentiae in axillas foliorum ramulorum, breviter angusteque paucipaniculatae ad 5–6 cm longae, axibus omnibus pergracilibus et sparsiter lepidotulis, pedunculis brevibus singularibus vel paucifasciculatis, ramis ad 10–12 mm longis, suboppositis, bracteis subulatis glandulosis 1–2 mm longis, pedicellis ca. 2 mm longis, cymis 1–3-floriferis, floribus ca. 2 mm longis, 4-meris, probabiliter omnino unisexualibus (masculis solis hic descriptis), calyce glabro cupulato 1.3 mm longo, lobis ovatis integerrimis multiglandulosis (glandulis in sicco prominulentibus); corollae lobis anguste ellipticis, 2.3 mm longis, basi breviter (0.5 mm) coalitis, extus conspicue atroglandulosis, intus omnino dense papillosis; filamentis subteretibus ca. 0.5 mm longis, e basi lobi corollae productis; antheris breviter oblongis fere 1 mm longis apice emarginatis, inornatis, pallidis, eglandulosis; gynoecio rudimentale stylo 1.1 mm longo, stigmate capitato incluso, ovario reducto 0.3 mm longo quam stylo vix latiore, ovulis nullis.

TYPE: NEW GUINEA. MOROBE PROVINCE: Boana, 1,219 m in mossy montane scrub, a slender shrublet, flowers dull pinkish, 4 Jul 1940, *M.S. Clemens 41551*-A (HOLOTYPE: MICH).
PARATYPE: NEW GUINEA. MOROBE PROVINCE: Boana, 1,219 m, 4 Jul 1940, *M.S. Clemens 41550* (MICH).

Etymology: Fittingia mariae is named for the indefatigable collector Mary

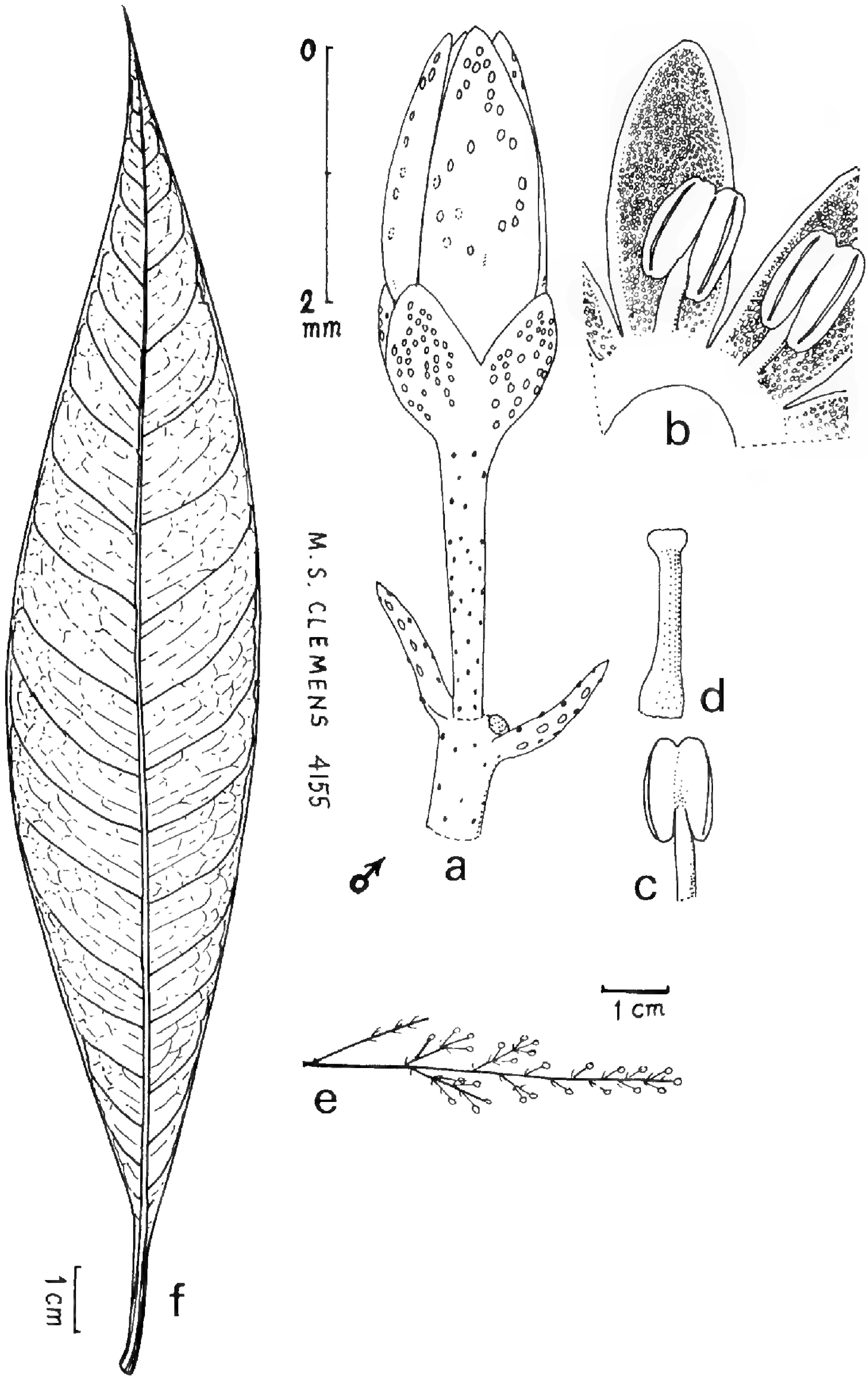

FIG. 3. *Fittingia mariae* Stone (drawn from holotype). A–D. Floral details. A. flower in profile with pedicel and part of partial inflorescence with bracts. B. Interior view of part of corolla, showing densely papillate inner faces of corolla-lobes, and short glabrous stamens with emarginate anthers. C. Stamen, abaxial view; note the non-glandular connective. D. Pistillode with discoid stigma. E. Diagram of inflorescence. F. Leaf.

FIG. 4. *Fittingia mariae* Stone. Photograph of holotype.

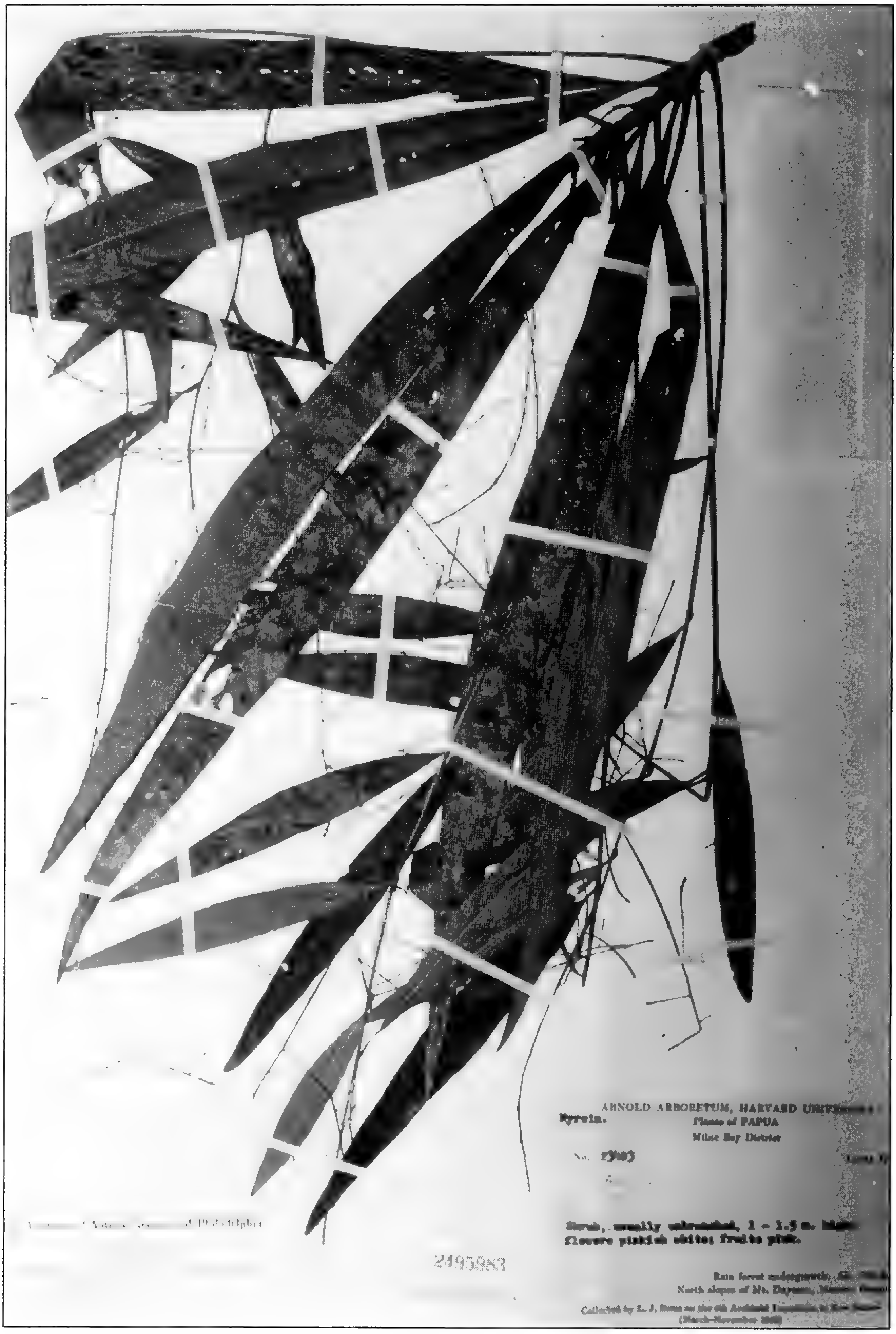

FIG. 5. *Tapeinosperma filipes* Stone. Photograph of holotype.

Strong Clemens who with her husband Joseph, and later alone, obtained numerous plant collections in the Philippines, Borneo, and New Guinea.

Notes: The dioecious habit, 4-merous flowers, and axillary inflorescences indicate that this species belongs to the genus *Fittingia*. Among other genera of the family that occur in New Guinea only *Loheria* could be considered as a possible alternative, but that has short lateral shoots with flowering panicles subtended by a subinvolucral group of bracts. In the absence of pistillate flowers, some doubt may remain, but the general habit and slender panicles, sharply acuminate leaves and low habit suggest *Fittingia* much more than *Loheria*. In *Fittingia* also the corolla seems to lack internal papillosity, while it is common in *Loheria*.

Among the species of *Fittingia, F. mariae* may be readily distinguished by the slender, sharply acuminate leaves and very slender panicles. Collection of pistillate materials including fruits remains a desideratum.

Tapeinosperma Hook.f.

Sleumer (1988) lists four species of *Tapeinosperma* in New Guinea. Among the L.J. Brass collections the following new species has been identified.

Tapeinosperma filipes B.C. Stone, sp. nov. (Fig. 5).

Arbuscula plerumque monocaulosa usque ad 1–1.5 m alta; caulis apicem versus usque ad 6 mm diametro; foliis spiraliter confertis; ramulis fertilibus pergracilibus axillaribus 1–3-foliatis elongatis teretibus 30–35 cm longis. Innovationes minute ferrugineo-tomentelli pilibus 0.05–0.06 mm longis capitatis cellulo apicale anguste ovoideo vel lanceoloideo quam cellulo basali 3–4-plo longiori. Folia lineari-lanceolatae, 30–32 cm longae, 2–2.2 cm latae utrinque acutae, basi sensim decurrente attenuato, chartaceae, integerrimae, infra sat pallidiora, supra glabra, infra glabrata (costa media excepto); costa supra basi anguste canaliculato, infra prominente; venis lateralibus prominulentibus 11–16-paribus venis intersecundariis subaequalibus intercalatis, reticulationibus in paginis duobus manifestis; glandulis atris ellipticis regulariter dispersis in areolis singulis omnibus. Petiolus plano-convexus, gracilis, 10–12 mm longus, primo minute tomentellus demum glabratus. Ramuli fertili tereti laevi 1–2.5 mm diametro, 18–26 cm longi (usque ad foliam primam); foliis reductis 7–11 cm longis subulatis; axibus, bracteis pedicellisque minute ferrugineo-tomentellis. Inflorescentia terminalis. Flores minute remoti subglobosi, pedicellis 2.5–3 mm longis; calyce cupulato 5-lobato, basi sparsiter hirtello, lobis ovato-deltatis 0.6 mm longis, late ovato-subrotundatis, utrinque glabris 5-venatis, glanduloso-punctatis, integris. Stamina ca. 1.3 mm longa, filamento 0.2 mm longo, antheris oblongo-ovatis, subacutis, dorso sublaeve vix glanduloso vel glandulis obscuris singulis in connectivo positis. Ovarium ca. 0.5 mm longum, glabrum, sensim in stylo 0.7 mm longo productum; stigmate minute truncato obscuriter discoideo et minime papilloso. Placenta ca. 0.4 mm alta, ovulis 2 vel 3, terminalibus.

TYPE: PAPUA NEW GUINEA. MILNE BAY DISTRICT: Maneau Range, Mt. Dayman, 700 m alt., rainforest, shrub with pinkish flowers and fruit, 14–24 Jul 1953, *Leonard J. Brass 23403* (HOLOTYPE: US)

Known only from this collection from lower montane rainforest.

Etymology: The epithet, filipes, refers to the very slender, almost thread-like inflorescence axes (fila = thread; pes = foot, stalk).

Notes: This distinctive species was cited as an indeterminate *Ardisia* by Sleumer (1988: 103), but the discoid-truncate stigma and strongly reduced ovular number exclude it from that genus. The flowers are very small but seem to be hermaphroditic, and in this respect conform to the condition in *Tapeinosperma*. The very long slender leaves and extremely slender open panicles borne on long, slender axillary branchlets bearing 1 or 2 reduced leaves are further characters of this species.

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A NEW SPECIES, *SYMPHORICARPOS GUATEMALENSIS* (CAPRIFOLIACEAE), FROM GUATEMALA WITH A KEY TO THE MEXICAN AND GUATEMALAN SPECIES

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ABSTRACT

Recent studies of Mexican and Central American *Symphoricarpos* have revealed the existence of a new species, described and illustrated below, from the Cuchumatanes Highlands of Guatemala. In addition, keys and distribution maps for the species of *Symphoricarpos* from Mexico and Guatemala are provided.

RESUMEN

Recientes estudios de los *Symphoricarpos* mexicanos y centroamericanos han revelado la existencia de una nueva especie, que se describe e ilustra a continuación, procedente de los Cuchumatanes de Guatemala. Además, se ofrecen claves y mapas de distribución de las especies de *Symphoricarpos* de México y Guatemala.

KEY WORDS: *Symphoricarpos*, Caprifoliaceae, Guatemala, Mexico.

Symphoricarpos guatemalensis J.K. Williams, sp. nov. (Fig. 1)

Symphoricarpi microphyllo HBK. similis sed differt fauce corollarum glabra et floribus ac foliis dimidia parte brevioribus.

Erect shrub, 2 m tall, much-branched, young twigs strigose. Leaves oval with rounded apices, tapering toward base, 3–6 mm long, 2–3 mm wide, dark green above, margins entire, glabrous to slightly villous, coriaceous; petioles up to 1 mm long. Flowers solitary or in pairs; pedicels up to 0.5 mm long, with two apical bracteoles 2–3 mm wide; calyx glabrous, 1–2 mm long, irregularly 5-toothed; corollas white, narrowly campanulate, actinomorphic, papillate towards base within, 4–6 mm long, tubes 3–5 mm, lobes 1–2 mm, erect; stamens 5, epipetalous, barely exserted, anthers 1.0–1.5 mm long, ca. half the length of filaments; style glabrous, 3–4 mm long, stigma capitate. Fruit a globose berry, 6–7 (10) mm long, white, and tipped with persistent calyx.

Distribution and Ecology: Limestone ridges of the Sierra de los Cuchumatanes in Guatemala (Fig. 2), 3000–3500 m; flowering July to September.

TYPE: GUATEMALA. HUEHUETENANGO: 3 mi SW of San Mateo, Ixtatan, 5 Aug 1965, *D.E. Breedlove 11544* (HOLOTYPE: TEX!; ISOTYPE: F!, MO).

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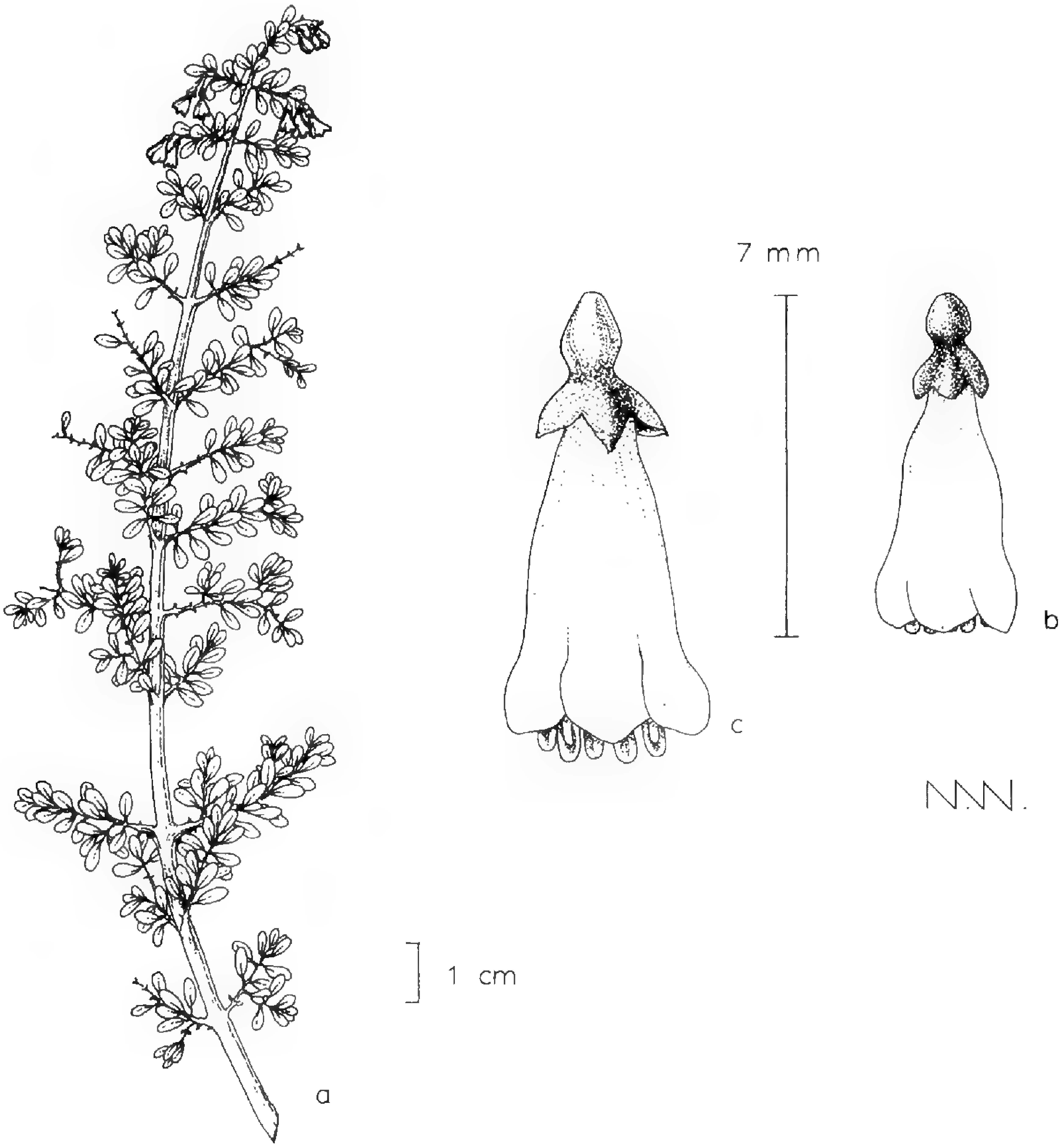

FIG. 1. A–B. *Symphoricarpos guatemalensis*. A. Habit. B. Flower. (*Breedlove 11544*). C. *Symphoricarpos microphyllus* flower.

Additional specimens examined: GUATEMALA. **Huehuetenango:** Sierra de los Cuchumatanes, on and below road from Huehuetenango, & 4 km SW of San Juan Ixcoy, E of Captzin, 15° 35'N 91° 28'W, 11 Jan 1976, *Iltis G-271* (F); between Paquix and San Juan Ixcoy, 8 Jan 1974, *Molina 30022* (F, MO); between Paquix and Llanos San Miguel, road to San Juan Ixcoy, 17 Nov 1967, *Molina 21248* (F); dry slopes of El Mirador, 12–23 Jan 1966, *Molina 16505* (F); along road to San Pedro Soloma, 3 mi SW of San Mateo Ixtatan, 5 Aug 1965, *Breedlove 11544* (F); limestone ridge near Chemal, Sierra de los Cuchumatanes, 29 Nov 1962, *L.O. Williams 21979* (F); just below Calveras, 29 Nov 1962, *L.O. Williams 22389* (F); Sierra de los Cuchumatanes, at KM 311 on Ruta Nacional 9N (between Paquix and Chemal), small limestone ridge with *Juniperus standleyi*, 2 Aug 1959, *Beaman 2989* (TEX); near Tunima, Sierra de los Cuchumatanes, 6–7 Jul 1942, *Steyermark 48304* (F); along road in region of Chemal, 31 Dec 1940, *Standley 81624* (F); rocky ridges beneath pines, Sierra Cuchumatanes, 15 Sep 1934, *Skutch 1253* (F).

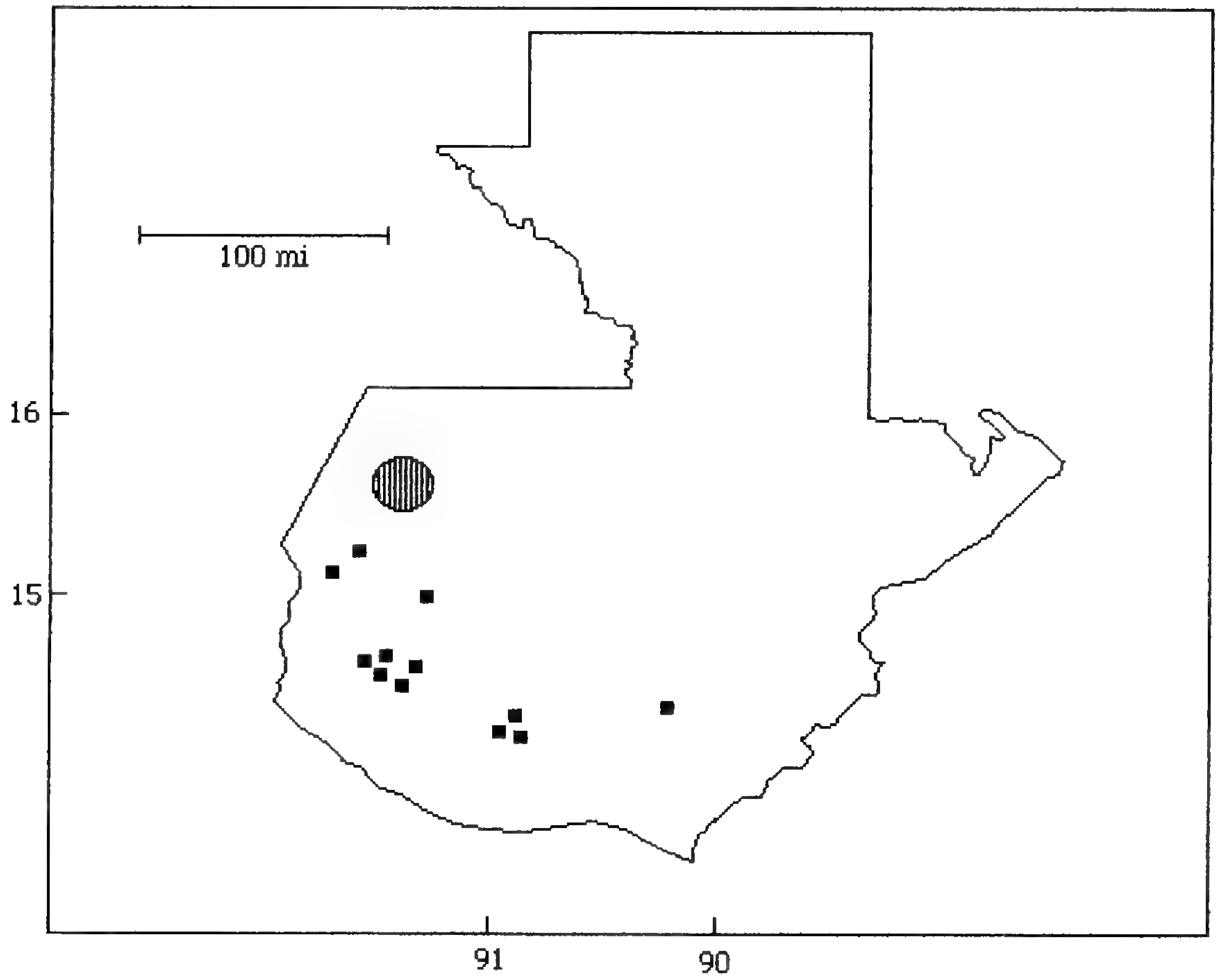

FIG. 2. Distribution of *S. guatemalensis* (hatched area) and *S. microphyllus* (squares) in Guatemala.

This narrow endemic of the Sierra de los Cuchumatanes is a member of subgenus *Anisanthus* G.N. Jones (Jones 1940), as evidenced by the corolla lobes shorter than the corolla tube and its included style. *Symphoricarpos guatemalensis* is most similar to *S. microphyllus* but differs in its glabrous (vs. villous) corolla throat, dark brownish-green leaves (vs. light green), and leaves and flowers of half the dimension. The leaves of *S. guatemalensis* are 3–6 mm long and 2–3 mm wide, compared to those of *S. microphyllus* which are 10–25 mm long and 7–15 mm wide (Fig. 3). In addition, the corolla length of *S. guatemalensis* is 4–6 mm, compared to 9–10 mm in *S. microphyllus* (Fig. 1).

In his monograph, Jones (1940) reported that species of *Symphoricarpos*, other than *S. microphyllus*, are rarely found in Mexico and further south. Accumulating collections from Mexico, however, have shown that the genus is more prevalent there than once suspected. In order to place the new species in a broader perspective and to provide a preliminary taxonomic evaluation of the Mexican and Central America species, I have constructed a key to the species of *Symphoricarpos* in this area based on specimens housed at BRIT, F, LL, and TEX. Characters used to delineate taxa have been essentially adopted from Jones (1940) and Gray (1873).

Symphoricarpos is divided into two subgenera: subg. *Symphoricarpos*, characterized by an exserted style and corolla lobes longer than the tube, and subg. *Anisanthus*, characterized by an included style and corolla lobes shorter than the tube. There is only one member of subg. *Symphoricarpos*, *S. orbiculatus*, native to Mexico. All other species in Mexico and Central America belong to subg. *Anisanthus*.

KEY TO THE MEXICAN AND GUATEMALAN SPECIES OF *SYMPHORICARPOS*

1. Corolla lobes equal to or longer than tube; fruits red .... 1. *S. orbiculatus*
1. Corolla lobes shorter than tube; fruits white 2
  2. Anthers sessile, style pilose or glabrous, 1 basal nectary .... 2. *S. longiflorus*
  2. Anthers with distinct filaments, style always glabrous, 5 basal nectaries 3
    3. Leaves 4–6 mm long, 2–3 mm wide; corolla 4–6 mm long, glabrous within .... 3. *S. guatemalensis*
    3. Leaves 6–25 mm long, 3–18 mm wide; corolla 6–10 mm long, villous within 4
      4. Shrubs erect, 2–3 m tall; mature leaves of older branches entire ... 4. *S. microphyllus*
      4. Shrubs trailing, branches arching, 1–1.5 m tall; mature leaves of older branches lobed to crenate 5
        5. Leaves of flowering and non-flowering branches mostly crenate with mucronate apices .... 5. *S. palmeri*
        5. Leaves of flowering branches mostly entire with rounded to acute apices, leaves of non-flowering branches lobed with rounded to mucronate apices .... 6. *S. parishii*

AN OVERVIEW OF THE MEXICAN AND CENTRAL AMERICAN SPECIES

Symphoricarpos orbiculatus Moench

This is the only member of the subg. *Symphoricarpos* native to Mexico; other species of the subgenus occur throughout North America and Asia. This particular species is unique to the genus in having red fruits (Fig. 5).

Representative specimens: MEXICO. **Coahuila:** Muzquiz, along Sabine River, 11 Jul 1936, *Marsh 475* (TEX). **Nuevo Leon:** Monterey, Diente Canyon, 20 Jul 1930, *Mueller 103* (F, TEX).

Symphoricarpos longiflorus A. Gray

This species is distinguished by its salverform corollas 11–13 mm long, the largest of any corolla among the *Symphoricarpos* of Mexico. Other features that characterize this species are its sessile anthers and solitary basal nectary (all other Mexican taxa have five nectaries). Another feature which helps separate this species from other Mexican *Symphoricarpos* is a pubescent style; this is a plastic character, however, and not always reliable. The foliage and style of populations in Mexico range from completely glabrous (in Baja California) to pubescent (in northern Chihuahua) (Fig. 4).

Representative specimens. MEXICO. **Baja California Norte:** Sierra San Pedro Martir, east slope of Cerro de la Culpa, 31° 02'N, 115° 27'W, 27 Jul 1970, *Moran 17890* (TEX). **Chihuahua:** ca. 23 mi ENE of Villa Ahumada, 30° 40'N, 106° 07'W, 12 Sep 1973, *Henrickson 12866* (TEX).

Symphoricarpos microphyllus HBK.

Symphoricarpos microphyllus is the largest of the *Symphoricarpos* species, sometimes attaining a height of over 2 meters. It is readily distinguished from *S. palmeri* and *S. parishii* in its erect habit and by having all its leaves entire (Fig. 3). This is the most widespread *Symphoricarpos* species in both Mexico (Fig. 4) and Guatemala (Fig. 2). Throughout most of its range *S. microphyllus* is pubescent, but there is a rather large isolated population of glabrous individuals in the Sierra Madre Oriental along the border of southern Coahuila and the Midwestern Nuevo Leon border (Fig. 4).

Representative specimens. GUATEMALA. **Chimaltenango:** slopes of Volcan de Acatenango, above Las Calderas, 3 Jan 1939, *Standley 61853* (F); Volcan de Agua, 22 Jul 1937, *J.R. Johnston 910* (F). **El Progresso:** between Calera and summit of Volcan Siglo, 21 Jan 1942, *Steyermark 43042* (F). **Huehuetenango:** across river from San Juan Atitan, 8 Sep 1942, *Steyermark 52018* (F); Cerro Pixpix, above San Ildefonso Ixtahuacan, 15 Aug 1942, *Steyermark 50566* (F). **Quezaltenango:** Summit of the Sierra Madre Mts, 15 km N of Ostuncalco, 9 Dec 1963, *L.O. Williams 25536* (F); Sierra Madre Mts, 5 km N of Ostuncalco, 8 Dec 1963, *L.O. Williams 25472* (F); Cuesta de El Caracol, Sierra Madre Mountains, 5–8 km N of San Juan Ostuncalco, department of Quezaltenango, 11 Dec 1962, *Williams 22768* (F, TEX); mts SE of Palestina, along new road to San Juan Ostuncalco, 21 Jan 1941, *Standley 84354* (F); Volcan Santo Tomas, 22 Jan 1940, *Steyermark 34804* (F); Volcan Santo Tomas, 22 Jan 1940, *Steyermark 34804* (F); Volcan Santa Maria, between Santa Maria de Jesus, Los Mojadas, and summit of volcano, 12 Jan 1940, *Steyermark 34050* (F); slopes of Volcan Santa Maria, above Palojunoj, 6 Mar 1939, *Standley 67668* (F); mts above Olintepeque, 20 Feb 1939, *Standley 65956* (F); Volcan Santa Maria, 27 Jul 1934, *Skutch 870* (F). **Sacatepequez:** Slopes of Volcan de Agua, above Santa Maria de Jesus, 11 Feb 1939, *Standley 65108* (F). **San Marcos:** between Sibinal and summit of Volcan Tacana, 19 Feb 1940, *Steyermark 36080* (F). **Totonicapan:** ravines in Sierra Madre mts near Villa Las Cruces, 8 km SW of Totonicapan, 13 Dec 1963, *L.O. Williams 22969* (F); Nebuloso de Maria Tecun, 21 Nov 1965, *Molina 15886* (F).

MEXICO. **Chiapas:** Zinacantan, 6 Oct 1986, *Ton 9333* (TEX); San Juan Chamula, 2 Jun 1988, *Ruiz 883* (TEX); Valley floor of Zinacantan Center, 13 Apr 1966, *Laughlin 668* (F); slope with Oak and Pine, along road to Zontehuitz near Piedrachitas, 25 Aug 1964, *Breedlove 7127* (F); near Ik'al Nab lake, on the boundary between Chamula and Zinacantan, along road to Zinacantan center, 21 Sep 1965, *Breedlove 12394* (F); along small stream 7 km NE of Huistan, along road to Oxchuc and Ocosingo, 21 Sep 1972, *Breedlove 27750* (F). **Coahuila:** Sierra El Coahuilon, Arteaga, 17 Jun 1991, *Hinton 20992* (TEX); Sierra Pilote de Fierro, 25° 10'N, 101° 25'W, 24 Oct 1991, *Carranza 1221* (TEX); Las Vigas canyon, Sierra de Arteaga, 25° 20'N, 100° 39'W, 5 Jun 1987, *Villarreal 3739* (TEX); Sierra la Marta E of Cerro Moro, 22 Jul 1985, *Ginzburg 141* (TEX); Muzquiz, Sabinas river, 11 Jul 1936, *Marsh 475* (BRIT-SMU). **Distrito Federal:** volcanic soil, SE side of D.F., 12 Jul 1947, *Barkley 2215* (TEX); Desierto de los Leones, 5 Nov 1942, *Steyermark 52250* (F). **Durango:** canyon head, 51 mi SW of Durango, 13 Aug 1957, *Waterfall 13727* (BRIT-SMU, F, TEX). **Guanajuato:** San Miguel de las Casitas, 8 Sep 1990, *Ventura 8692* (F). **Hildago:** on Hwy 104 NE of Pachuca, 49.7 mi E of Ajacuba, 10 Jul 1985, *Cowan 5493* (TEX); San Vicente, 16 Aug 1937, *Fisher 37191* (F); upper cliffs

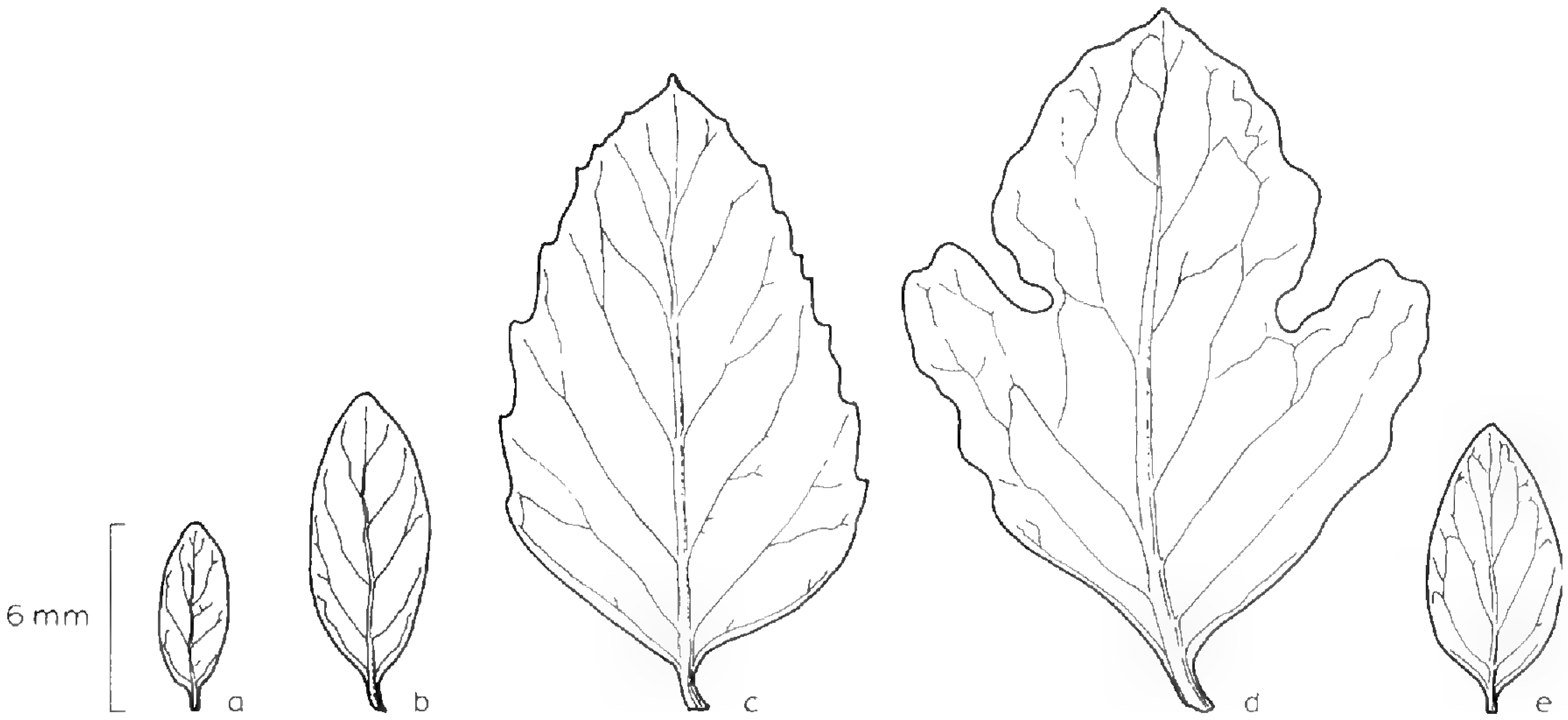

FIG. 3. Leaf shape of selected *Symphoricarpos* species. A. *Symphoricarpos guatemalensis*. B. *S. microphyllus*. C. *S. palmeri*. d. *S. parishii*, non-flowering branch. E. *S. parishii*, flowering branch.

near Metepec Station, 27 Jun 1904, *Pringle 13010* (F); Sierra de Pachuca, 20 Jul 1901, *Pringle 9480* (F). **Jalisco:** Nevado de Colima, brecha entre El Izote y la Micronda las Viboras, 5 Feb 1992, *Chazaro 6868* (TEX); NE slopes of Nevado de Colima, below Canoa de Leoncito, 10 Sep 1952, *McVaugh 12875* (BRIT-SMU). **Mexico:** 11 mi E of Amecameca, 31 Jul 1975, *LeDoux 2037* (TEX); between Toluca and Mexico, 24 Jul 1962, *Molseed 39* (TEX); pine forest of Las Crucea, 12 Jul 1932, *Hinton 1013* (F); 2 km SE of Totoloapan, 18 km E of Tezcoco, 10 Jul 1979, *Koch 7949* (F); valley in mountains, 16 mi E of Toluca, 18 Aug 1957, *Waterfall 14067* (F). **Michoacan:** on road to Uruapan, 4 mi S of Cheran, 3 Nov 1958, *Jones 23326* (TEX). hills of Patzcuaro, 11 Oct 1892, *Pringle 4261* (F); Cerro Huashan, 2 km S of Nahuatzen, 28 Jun 1990, *Garcia 2724* (F); Zitacuaro, 19 Aug 1938, *Hinton 13120* (F); 1 km W of Rancho Seco on Hwy 37, 2 km W of Morelos, 13 Sep 1986, *Swagel 167* (F); 6 km SE of Villa Madero, 30 Sep 1982, *Nunez 4732* (F). **Morelos:** Tepoztlon, 15 Jul 1938, *Kenoyer A340* (F). **Nuevo Leon:** 6 km SE of La Trinidad, summit of one of the picachos of Sierra Cebolla, 25° 11'N, 100° 07'W, 5 Aug 1988, *Patterson 6174* (TEX); Sierra La Marta, Galeana, 6 Sep 1981, *Hinton 18343* (TEX); Cerro, El Potosi, 21 Jun 1969, *Hinton 17115* (TEX); 1.5 mi SW of Pabillo, 21 Jul 1958, *Correll 19953* (TEX); Municipio Galeana, open pine forest near Cerro Potosi, 23 Jul 1938, *Schneider 953* (F); peak of Cerro Potosi, Municipio de Galeana, 21 Jul 1935, *Mueller 2256* (F); Sierra Potosi, by the N hogback, 20 mi NE of Galeana, 26 Jul 1934, *Mueller 1243* (TEX); Lerios Mts., Coahuila, 45 mi E of Saltillo, 10–13 Jul 1880, *Palmer 390* (F). **Oaxaca:** Cerro Verde, Jul 1908, *Purpus 3518* (F). **Puebla:** El Cimarron, 28 Jul 1971, *Ventura 3954* (TEX); el Chamizal, 20 Jul 1970, Ventura 1722 (F); in moist sandy loam, Pine and Juniper woodland, 10 mi W of San Salvador de Seco, 2 Aug 1947, *Barkley 2469* (F). **Queretaro:** 0.5 km of Cuatro Palos, along road to La Canada, 20 Sep 1989, *Carranza 2110* (F); Campo Alegre, 3 km S of San Joaquin, 24 May 1986, *Fernandez 3298* (TEX). **San Luis Potosi:** 7 km SW of Pozuelos and 22 km SW of San Luis Potosi, on Hwy to Guadalajara, 22° 03'N, 101° 10'W, 21 Aug 1973, *Johnston 12271.* (TEX).

Symphoricarpos palmeri G. N. Jones

Symphoricarpos palmeri is a relatively restricted endemic, occurring in the Trans-Pecos region of Texas and the Sierra del Carmens of northern Coahuila,

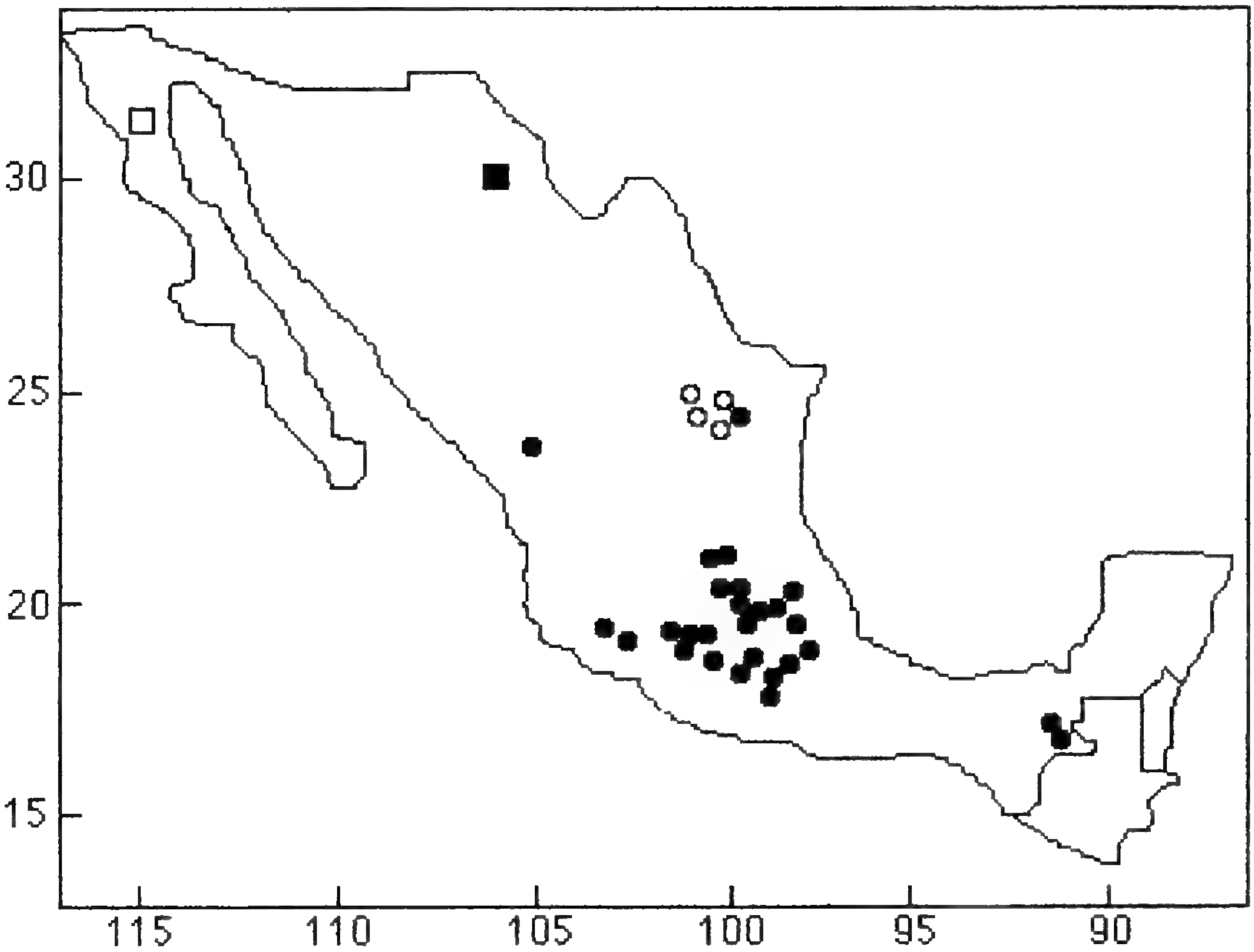

FIG. 4. Distribution of *S. longiflorus* (squares), and *S. microphyllus* (circles) in Mexico. Open characters represent glabrous populations, closed characters represent pubescent populations.

Mexico. It is recognized by its trailing habit and crenate-mucronate leaves of both flowering and non-flowering branches (Fig. 3). The species has mostly pubescent stems and leaves, but individuals with glabrous stems occur throughout its range (Fig. 5).

Representative specimens: MEXICO. **Coahuila:** 3.5 km N of Cerros El Centinela Creek and 4.8 km S of Canyon El Jardin, 29° 06'N, 102° 35'W, 19 May 1992, *Mayfield 1449* (TEX); Sierra Santa Fe del Pino, WNW of Hacebuches, 28° 13'N, 103° 02'W, 26 May 1973, *Johnston 11236* (F, TEX); 4 mi W and 10 mi S of Ocampo, 16 Jun 1956, *Graber 163* (TEX); N igneous slope of Picacho del Centinela, 24 Aug 1953, *Warnock 11603* (TEX).

Symphoricarpos parishii Rydb.

Symphoricarpos parishii is distinguished from the other Mexican taxa by its trailing habit, entire leaves of the flowering branches, and lobed leaves of the older non-flowering branches (Fig. 3). Specimens studied from Mexico have glabrous stems, although pubescent individuals are found scattered throughout its range in the United States. This species has been regarded as a variety of both *S. oreophilus* A. Gray by Cronquist et al. (1984) and *S. rotundifolius* A. Gray by Dempster (1992), but this problem is beyond the scope of the present paper (Fig. 5).

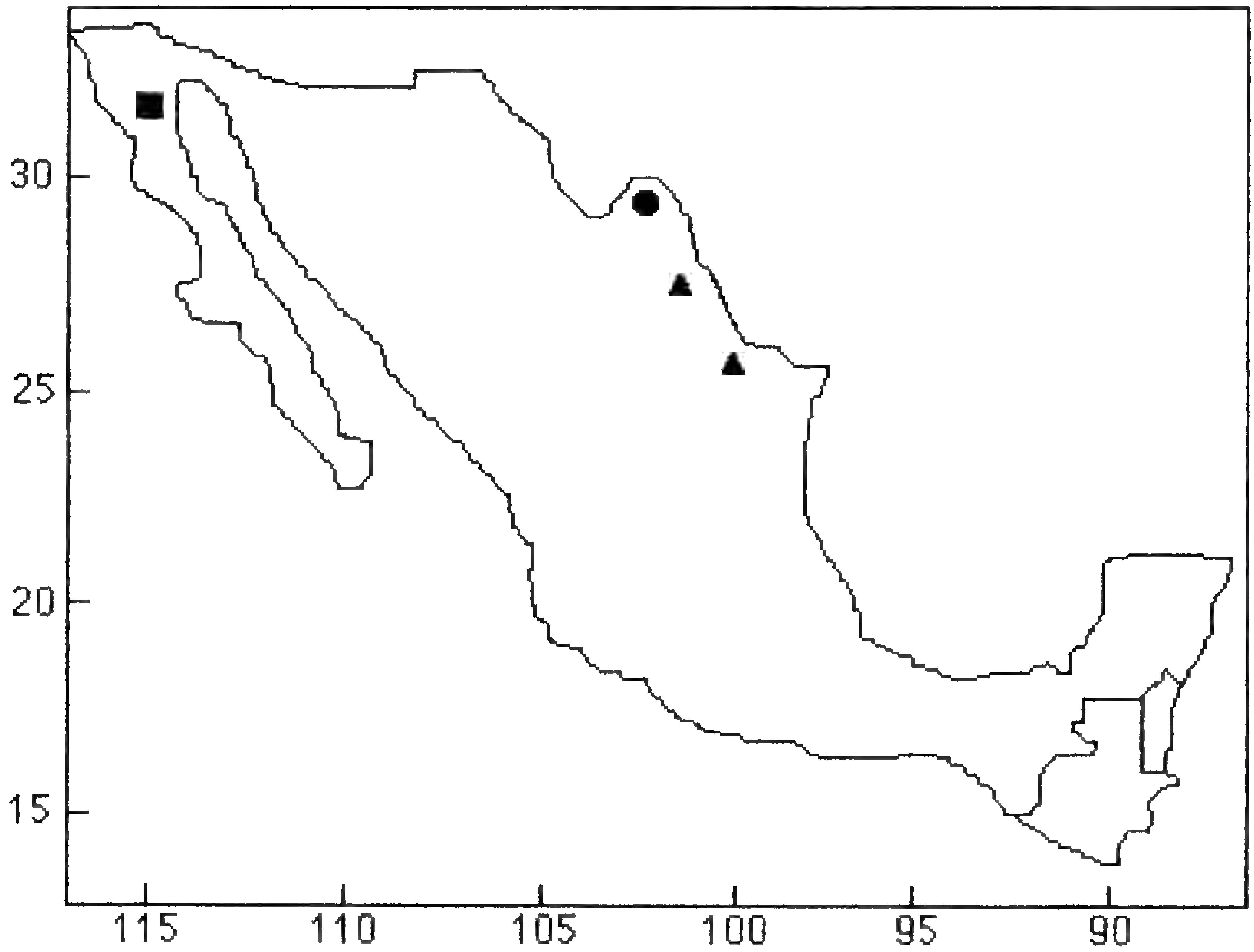

FIG. 5. Distribution of *S. orbiculatus* (triangles), *S. palmeri* (circle), *S. parishii* (square) in Mexico.

Representative specimens. MEXICO. **Baja California Norte:** Parque Nacional Sierra San Pedro Martir, Vallecitos, 31° 02'N, 115° 27.5'W, 1 Sep 1985, *Thorne 61437* (TEX); Sierra de Juarez, Parque Nacional Constitucion de 1857, Laguna Hanson & adjacent rocky flats and slopes, 26 May 1987, *Thorne 62362* (F); upper east end of Vallecitos meadow, 31° 00'N, 115° 27'W, 3 Jul 1973, *Moran 21082* (TEX).

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SPECIES POOLS IN EASTERN ASIA AND NORTH AMERICA

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ABSTRACT

A species pool refers to the total species in a defined region at a given time. The species pool in eastern Asia is the product of a long history with low speciation rates, while the species pool in northwestern North America is largely due to recent rapid speciation. Data fail to support the theoretical dominancy of ecological determinism in the development of regional species diversity. A species pool is the product of evolution, immigration, and extinction and thus postulates extant species richness to be an historical artifact rather than an ecologically determinate reality.

RESUMEN

La gran riqueza de especies en el este de Asia es el efecto de una historia larga con unas tasas de extinción y especiación bajas, mientras que la gran riqueza en el noroeste de Norte América es debida a especiación reciente rápida. Los datos no explican la dominancia teórica del determinismo ecológico en favor de la historia geofísica regional específica como base para explicar la diversidad regional de especies. Se propone un "pool" de especies como resultado de la evolución, inmigración y extinción, y por ello se postula que la riqueza en especies vivientes es un artefacto histórico en vez de una realidad ecológicamente determinada.

INTRODUCTION

Species diversity is a central theme of environmental studies. Scientists have accumulated much data on species diversity over the past 250 years. However, there are still no answers to some basic questions. One critical question that is frequently asked by scientists is why there are just so many species in a region, and not more or less than that number. In other words, what factors determine regional species richness? In fact, a comprehensive, rigorous, and general theory of species diversity is lacking (Solbrig 1991). Ricklefs (1987) thus claimed that species diversity is "the major, unexplained pattern in natural history," one that "mocks our ignorance."

One dominant hypothesis is that available energy determines regional species richness (Hairston et al. 1960, MacArthur and Wilson 1967, Currie and Paquin 1987, Moore 1987, Adams and Woodward 1989, Andersson 1990, Currie 1991). Currie and Paquin (1987) and Currie (1991) clearly claimed that

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regional tree species richness can be explained in terms of actual evapotranspiration (AET). Alternatively, White (1983) claims that the tree species diversity pattern of the Northern Hemisphere is the product of extinction. Goldsmith (1985) believed that periodic, or episodic, catastrophic destruction of life was caused by comet or asteroid impacts. However, there are three critical problems with these positions: First, almost all studies of species richness concentrate, very naturally, on just one taxonomic group (e.g. pines, oaks) (Moore 1987). But each group may have some peculiar requirement of its own that obscures the general causes of species diversity (Moore 1987). Second, studies were often made using small biogeographic regions. Micro-environmental variations greatly influence the result when comparing two small regions. Third, more importantly, the conceptual definition of a species has not been consistent from taxonomist to taxonomist nor from region to region.

To minimize the observation biases caused by the factors mentioned above, this study examined all seed plants in the larger biogeographic regions in the Northern Hemisphere. Eastern Asia in this study refers to the eastern forest region of China, Far East and eastern Siberia of Russia, and Korea (Fig. 1). North America includes the continental regions of Canada and United States. The forests of North America are naturally divided into those west and those east of the Great Plains (Fig. 2). The boundary of the boreal zone in the Northern Hemisphere follows Larsen (1980) with modification in eastern Asia. The boreal region in Europe includes the area westward from the Ural Mountains (Fig. 3: I). Boreal eastern Asia includes eastern Siberia in Russia and the Da Xingan Ling Mountains of China (Fig. 3: II). The east-west division of the boreal zone in North America follows Daubenmire (1978). The eastern section includes the area east of the Rocky Mountains (100°W) (Fig. 3: IV) and the western or Cordilleran Section extends westward (Fig. 3: III).

In eastern Asia, the temperate forest region includes the Xiao Xingan Ling, Wanda, and Changbai mountains in Northeast China, southern portion of Far East of Russia, and northern Korea (Fig. 3: V). This region is known as the Korean pine conifer and hardwood forest region (Chou and Li 1990). In western North America, the temperate forest region covers portions or all of the Pacific Northwest states of Oregon, Montana, Idaho, Washington, and southern British Columbia (Fig. 3: VI). This region includes the Pacific Northwest forests (Franklin 1988) and the northern portion of the forests of the Rocky Mountains (Peet 1988). In eastern North America, the temperate forest region extends from northern Minnesota upper Great Lakes region and eastward to southern Canada and New England, including, toward the southeast, much of the Appalachian Plateau in New York and northern Pennsylvania (Braun 1967, Fig. 3: VII). The region is known as the Hemlock-white pine-Northern Hardwoods region (Braun 1967, Vankat 1979) as well as the mixed conifer and deciduous forest region (Bailey 1976).

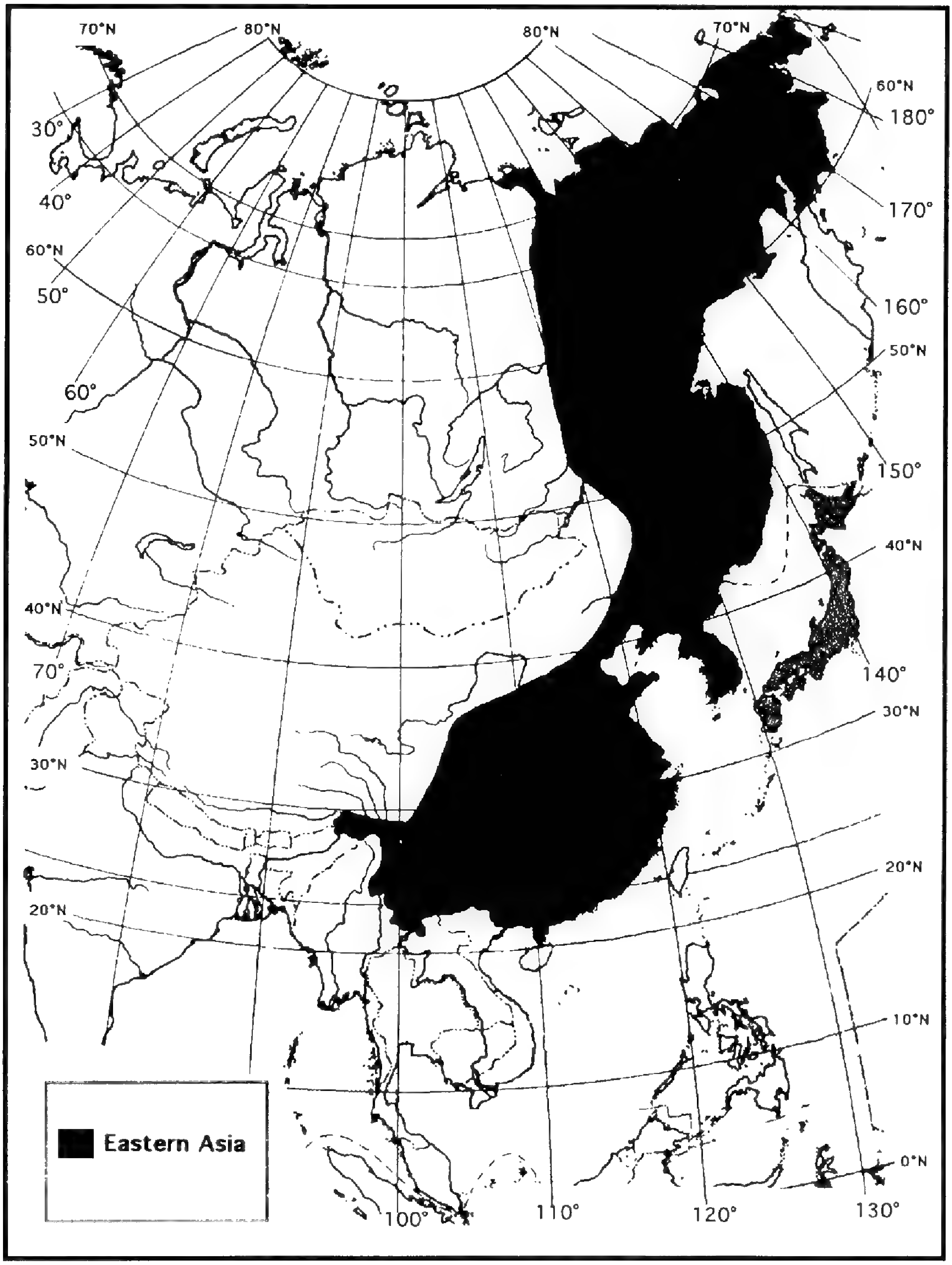

FIG. 1. Map showing the definition of eastern Asia in this study.

The main data sources of this study include field investigations, specimen observations, personal communications, and literature (including flora and fossil records). The primary data for eastern Asia were collected from a comprehensive forest survey conducted by authors and their colleagues at Northeast Forestry University and numerous forestry agencies during 1984-1988. Data for

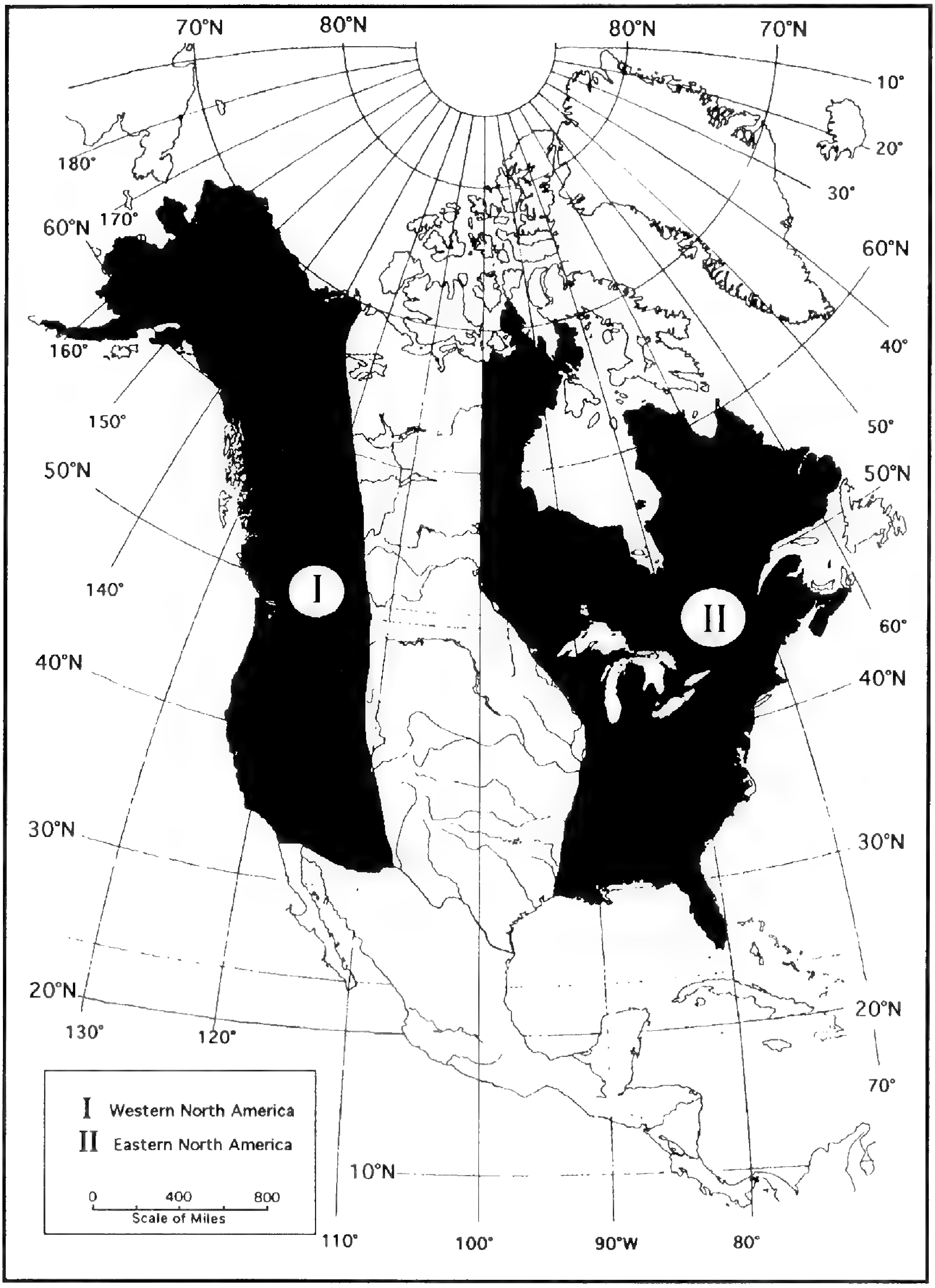

FIG. 2. Map showing the definition of western and eastern North America in this study.

North America is based on literature, supported where possible, by field collections, herbarium investigations, and personal interviews during 1989-1992. By using established methods and the same principal observer in the herbarium and field, the observational biases that often plague broad-scale comparisons were minimized.

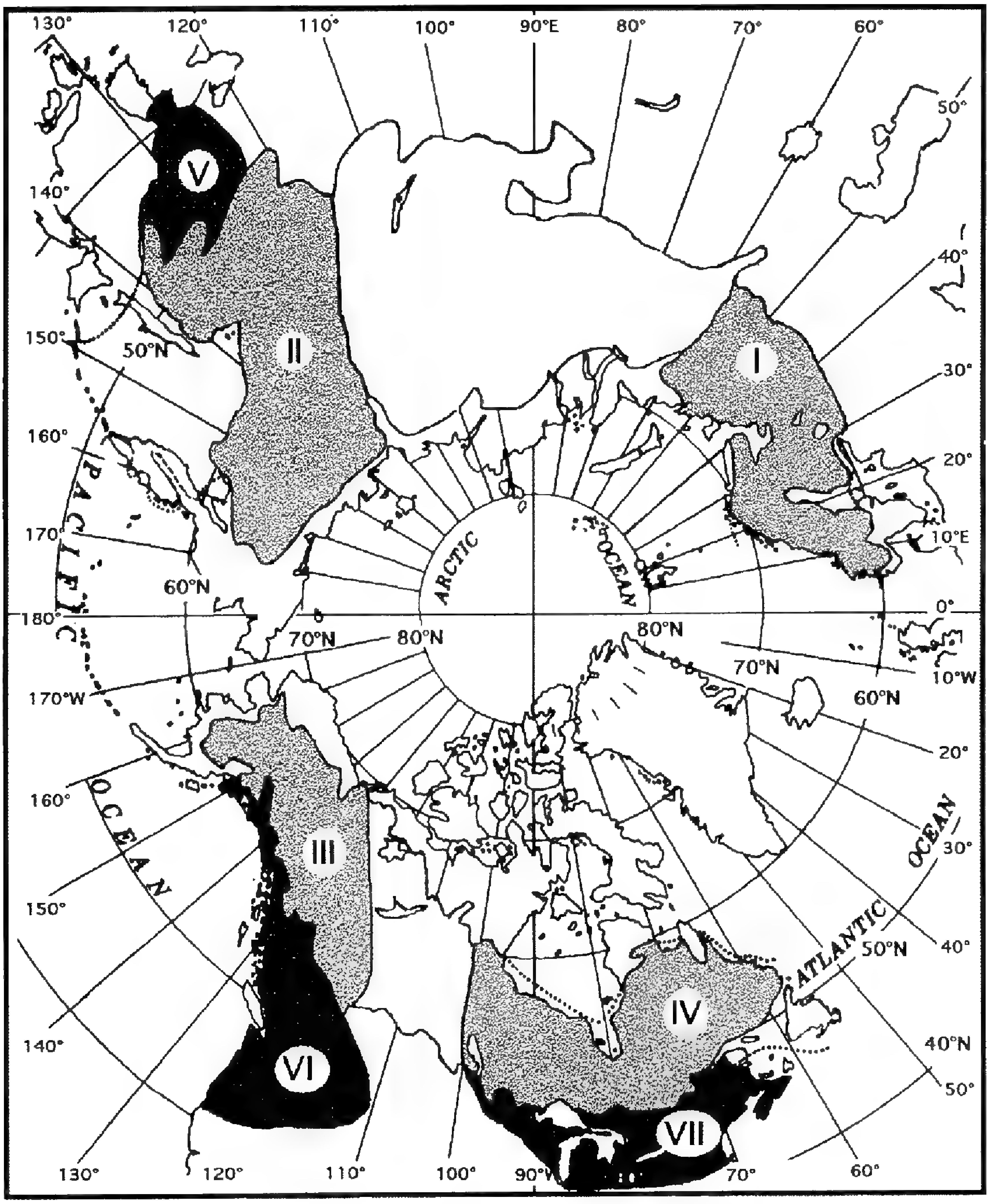

Fig. 3. Map showing the boreal and temperate forest regions involved in this study (I–IV—boreal forest zone: I-Europe, II-eastern Asia, III-western North America, IV-eastern North America; V–VII—temperate forest zone: V-eastern Asia, VI-western North America, VII—

Five sheets of voucher specimens of each taxon of seed plants found in the boreal and temperate forests of eastern Asia were collected during the field investigations. The location, life history, growth forms, function of woody plants, vegetative organs, habitats, and other characteristics such as flower color of each species were recorded for each specimen. The voucher specimens were retained in the Institute of Plant Sciences at Northeast Forestry University in Harbin, China. Manuals involving the floras of East Siberia, Far East, Korea, and Japan were also used to identify voucher specimens. Herbarium collections, located in Northeast Forestry University, the Botanical Institute in Beijing, and the Applied Ecological Institute in Shenyang were also used to confirm identification of voucher specimens. Seed plant checklists of the boreal and temperate forests of eastern Asia were created separately from these comparisons. Additional floristic checklists were created separately for boreal Europe, boreal western North America, boreal eastern North America, temperate Japan, temperate western North America, and temperate eastern North America using scientific references: Ohwi (1965), Polunin (1959), Gleason and Cronquist (1991), Hitchcock and Cronquist (1974), and Scoggan (1978–1979).

In both boreal and temperate forest comparisons of Europe, eastern Asia, and western and eastern North America, floristic analyses were made at the family, genus, and species levels. Evolutionary analyses of flora were based on the diversification ratios (family and genus size), diversification rate (Eriksson and Bremer 1992), and flower characters. Phylogenetic analyses were made in terms of three categories: 1) primitive—subclasses Magnoliidae and Alismatidae; 2) intermediate—subclasses Caryophyllidae, Hamamelidae, Dilleniidae, Rosidae, Arecidae, Commelinidae, and Zingiberidae; and 3) advanced—subclasses Asteridae and Liliidae (following Cronquist' system in 1988).

EASTERN ASIA: A LONG EVOLUTIONARY HISTORY COUPLED WITH LOW SPECIATION RATES

The great plant species diversity of eastern Asia is well-known and has been widely emphasized by scientists (Sargent 1913, Hu 1935, Takhtajan 1969, Li 1952, Wu and Wang 1983, Boufford and Spongberg 1983, Latham and Ricklefs 1992). To date, 25,480 species of native vascular plants have been identified in eastern Asia, representing 300 families and 2,875 genera (Li 1993). This amounts to 10.7% of the total known species in the world and about 1.6 times the figure for North America (Table 1). The great plant diversity in eastern Asia is the product of long evolutionary history. The geological and paleobotanical records failed to support the existence of continental Quaternary glaciers in most of eastern Asia and thus extinction is not a main process in the development of the extant eastern Asian flora. Also, eastern Asian flora consists of a host of taxa that are presumed to be phylogenetically primitive, with many occurring as monotypic taxa in the subtropical or tropical regions. These factors have led to the concept that eastern Asia was the evolutionary source of modern flora in the Northern Hemisphere (Takhtajan 1969, Latham and Ricklefs 1992).

Ferns are phylogenetically primitive vascular plants. 52 families (80.0% of the total flora of the world), 204 genera (46.0%), and 2,300 species (19.5%) of ferns are known in eastern Asia. The family, genus, and species numbers are 3.5, 3.4, and 6.7 times those in North America, respectively. Gymnosperms, another phylogenetically primitive group of plants, are represented by ten families

TABLE 1. Comparison of taxon richness of native vascular plants of eastern Asia and North America.

	Eastern Asia *	North America **	World ***
Family			
Ferns	52	15	65
Gymnosperms	10	5	11
Angiosperms	238	202	542
Total	300	222	620
Genus			
Ferns	204	60	443
Gymnosperms	34	19	57
Angiosperms	2637	2261	12500
Total	2875	2340	13000
Species			
Ferns	2300	341	11820
Gymnosperms	180	118	670
Angiosperms	23000	15827	225000
Total	25480	16285	237490

Notes: * from Li (unpublished, 1988); ** based on Checklist of D. E. Moerman (Nancy Morin, pers. comm.); *** from Wu and Wang (1983).

in eastern Asia, but only five in North America. Eastern Asia contains almost all primitive monotypic families, including Ginkgoaceae, Cycadaceae, and Gnetaceae. *Ginkgo*, for example, is the oldest of all trees, it dates back to the Triassic some 200 million years ago (Flora of North America Editorial Committee 1993). It is now naturally restricted to China although it was quite widespread in the world during the Cretaceous (Hsu 1983). Conifers apparently represent the greatest taxonomic diversity in eastern Asia. They are distributed among Europe, eastern Asia, and western and eastern North America, respectively, approximately in the ratio 1.0 : 3.4 : 2.1 : 1.6 by genus and 1.0 : 5.9 : 2.4 : 1.2 by species (Table 2).

There are 2,637 genera and 23,000 species of angiosperms belonging to 238 families native to eastern Asia (Li 1993). The family, genus, and species numbers in eastern Asia are 1.4, 1.2, and 1.6 times those in North America, respectively. Almost all ancestral families of angiosperms based on fossil records have greater diversities in eastern Asia than in North America. Chloranthaceae, as the earliest angiosperm (appeared in the early Cretaceous, Muller 1981) has three genera and 16 species in eastern Asia and only one genus and one species in North America. Aquifoliaceae, one of the earliest woody angiosperm families (Muller 1981) represents 168 species in eastern Asia and about 20 species in North America. Moreover, Magnoliaceae, the most phylogenetically primitive woody family of angiosperms (Hutchinson 1973), contains 12 genera and 250 species ranging from Asia to North America (Wu and Wang 1983). Ten genera and 100 species of this family are known in eastern Asia, but only two genera

TABLE 2. Distribution of conifer species among Europe, eastern Asia, and western and eastern North America.

Family/genus	Europe	Eastern Asia	Western North America	Eastern North America
Cephalotaxaceae				
Cephalotaxus	0	7	0	0
Taxaceae				
Amentotaxus	0	4	0	0
Pseudotaxus	0	1	0	0
Taxus	1	6	1	2
Torreya	0	3	1	1
Taxodiaceae				
Cryptomeria	0	1	0	0
Cunninghamia	0	2	0	0
Glyptostrobus	0	1	0	0
Metasequoia	0	1	0	0
Sciadopitys	0	0	0	0
Sequoia	0	0	1	0
Sequoiadendron	0	0	1	0
Taiwania	0	2	0	0
Taxodium	0	0	0	2
Cupressaceae				
Chamaecyparis	0	1	2	2
Calocedrus	0	2	1	0
Cupressus	0	7	12	0
Juniperus	6	19	5	5
Thuja	0	2	1	1
Thujopsis	0	0	0	0
Pinaceae				
Abies	5	22	7	2
Cathaya	0	1	0	0
Cedrus	1	0	0	0
Keteleeria	0	9	0	0
Larix	1	10	2	1
Picea	3	16	6	1
Pinus	9	23	19	13
Pseudolarix	0	1	0	0
Pseudotsuga	0	6	2	0
Tsuga	0	6	3	3
Total Genera	7	24	15	11
Total Species	26	153	63	32

and 9 species are known in North America. Hamamelidaceae, another primitive family, has 25 genera and 90 species widely distributed in eastern and southeastern Asia and North America with some reaching south to Australia and Africa. 17 or 18 genera and 70 species of this family are known in eastern Asia. *Disanthus, Exbucklandria,* and *Rhodoleia*, ancestral genera of the family (Takhtajan 1969), are all found in southern China. Only three genera and five species are present in North America.

The data above imply that eastern Asian flora has a long evolutionary history. However, the analysis of diversification rates (Eriksson and Bremer 1992) of families based on fossil records shows that species diversification rates* of most families in eastern Asia are much lower than those in North America. 20.7% of the total species in eastern Asia belong to families with low diversification rates ($R<0.15$ my^{-1}), while only 11.2% of the total species in North America belong to the same families.

Thus, we concluded that the great taxonomic richness of eastern Asia is largely the result of a lengthy evolutive history coupled with low extinction and low diversification rates.

NORTHWESTERN NORTH AMERICA: A SHORT EVOLUTIONARY HISTORY COUPLED WITH HIGH SPECIATION RATES

Geologically, northwestern North America is young. But the northwestern North American flora has the highest species diversity among all northerly regions in the Northern Hemisphere (Table 3 and 4). This great species diversity results from high speciation in a short evolutionary history.

The taxonomic and evolutionary structure of extant flora is consistent with the concept of a geologically young western North America. In the temperate zone, for example, western North America has a total 3,161 species, which is about 50% of the total species of all three temperate floras and about 1.5 times that of either eastern Asia or eastern North America. However, this flora has 19 families fewer than in eastern Asia and 27 families fewer than in eastern North America (Li 1993). Therefore, families of temperate floras, on average, have more species in western North America (roughly 30 species per family) than in eastern Asia (roughly 17) and eastern North America (15, see Table 5). Theoretically, the larger the family (containing more species), the more evolved (Stebbins 1981), because family is parental to species. From this point of view, the temperate flora in western North America is young.

The evolutionary analysis of flowers strengthens this statement. The solitary flower, both terminal and axillary, is the initial form of arrangement for flowers, while inflorescence is more advanced and of a greater biological advantage (Takhtajan 1991). In the temperate zone, western North America contains the highest proportion of inflorescence (87.8% of the entire flora, compared with 80.4% in eastern Asia and 79.1% in eastern North America) (Li 1993). Flower color is an important factor affecting pollination of plants. Green flowers are

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*Diversification rate (R) refers to the speciation rate minus the extinction rate and is measured as the number of extant species over the time since the first appearance of a family. R is measued by the species number per million years (my^{-1}).

TABLE 3. Family, genus, and species richness of the seed plants in the three temperate regions.

	Eastern Asia	Western North America	Eastern North America	Total
Family				
Total	125	106	133	144
Genus				
Trees	30	23	43	52
Shrubs	74	54	77	119
Lianas	10	2	5	13
Herbs	537	574	495	909
Total	652	650	615	1090
Species				
Trees	65	50	95	200
Shrubs	228	235	263	652
Lianas	13	9	10	31
Herbs	1786	2867	1632	5505
Total	2092	3161	2000	6388

TABLE 4. Family, genus, and species richness of the seed plants in the four boreal regions.

	Europe	Eastern Asia	Western North America	Eastern North America	Total
Family					
Total	84	95	76	80	104
Genus					
Trees	18	20	14	20	25
Shrubs	35	44	37	46	59
Lianas	0	5	0	1	5
Herbs	215	311	278	206	385
Total	266	379	326	268	470
Species					
Trees	25	36	28	45	117
Shrubs	84	113	127	100	279
Lianas	0	6	0	1	7
Herbs	597	1006	1012	612	1970
Total	706	1161	1167	758	2373

largely pollinated by wind, and thus the anemophilous plants are claimed to be primitive in evolution (Takhtajan 1991). Alternatively, bright colored flowers are usually pollinated by insects, and entomophilous plants are considered more advanced in evolution. In western North America, only 21.8% of the total species have green flowers, a lower percentage than in either eastern Asia (27.8%) or eastern North America (33.6%). However, colorful flowers (white, yellow, pink, rose, purple, blue, and red) are more frequent in western North America

TABLE 5. Comparisons of evolutionary levels of the temperate and boreal floras based on the ratios of genera/family, species/family, and species/genus.

	Europe	Eastern Asia	Western North America	Eastern North America
Genus No./Family				
Temperate		5.2	5.3	4.6
Boreal	3.2	4.0	4.3	3.4
Species No./Family				
Temperate		16.7	29.8	15.0
Boreal	8.4	12.2	15.4	9.5
Species No./Genus				
Temperate Zone				
Trees		2.2	2.2	2.2
Shrubs		3.1	4.3	3.4
Lianas		1.3	4.5	2.0
Herbs		3.3	5.0	3.3
Total		3.2	4.9	3.3
Boreal Zone				
Trees	1.4	1.8	2.0	2.3
Shrubs	2.4	2.6	3.4	2.2
Lianas	0.0	1.2	0.0	1.0
Herbs	2.8	3.2	3.6	3.0
Total	2.7	3.1	3.6	2.8

and comprise 78.2% of the total flora. The same colors account for 72.2% in eastern Asia and 66.4% in eastern North America.

Life history, as the result of natural selection, reflects the long-term adaptation of a plant to its environment. Annuals are unknown in primitive ferns and gymnosperms, but their sexual reproduction processes enable them to persist in habitats that restrict the establishment of perennials. Therefore, annuals are believed to arise relatively late in the evolution of terrestrial plants (Bazzas and Morse 1991). Annuals are distributed among eastern Asia, western and eastern North America at the ratio of 1.0 : 2.5 : 1.0. Alternatively, as the early evolved group, trees are distributed among eastern Asia, western and eastern North America at ratios based on total numbers of both genus and species as follows: 1.3 : 1.0 : 1.9. Obviously, the temperate flora in western North America is relatively young in evolution relative to the other two temperate floras.

Further, phylogenetic data strengthen the argument. Magnoliidae and Alismatidae are the most primitive taxa of flowering plants in Cronquist's system (1988). They, together with gymnosperms represent the lowest diversity in temperate western North America (16 families and 56 genera) and the highest in temperate eastern Asia (23 families and 72 genera). But Asteridae and Liliidae, the most advanced taxa in Cronquist's system have the highest diversities in temperate western North America (243 genera, compared with 233 genera in temperate eastern Asia and 199 in temperate eastern North America respectively).

In brief, all these evidences from taxonomic structure of flora, flower diversity, life history and phylogeny show that northwestern North American flora is relatively young in evolution. However, data on diversification rates (R) for families show that there is high species diversification in northwestern North America. A total of 25 families with low diversification rates ($R<0.10$ my^{-1}) are recorded in the temperate regions, and they are distributed among eastern Asia, western and eastern North America, respectively, at a species ratio of 2 : 1 : 3 (Table 6). Western North America clearly has the smallest taxon diversity among families with low diversification rates. In contrast, the nine families with higher diversification rates ($R>0.60$ my^{-1}) are distributed at a ratio of total number of species of 1 : 3 : 1 in eastern Asia, western and eastern North America. Further, three genera with the highest diversification rates, *Astragalus, Senecio*, and *Carex* display maximum species richness in western North America and exceed that of any other region (279 species relative to 51-145 species in the temperate regions and 144 species relative to 56-90 species in the boreal regions). Boreal floras show a similar pattern (Li 1993).

Thus, there is little doubt that the data indicate that the northwestern North American flora is the product of high species diversification and relatively recent evolution. Considering that the species-rich northerly flora of western North America has over 50% of the total species restricted to this region, we conclude that this great species richness in northwestern North America is largely the effect of rapid speciation rather than immigration.

SPECIES POOL HYPOTHESIS

Based on our studies, we argue that species exist in a pool in a given region at a given time. This regional species pool is a relatively static spot in a dynamic river of species diversity development over time. It is the result of two additive processes: speciation and immigration; and, one subtractive process: extinction (both locally and globally) (Fig. 4, Table 7)! Thus, a species pool has largely an historical rather than an ecological basis for its existence (Li 1993).

Speciation is the formation of new species from pre-existing ones usually by a process of improved adaptation of survivors to the environment. New species may be better adapted to the environment and replace the less well adapted ones. Speciation began long ago and is still going on. It is best characterized as a regional subset of the global genetic pool. The rate of speciation depends not only on environmental diversity within the pool, especially under conditions of geographic or ecological isolation, but also on chance. Thus, it is impossible to predict the speciation rate for a region.

Immigration, however, does not involve global genetic variability, but does

Table 6. Evolutionary levels of temperate and boreal floras based on diversification rates (R).

Diversificate Rate (R)	Europe	Eastern Asia	Western North America	Eastern North America
R < 0.10 my^{-1*}				
Temperate				
Family Number		21	11	22
Species Number		77	42	111
% of Total Species		3.7	1.3	5.6
Boreal				
Family Number	10	13	7	11
Species Number	21	35	7	11
% of Total Species	3.0	3.0	1.7	4.6
R > 0.60 my^{-1*}				
Temperate				
Family Number		8	9	9
Species Number		95	258	91
% of Total Species		4.5	8.2	4.6
Boreal				
Family Number	6	8	7	6
Species Number	45	83	108	42
% of Total Species	6.4	7.1	9.3	5.5

Notes: *species per million years.

Table 7. Basic patterns of development of regional species pool.

Environmental Pattern								
Historical Changes	+	+	+	+	-	-	-	-
Heterogeneity in Pool	+	+	-	-	+	+	-	-
Barriers around Pool	-	+	-	+	-	+	-	+
Process								
Extinction	+	+	+	+	-	-	-	-
Speciation	+	+	-	-	+	+	-	-
Immigration	+	-	+	-	+	-	+	-
Species Diversity	M	M$^{@}$	L	L	H	H$^{@}$	L	L
Example	CI	NW	NE	EE	X	SEA	NEA	SP

Notes: "+" represents great and "–" represents weak; L—low, M—median, H—high; @ represents more endemic species. CI—some continental islands; NW—northerly western North America; NE—northerly eastern North America; EE—extreme environment; X—unidentified region; SEA—southerly eastern Asia; NEA—northerly eastern Asia; SP—specialized habitat.

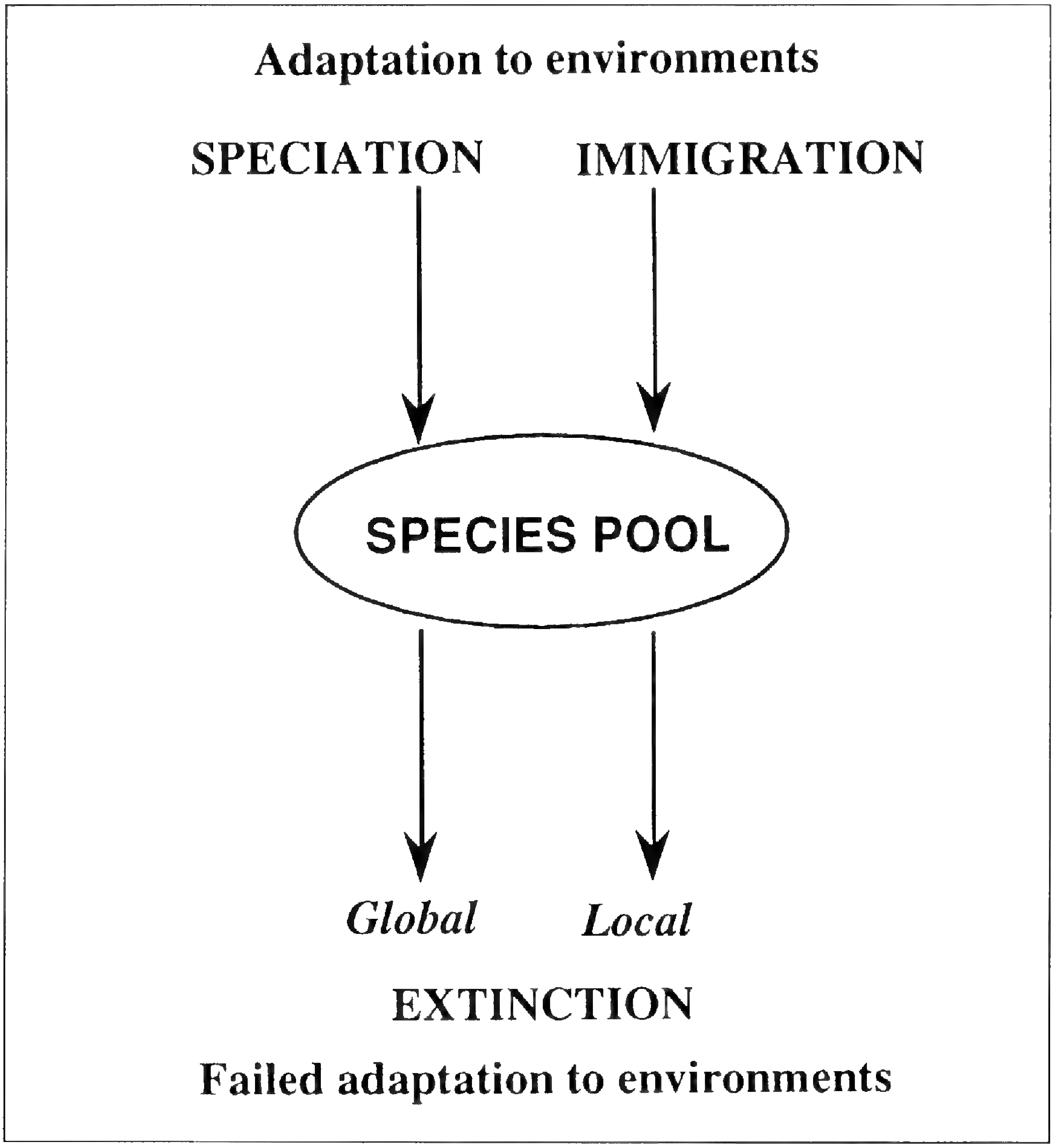

FIG. 4. Species pool in a given region at a given time (After Li 1993).

contribute to regional changes. During migration, species may evolve. If genetic change makes it possible to distinguish new species from the parent species, this process is evolutionary (speciation); if not, it is called immigration. Both natural selection and chance play roles in immigration of species to a region. This also means that the absence of a species in a region may result purely from chance rather than deterministic natural processes.

Extinction of a species can occur locally (exclusion or emigration), in which one or more populations vanish but others survive elsewhere, or globally, in which all members of the species population everywhere in the world vanish. Extinction of a species is a natural process. The fossil record indicates that most, if not all, species have a finite life span, averaging between 1 and 10 million years (Solbrig 1991). Drastic environmental change is a major cause of species extinction especially on a global scale. Because the environment is in a constant state of transformation, some species are always being lost while others are added. Some changes in the physical environment are cyclic and periodical, while others are less predictable. Thus, it is impossible to establish a normal rate of species change and based on the data presented in this study, it may be impossible to do so at all.

A species pool has the following main characteristics.

Liquidity and Irreversibility

A species pool is a dynamic flow of species through a storage area. Adapted to new environments, species that have become locally extinct (exclusion) may remigrate back into a region. However, the natural process from speciation to extinction is irreversible. Species that have become globally extinct cannot be recovered naturally. Thus, conservation of biodiversity is needed on a global level. But, it is impossible for humans to interrupt the natural extinction process and store all species on a global scale. Man can temporarily store as many species as possible in regional species pools, but even these are present only on a dynamic basis.

A species pool is not the accumulation of species only over long evolutionary time spans, and species-rich communities may not always be the oldest as Whittaker (1977) has stated. Western North America has a young geological history. The rapid rise of the Rocky Mountains in the Tertiary and extensive glaciation in the Pleistocene caused widespread extinction of life in western North America. However, western North America has the greatest species pool in the northerly regions of the Northern Hemisphere. The northerly flora of western North America, which is both young and species-rich, is a striking example that fails to support Whittaker's hypothesis. This fact is also not consistent with White's hypothesis that emphasizes that the differences in taxon richness among eastern Asia, North America, and Europe results from differing Pleistocene extinction rates in the three areas (White 1983). In fact, it is not realistic to focus on preservation of static ecosystems for preservation of maximum species richness or biodiversity.

Stochasticity and Non-equilibrium

Nature is not in balance. Disturbances and irregularities of all sorts are not aberrations, but integral parts of nature (Solbrig 1991). Both chance and natural selection produce the steady coming and going of species through a pool. Speciation, immigration, and extinction function continuously. Thus, the size of a species pool (species richness) is indeterminate and unpredictable. The theory of species equilibrium, namely, that the steady-state number of species, found on an island or isolated patch of habitat due to a balance between the immigration of new species and the extinction of old residents (MacArthur and Wilson 1967, Wilson 1992) is inadequate because it denies the reality of chance.

Heterogeneity and Non-saturation

The basic arguments of the currently dominant energy hypothesis are: (1) species richness is a measure of available energy, and (2) the product of a balance between immigration and extinction which causes richness to approach its theoretical maximum over time (MacArthur and Wilson 1967). Therefore, this hypothesis is that species richness in similar environments is the result of inevitable convergence. In general, tree species richness supports this and increases in direct relation to precipitation or AET, suggesting that a positive relationship exists between diversity and productivity of the habitat (Latham and Ricklefs 1992). But this is not always true. There are many examples of species richness decline at high habitat productivity levels (Ricklefs 1987, Latham and Ricklefs 1992). The total number and species of plants within a community may reflect total productivity, but species richness does not. Different species have different individual size, population and distribution patterns and thus have different energy needs and different ecological roles in an ecosystem. Some species, known as keystone species (Wilson 1992), affect the survival and abundance of many other species in the community in which they live. In contrast, the presence of some species may be caused by, and be largely dependent on, the existence of other species.

Clearly, species is not an energy or ecological unit. Theoretically, every species has a unique niche because every species has at least one physical or behavioral characteristic that defines it from other species (Solbrig 1991) even though the current measures of environmental parameters are too crude to distinguish all differences among species. The ecological inequality of species indicates that the number of species present is not a function of the physical environment. On the other hand, all regions exhibit heterogeneity and patchness and no environment is completely homogeneous. This variability and patchness in the environment provides a foundation for the coexistence of species. Consequently, competition seems less important as a determinant of species richness throughout a large scale biogeographic region than on a local site. However, species richness does not always tend toward its possible maximum largely due to the effect of chance. There is reason to assume that nowhere in the world have resources been fully utilized by plants. A measure of energy availability cannot even allow prediction of the maximum number of species in a region because plants have the ability to expand local environmental constraints during colonization. If species saturated biological communities exist within limits set by local conditions, new species could not join the community without the compensating disappearance of others

(Ricklefs 1987). But many successful introductions of exotic species cannot be shown to have caused an apparent loss of native species. In subtropical eastern Asia, for example, where tree species richness is about four times that of subtropical eastern North America, about 50 species of trees and woody vines introduced from eastern North America have successfully colonized without the compensating disappearance of the native species. American *Robinia pseudoacacia* L., *Campsis radicans* Seem., *Sabina virginiana* (L.) Antoine, *Pinus elliottii* Engelm., *P. taeda* L., *P. rigida* Mill., *Magnolia grandiflora* L., *Carya illinoensis* (Wangenh.) Koch, and *Liriodendron tulipifera* L., all now grow well in China and do even better locally than their eastern Asian species pairs. Of them, *Robina pseudoacacia* and *Campsis radicans* have escaped from plantations and gardens and became naturalized species in China (He and Gu 1990). In these cases, competition between exotic and native species has lead to increased diversity rather than extinction and loss of species in the area. Thus, a climate or energy hypothesis alone cannot explain this fact of additional species richness because both neglect historical plant evolution and migration.

Previous studies have usually concentrated on a small taxonomic group of organisms and thus failed to provide a general theory for the existence of species pools. In short, what is present on a given site at a given time, or interval of time, is a product of chance. The natural processes flowing in a river of information are relatively deterministic, but the residents on site at a given time are only those who then happen to reside there.

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BOOK NOTICE

SWINK, FLOYD and GEROULD WILHELM. 1993. **Plants of the Chicago Region.** Fourth Edition. (ISSN 1-883362-01-6, hbk). Indiana Academy of Science, 1102 North Butler Avenue, Indianapolis, IN 46219-2918. $28.00 (Academy members); $35.00 (non-members) (+ postage: $2.50 domestic, $5.00 foreign). 921 pp.

The "Chicago Area," lying within a 75-mile radius of the Windy City's center, includes parts of Illinois, Indiana, Michigan, and Wisconsin. The first (1969) and second (1974) editions of this work were by Swink alone; the third (1979) added Wilhelm and well-done keys. This fourth edition, with 226 more taxa than its predecessor, is the most splendid of them all. Even though Chicagoland is urbanized and depressingly industrialized, it still has many "natural" areas and a flora of 2530 taxa, about 35% of them introduced. The arrangements of families, genera, and species is strictly alphabetical, as in an ordinary dictionary. Look, then, for the key to genera of Cyperaceae under the C's; the key to, and species entries for, *Scirpus* under the S's. The species accounts include not only habitat/historical/phenological/taxonomic/nomenclatural data, but also listings, often lengthy, of associated species. The glossary is well illustrated; the bibliography has about 1750 entries. Swink & Wilhelm bring to this impressive and authoritative work a total of some 75 years of experience in passionate pursuit of plants in their region. Could a flora be written by authors more qualified for the task? I doubt it.—*John W. Thieret.*

SYNOPSIS OF THE GENUS *LYCORIS* (AMARYLLIDACEAE)

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ABSTRACT

Species of the East Asian genus *Lycoris* are easily hybridized; diverse morphological features occur frequently among them in nature and in cultivation. This has caused much difficulty in identifications. Based on taxonomic and karyological investigations and crossing tests, 20 species are recognized of which four are regarded as hybrids: *Lycoris ×haywardii*, *L. ×albiflora*, *L. ×houdyshelii,* and *L. ×rosea*. *Lycoris aurea* var. *angustitepala* is proposed as new. Keys, descriptions, synonymies, typifications, and karyotypes are included.

RESUMEN

Las especies del este asiático del género *Lycoris* se hibridan fácilmente y diversas características morfológicas se dan frecuentemente tanto en la naturaleza como en cultivo. Esto ha causado mucha dificultad en las identificaciones taxonómicas. En base a investigaciones taxonómicas y cariológicas, así como pruebas de cruzamiento, se han reconocido veinte especies de las que cuatro son consideradas como híbridos. *Lycoris ×haywardii, L. ×albiflora. L. ×houyshelii y L. ×rosea.* Por otro lado, L. aurea var. angustitepala se propone aquí como nueva. Se incluyen claves, descripciones, sinonimias, tipificaciones y cariotipos.

The genus *Lycoris* Herb. consists of 20 species distributed in warm temperate to subtropical zones of East Asia from southwestern China to Japan and southern Korea, with a few extending to northern Indochina and Nepal. The species are easy to hybridize with each other, and a number of the presently recognized taxa are certainly of hybrid origin.

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Introduction and cultivation of *Lycoris* species began in the 18th century, first to England and then to the United States. To date, most of the species have proven successful in cultivation. They are summer- and autumn-blooming plants of great beauty and common in the gardens of China, Japan, and the United States. In comparison with other well-known bulb flowers, such as narcissi and lilies, *Lycoris* has its own characteristics and merits. *Lycoris* comes into flower at a time when few other bulbous plants are active. The flowers are characterized by their pastel and plentiful colors as well as by beautiful and varied shapes. The plants are tolerant to drought, waterlogging, and pests, growing vigorously even in barren land, and thus show good prospects in horticulture.

The genus *Lycoris* was founded by Herbert in 1821, and *L. aurea* (L'Hér.) Herb. was assigned to be the type. In the mid 19th to the early 20th century, nine new species were published by various European authors: *L. africana* (Lam.) M.J. Roem. (1847), *L. straminea* Lindley (1848), *L. sewerzowii* Regel (1868), *L. squamigera* and *L. sanguinea* Maximowicz (1885), *L. terracianii* Dammann (1889), *L. sprengeri* Comes ex Baker (1902), *L. incarnata* Comes ex Sprengel (1906), and *L. argentea* Worsley (1928). In the first half of the 20th century, three new species from Japan were added: *L. albiflora* Koidzumi (1924), *L. koreana* Nakai (1930), and *L. kiusiana* Makino (1948). After that, the American botanist Hamilton P. Traub focused his research on the tribe Amarylleae, Amaryllidaceae, and published 10 new species (two with Moldenke) of *Lycoris* based mainly on materials introduced from China and Japan and cultivated in American gardens: *L. rosea* (1949); *L. haywardii*, *L. caldwellii*, *L. houdyshelii*, and *L. ×woodii* (1957); *L. chinensis* and *L. elsiae* (1958), *L. ×lajolla* (1963), *L. ×jacksoniana* (1964); and *L. josephinae* (1965). Two keys to the species of the genus were presented in his two issues (Traub 1957, 1958). Two American horticulturists, Hayward and Caldwell, had done much of work on introduction and cultivation of *Lycoris* species. Hayward (1957) published a new species: *L. traubii*. After an interval of about 15 years, the Chinese botanists Hsu & Fan (1974) and Xu et al. (1982) published four new species of *Lycoris* from China: *L. longituba*, *L. anhuiensis*, *L. guangxiensis*, and *L. shaanxiensis* (1982). Their revision of the Chinese *Lycoris*, in which 15 species were included, was published in *Flora Reipublicae Popularis Sinicae* (1985). Recently, M. Kim and S. Lee (1991) published a new species, *L. flavescens*, in their study of Korean *Lycoris*. To date then, 29 species have been published. However, some of these have been reduced to synonyms, some to infraspecific rank, and still some are cultivars or hybrids. Twenty species are included in the present paper, though the identity of a few of them is still equivocal and deserves further study. A number of species published in the earlier period are without indications of type specimens or even precise type localities; many type specimens are not available to us. Besides, the classification of the genus *Lycoris* is largely based on morphology and color of flowers; leaf morphology is not of much value in identifications. Furthermore, *Lycoris* species are easy to hybridize with each other, and hybrids of diverse morphological features occur frequently in nature and in cultivation. All this has caused great difficulties in our research work. In many cases, karyological investigation furnishes a taxonomic identification with solid data.

Lycoris belongs to the subtribe *Lycorinae* of the tribe *Amarylleae* of subfamily *Amaryllidoideae*. *Ungernia* Bunge, the only other genus of the subtribe, differs from *Lycoris* mainly in its stamens inserted in two rows instead of one row near the throat of the tepaltube, and in its basic chromosome number, x=11. *Ungernia* has six species with a distribution confined to Iran and central Asia.

Lycoris was divided by Traub and Moldenke (1949) into two subgenera based largely on flower form and length of stamens. Species of subgen. *Symmanthus* Traub & Moldenke have wide tepals that are erect or recurved only at the tips, with the distal part more like a trumpet lily. In this subgenus, some species have slightly wavy-margined tepals, but the majority do not. Fragrance is found only among the funnel-form species. Species of subgen. *Lycoris* have spiderlily-form flowers with substantially reflexed tepals, and the stamens and style usually long-exserted. The tepals are almost invariably crisped, wavy, or undulate. The flowers are not fragrant.

Phenologically, the species of *Lycoris* may be divided into two types. Those species from areas with colder winters make little or no leaf growth until January or later. Those species from areas with warmer winters make leaf growth in the autumn and remain in active growth all winter. In both cases, leaf growth continues actively until late spring, whereupon the leaves die back. The plants are leafless during summer.

Cytological studies on *Lycoris* were initiated in the late 1920s. To date, chromosome number determination and karyotype analyses have been made for most of the species. There are three major chromosome types: (1) M (metacentric chromosomes); (2) A (acrocentric chromosomes); and (3) T (telocentric chromosomes). In the species with $2n=22$, all rod chromosomes are As; in the species with $2n=12–16$, all rod chromosomes are Ts. The genus has a series of basic chromosome numbers—6, 7, 8 and 11—but the total number of arms of a chromosome complement of any species is always multiples of 11. It seems that 11 is the primitive basic chromosome number (Liu & Hsu 1989). However, it is still unresolved whether a successive decrease in chromosome numbers as a result of Robertsonian fusion or a gradual increase in chromosome numbers brought about by centric fission has been the essential mechanism for karyotype evolution and speciation in the genus. Hsu and Liu (1987) proposed a new "fusion-fission synthetic theory" for explaining the karyotype evolution and speciation in *Lycoris*. The theory embodies three central ideas: (1) the basic chromosome number of *Lycoris* is x=11, and $2n=22$ is the primitive karyotype; (2) both fusion and fission have taken place, at different times during the process of karyotype evolution; and (3) duplications, translocations, and other chromosome aberrations must have occurred in the process of fusion. The meiotic behavior of the diploid hybrid *L.* aff. *albiflora* gives evidence for the assumption that Robertsonian changes have occurred in the process of karyotype evolution (Liu & Xu 1990). Kurita (1988b), however, insisted that the M type chromosome is not a simple product of the fusion of two A type chromosomes. Based on karyological and karyogeographical evidences, together with C-banding patterns and DNA contents of certain species, he is inclined to the fission theory.

Much work on hybridization and breeding was accomplished mainly by horticulturists from the United States, Japan, and China in the past 50 years. In the early 1940s, Wood (cf. Adams 1976) crossed *L. radiata* with *L. traubii*, creating the hybrid *L.* ×*woodii* Traub. Creech (1952) reported the pollination of *L. radiata* by *L. aurea;* the resulting hybrid had $2n=19$. Takemura (1961, 1962a,b) made a series of artificial crosses between *L. sprengeri*, *L. straminea* (probably not true *L. straminea*), *L. radiata*, *L. radiata* var. *pumila*, *L. sanguinea*, and *L. aurea*, and investigated morphology and cytology of the hybrids. Caldwell (1972, 1981) made many crosses beginning in 1954. One beautiful Caldwell hybrid is *L. jacksoniana* (Traub 1964), the parental species of which are *L. sprengeri* and *L. radiata*. Koyama (1962) observed meiotic behavior of that hybrid. Adams (1976) made numerous crosses, mostly repeating those that had been done before. Lin et al. (1990, and unpub.) have been successful in bringing forth new hybrids and have shown that both *L. rosea* and *L. haywardii* are hybrid segregates of *L. radiata* var. *pumila* ♀ × *L. sprengeri* ♂, and that *L. squamigera* is the hybrid of *L. chinensis* ♀ × *L. sprengeri* ♂. One new hybrid resulting from *L. sprengeri* ♀ × *L. chinensis* ♂, which they have named *L.* ×*elegans*, ined. resembles *L. albiflora* in general appearance, but its karyotype is $2n=3M+16A=19$. Diploid species of *Lycoris* are easy to hybridize with each other, irrespective of their conspicuous morphological and ecological differences. The fertility of these hybrids is high (Lin et al. 1990). The properties of hybrids can be maintained by means of vegetative propagation. This is probably why hybrids often occur in nature as well as in cultivation. On the contrary, hybridizations between the triploid lycorises are generally unsuccessful (Lin et al. 1990). Results obtained from an extensive interspecific crossing program involving reciprocal combinations of many species by Xu et al. (1986) have shown that both pollen viability and seed-set after crossing are correlated with ploidy level.

Only a few palynological studies of *Lycoris* have been carried out. Kurita (1985) found that there was a latitudinal topocline of variation in pollen ornamentation as well as in the amount of gemmate protrasion on the foot layer of pollen grains within *Lycoris sanguinea* var. *sanguinea* in Japan. As a result of a palynological study of five species of *Lycoris* from southern Korea, Lee and Kim (1987) conclued that pollen size, muri thickness, lumina size, and lumina number per 100 μm^2 of these species were fundamentally in direct proportion to number and size of chromosomes.

Because many investigations of karyology, morphological variation, distribution patterns, and breeding of *Lycoris* species have been carried out in recent years, Traub and Moldenke's revision (1949) requires modification. It is hoped that the present revision of the genus will contribute to this objective.

LYCORIS Herb., Bot. Mag. 47:t.2113. 1821. Benth. & Hook.f., Gen. Pl. 3:727. 1883; Maxim., Bot. Jahrb. 6:73. 1885; Baker, Handb. Amaryll. 39. 1888; Spreng., Bull. Soc. Tosc. Ortic. 8:323. 1888; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 165. 1949; Traub, Pl. Life 13:42. 1957 & l.c. 14:42. 1958; Ohwi, Fl. Jap. 383. 1978; Hsu et al., Fl. Reipub. Pop. Sin. 16:16. 1985; Kim & Lee, Korean J. Pl. Taxon. 21:3. 1991.

Bulbous perennial herbs. Leaves after or before the flowers, strap-shaped or linear, basal, dying away before flowers develop. Flowers showy, red, yellow, peach, lilac and blue, or white (intermediates and pastel tones of the colors are also present in some species and hybrids), subtended by 2 spathe-valves, in an umbel on a solid scape; perigone 6-lobed, funnel-form and regular or spiderlily-form and irregular; tepaltube short but expanded at top, throat bearing scales; tepals clawed, reflexed at the tips or not; stamens 6, inserted near throat, declinate, exserted or not; style long, with a very small capitate stigma, ovary inferior, 3-loculed, ovules few in each locule, placentation axile. Fruit a loculicidal capsule; seeds few, round, smooth, black.

There are about 20 species native to China, Japan, and southern Korea, with a few extending southwestward to northern Indochina and Nepal.

1\. Flowers funnel-form, regular; tepals not crisped-margined or only minutely wavy at base, erect or slightly recurved at the tips; stamens included or slightly exceeding tepals (Subgen. *Symmanthus* Traub & Moldenke).

  2\. Leaves appearing in early spring or in autumn; flowers tinged with blue in various degrees.

    3\. Leaves appearing in early spring.

      4\. Flowers produced in Aug.–Sep., vivid rose in the throat, ink-blue at the tips of tepals, otherwise purplish rose (China) .... 1. *L. sprengeri*

      4\. Flowers produced in Jul.–Aug., bluish-mauve with a deeper mauve keel (Upper Burma) .... 2. *L. argentea*

    3\. Leaves appearing in autumn; flowers produced in Jul.–Aug., reddish violet with a deeper keel and changing to ink-blue at tips of tepals (China, Japan, only cult.) .... 3. *L.* ×*haywardii*

  2\. Leaves usually appearing in early spring; flowers never tinged with blue.

    5\. Leaves 1–1.2 cm broad, without a distinct whitish stripe; tepaltube 1–2.5 cm long; flowers flesh-colored or light rose.

      6\. Flowers light purplish pink; tepals 6.3–7 cm long (China, Japan, Korea). .... 4. *L. squamigera*

      6\. Flowers not light purplish pink; tepals 5–7 cm long.

        7\. Flowers white, changing to flesh-colored or light rose; tepals with a reddish band above and a deeper keel below, 5–5.6 cm long (China) .... 5. *L. incarnata*

        7\. Flowers apricot-orange or rarely white; tepals 6.4–7 cm long.

- 8. Tepals slightly recurved; stamens shorter than or subequalling tepals; flowers in late Jul.–Aug. (Japan) .... 6a. *L. sanguinea* var. *sanguinea*
- 8. Tepals distinctly recurved; stamens distinctly exceeding tepals.
  - 9. Flowers 7–8 cm long (Japan) .... 6b. *L. sanguinea* var. *kiusiana*
  - 9. Flowers 5–6 cm long (Korea, Japan) .... 6c. *L. sanguinea* var. *koreana*
- 5. Leaves 1.5–2.5 cm broad, with a distinct whitish stripe; tepaltube 2–6 cm long; flowers yellow or white.
  - 10. Tepaltube 2–3.5 cm long; flowers yellow (China) .... 7. *L. anhuiensis*
  - 10. Tepaltube 4.2–6 cm long; flowers yellow or white to peach-colored.
    - 11. Flowers white with light reddish stripes or peach-colored in bud and opening pinkish (China) .... 8a. *L. longituba* var. *longituba*
    - 11. Flowers yellow (China). .... 8b. *L. longituba* var. *flava*

1. Flowers spiderlily-form or nearly so, distinctly irregular; tepals strongly or medium crisped-margined, strongly recurved at the tips (Subgen. *Lycoris*).
- 12. Leaves produced in early spring; stamens shorter than to slightly exceeding tepals.
  - 13. Leaves without a distinct whitish stripe; stamens shorter than tepals.
    - 14. Flowers in bud peach-colored, opening to creamy yellow, changing to creamy white with age; tepals without pinkish stripes (China) .... 9. *L. caldwellii*
    - 14. Flowers white with a few pinkish stripes inside and a reddish keel underside of each tepal (China)... 10. *L. shaanxiensis*
  - 13. Leaves with a distinct whitish stripe; stamens subequalling or slightly exceeding tepals; flowers yellow.
    - 15. Leaves narrow strap-shaped, dark green, 24–29 cm long, 1–1.2 cm broad; tepals with reddish bands (China) .... 11. *L. guangxiensis*
    - 15. Leaves strap-shaped, green, ca. 35 cm long, ca. 2 cm broad; tepals without reddish bands .... 12. *L. chinensis*
- 12. Leaves produced in autumn; stamens usually far exceeding tepals.
  - 16. Leaves more than 12 mm broad; flowers various colored, but never red.
    - 17. Flowers yellow.
      - 18. Remains of leaf-bases prominent at the base of scape; flowers somewhat upright, cadmium yellow; tepals with a pale green band underside, narrowly elliptic, 8–12 mm broad; spathe-valves lanceolate, 7–8 cm long; pedicels 15–22 mm long.
        - 19. Tepals 7–12 mm broad.
          - 20. Tepals distinctly recurved (China, Burma) .... 13a. *L. aurea* var. *aurea*
          - 20. Tepals upright (Upper Burma) .... 13b. *L. aurea* var. *surgens*
        - 19. Tepals 4–8 mm broad (China) .... 13c. *L. aurea* var. *angustitepala*
      - 18. Remains of leaf-bases not prominent at the base of scape; flowers more or less horizontally spreading, rich orange-yellow; tepals with a deeper orange-yellow band underside, narrow oblanceolate, 13–16 mm broad; spathe-valves ovate, 3.5 cm long; pedicels 8–9 mm long (Japan, Korea, China: Taiwan) .... 14. *L. traubii*
    - 17. Flowers pale straw-colored, creamy white to white, or salmon-colored.
      - 21. Flowers creamy-white to white or pale straw-colored.
        - 22. Flowers creamy white to white.
          - 23. Flowers pinkish in bud, opening creamy white, changing to white with age; tepals with a very light orange-

yellow band in the center; tepaltube ca. 2 cm long (Japan, Korea, China) .... 15. *L. ×albiflora*

23. Flowers creamy white, changing to whitish; tepals with a greenish band underside; tepaltube ca. 8.5 mm long (China) .... 16. *L ×houdyshelii*

22. Flowers pale straw-colored; tepals with a pink band and a few scattered red dots in the upper surface, changing to white in full blossom; tepaltube 4–5.5 mm long (China) .... 17. *L. straminea*

21. Flowers salmon-colored, finally fading to a flesh-color; tepals with a deep purplish band tinged with creamy and yellow along the center; tepaltube 12–13 mm long (Japan). .... 18. *L. elsiae*

16. Leaves less than 9 mm broad; flowers bright red or rose-colored.
    24. Flowers bright red or sometimes with white-margined tepals; tepals distinctly crisped-margined and strongly reflexed; stamens 2–2.5 times the length of tepals.
        25. Flowers bearing no seeds (China, Japan, Korea, Nepal) .... 19a. *L. radiata* var. *radiata*
        25. Flowers bearing seeds (China) .... 19b. *L. radiata* var. *pumila*
    24. Flowers rose-colored, pale red, or becoming whitish; tepals not crisped-margined or only ruffled at the base, slightly reflexed; stamens a little longer than tepals.
        26. Flowers pale red or becoming whitish, with tepals 1.5–3.2 cm long and 2–5 mm broad (Japan) .... 19c. *L. radiata* var. *kazukoana*
        26. Flowers rose-colored, with tepals 4–6 cm long and 7–8 mm broad (China) .... 20. *L. ×rosea*

1. **Lycoris sprengeri** Comes ex Baker, Gard. Chron. ser. 3, 32:469. 1902. Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 170. 1949; Traub, Pl. Life 13:43. 1957, in clavis; Hsu et al., Fl. Reipub. Pop. Sin. 16(1):24. 1985. TYPE: HUBEI PROVINCE: mountains near Xiangyang, not indicated. Sprenger (1906, cf. Traub & Moldenke 1949) stated this species was sent to him by his collector from China about 1900. They (1949) remarked that Comes' reference, which had never been found, was probably a specimen label.

Leaves ensiform-linear, ca. 30 cm long and 1 cm broad, dark green. Perigone vivid rose in the throat, otherwise purplish rose with ink-blue tips on the tepals. Tepaltube 1.2–2.3 cm long; tepals oblanceolate, 4.5–7 cm long, 1–1.7 cm wide, not ruffled-margined, recurved. Stamens somewhat shorter than tepals. Style about as long as or slightly exceeding tepals.

Phenology: leaves appearing in early spring; scape produced in August to September.

Karyotype: $2n=22A=22$ (Kurita 1987a; Liu & Hsu 1989).

Distribution: endemic to China (Anhui, Hubei, Jiangsu, Zhejiang). In bamboo groves and on moist slopes in sparse woods; ca. 100 m.

Specimens examined: CHINA. **Anhui:** Chuxian, Langya Shan, *East China Bot. Station 3114* (JSBI). **Jiangsu:** Yixing, *W.Z.Fang 297* (PE); *Y.L.Keng 2559* (JSBI); Jiangning, *J.S.Yue 0561*(JSBI); Shanghai, Tianma Shan, *G.J. Fan s.n.* (PE); same locality, Heng Shan, *G.J.Fan s.n.*

(PE); *S.S.Su 253* (JSBI); *Nanjing Univ. Exped. 253* (SZ); same locality, Songjiang, *G.J.Fan s.n.* (PE); without precise locality, *W.C.Chow 819* (FUS). **Zhejiang:** Xiaoshan, *Y.L.Keng 1111* (FUS); Hangzhou, Hangzhou Bot. Gard. cult., *Z.Z. Yu 004, 012, 013* (HZBG); Zhoushan, *J.Z.Lin 008* (HZBG).

This species shows much variation in breadth of tepals and in lengths of tepaltube and stamens. The plants coming from Zhoushan, Zhejiang, show some differences in length of stamens, some with stamens shorter or subequalling the tepals, some with longer and exserted stamens.

2. **Lycoris argentea** Worsley, Gard. Chron. ser. 3, 84:169, fig. 72. 1928. Grey, Hardy Bulbs 2:57. 1938; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 169. 1949. TYPE: not indicated. Worsley (1928) remarked that the type material was sent to the Royal Horticultural Society, England, in October 1904 by C. Judes from Upper Burma.

Leaves bluish green. Perigone bluish mauve with a silvery sheen and some sparkles and a deeper mauve keel. Tepaltube very short; tepals oblong, neither undulate-margined nor recurved. Stamens and style subequalling tepals.

Phenology: leaves appearing in autumn; scape produced in July to August.

Karyotype: no reports.

Distribution: Upper Burma.

The above morphological description is based on Worsley's brief description of the type. No other detailed information is available. According to Worsley (1928), this species differs from *L. squamigera* Maxim. in having bluish-mauve tepals with a deeper mauve keel, and in the stamens and style being about equal to the tepals. We have not seen any specimens of this species at Kew. It has probably a more close affinity to *L. ×haywardii* than to *L. squamigera*, at least in morphology. At present, the identity of this species, be quite equivocal, deserves further study.

3. **Lycoris ×haywardii** Traub (pro sp.), Pl. Life 13:44, fig. 16. 1957. Caldwell, Pl. Life 13:53. 1957. TYPE: UNITED STATES. TENNESSEE: Nashville (cult.), *S. Caldwell 554* (HOLOTYPE: TRA). PARATYPE: FLORIDA: Winter Park, *W. Hayward 291* (TRA). According to Caldwell (1957), the type was from Japan.

Leaves up to 48 cm long, 7–11 mm broad, deep green, glaucescent. Perigone reddish violet, a little lighter than in *L. sprengeri*, tepals with a deeper keel and changing to ink-blue at the apex. Tepaltube 1.1–1.3 cm long; tepals oblanceolate, 4.4–5.5 cm long, 1–1.1 cm broad, not crisped-margined. Stamens somewhat shorter than tepals. Style moderately exserted.

Phenology: leaves appearing in autumn; scape produced in July to August.

Karyotype: $2n=22A=22$ (Hsu et al. 1981; Liu & Hsu 1989).

Distribution: known only in cultivation.

Specimens examined: CHINA. **Zhejiang:** Hangzhou, Hangzhou Bot. Gard., cult., *J.Z.Lin 002, 003, Z.Z.Yu 026* (HZBG). The specimens cited differ from the type in having longer stamens exceeding the tepals.

This species is most closely allied with *L. sprengeri* Comes ex Baker and differs from that species mainly in having smaller flowers with a paler bluish purple color and an earlier blooming time.

Hybridizing tests accomplished by Lin et al. (unpub.) have shown that *L. ×haywardii* is a hybrid between *L. sprengeri* and *L. radiata* var. *pumila*. The artificial hybrids resemble *L. ×haywardii* very much in external morphology. Karyologically, both of the parental species have $2n=22A$, also in accord with *L. ×haywardii*.

4. **Lycoris squamigera** Maxim., Bot. Jahrb. 6:79. 1885. Baker, Handb. Amaryll. 40. 1888; Bot. Mag. 123:pl.7547. 1897; Spreng., Bull. Soc. Tosc. Ortic. 8:327. 1888; Nakai, Fl. Kor. 234. 1911; Worsley, Gard. Chron. ser. 3, 84:169. 1928; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 173. 1949; Koyama, Baileya 7:6, fig. 18. 1959; Ohwi, Fl. Jap. ed. 2,384. 1978; Hsu et al., Fl. Reipub. Pop. Sin. 16(1):24. 1985; M.Kim & S.Lee, Korean. J. Pl. Taxon. 21:10. 1991. Type: JAPAN: Maximowicz cited three specimens from Japan, two of which were from a locality near Oyo of Simabara Pref., Kiusiu, with a shady seashore habitat, and one of which was cultivated in Yokohama. No mention about the collectors of the type material.

Amaryllis hallii Hovey ex Baker, Bot. Mag. 123:t.7547. 1897, in syn.

Leaves 1.8–2.5 cm broad, bright green. Perigone light purplish pink with a gold throat. Tepaltube 1.6–2.5 cm long; tepals oblanceolate, 6–7 cm long, 1.2–1.8 cm broad, minutely wavy-margined at base, not reflexed. Stamens subequalling tepals. Style slightly exserted.

Phenology: leaves appearing in spring in Japan and Korea, in autumn in China, then dying down and regenerating in spring; scape produced in August.

Karyotype: $2n=6M+10T+11A=27$ (Kurita 1987a; Liu & Hsu 1989).

Distribution: eastern China (Jiangsu, Shandong, Zhejiang), Japan, and Korea. In moist often disturbed places, such as margin of plantations, around dwellings, and graveyards; to 1200 m.

Specimens examined: CHINA. **Jiangsu:** Yuntai Shan, *F.X.Liu 10732* (PE); *X.R.Chang* et *al. 19608* (SHMI); Shanghai, cult., *P.S.Hsu 486* (FUS, JSBI); *C.N.Yan 10391* (FUS). **Shandong:** Qingdao, Lao Shan, *H.B.Cui 376* (PE). **Zhejiang:** Shonshan, *Y.L.Keng 1111* (FUS).

JAPAN. **Chiba Pref.:** Chiba Univ., cult., *S.Kurita 910820* (CBM). **Nagano Pref.:** Kamiminochi-gun, Tokakushi-mura, *S.Kurita 870810* (CBM). **Tokyo Pref.:** Hachioji, Kamiange, *S.Kurita 860815* (CBM).

KOREA. **Kangwon-do:** Kangwon, Mt. Kumgangsan, *T.Uchiyama s.n.* (TI). **Kyonggi-do:** Suwon, *H.Ueki s.n.* (TI).

Based on karyological and morphological studies, Inariyama (1948, 1951, 1952, 1953) considered this sterile species a triploid hybrid between *L. straminea*[2] and *L. sprengeri*. Takemura (1961) crossed *L. straminea*[2] and *L. sprengeri*. The hybrids resembled *L. squamigera* in gross morphology, but they were diploids

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[2] Plants examined by Inariyama, Takemura and Kurita were *L. straminea* auct. non Lindl., and might be *L. longituba* Y. Hsu & G.J. Fan.

having $2n=19$. Based on cytological investigation, Kurita (1987a) supported Inariyama's proposition and was of the opinion that since *L. squamigera* occurs only in human habitations or as an escape in Japan, it was brought to Japan from China for ornamental purposes in early time.

5. **Lycoris incarnata** Comes ex Spreng., Gartenwelt 10:490, fig. 1. 1906. Worsley, Gard. Chron. ser. 3, 84:169. 1928; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 172. 1949; Traub, Pl. Life 13:43. 1957; Hsu et al., Fl. Reipub. Pop. Sin. 16(1):25. 1985. TYPE: no type specimen cited. Sprenger stated that *L. incarnata* was first described by Comes in Portici, Italy. But it has not been possible to verify this statement (Traub & Moldenke 1949). According to Sprenger, this species was collected in Hubei, China, and sent to him in Naples about 1901 by a collector.

Leaves strap-shaped, ca. 50 cm long, ca. 1.2 cm broad, dark green. Perigone white in bud, opening white, changing gradually to flesh-colored or light rose. Tepaltube 1.8–2 cm long; tepals oblanceolate, with a reddish stripe above and a deeper keel below, 5–5.6 cm long, 1.2–1.4 cm broad, barely undulate-margined, only very slightly recurved. Stamens purplish, subequalling or somewhat shorter than tepals. Style purplish, a little exceeding tepals.

Phenology: leaves appearing in spring; scape produced in September to October.

Karyotype: $2n=4M+3T+22A+1m=30$ (Kurita 1987a).

Distribution: endemic to China (Hubei and Yunnan).

This species is most similar to *L. squamigera* Maxim. from which it differs mainly in the leaves appearing only once in spring, in the size and color of flowers, and in the karyotype.

Kurita (1987a) strongly suggested that *L. incarnata* must have originated from a cross between a gamete having $4M+3T$ and another gamete having $22A+1m$, though the parental species could not be decided.

6. **Lycoris sanguinea** Maxim., Bot. Jahrb. 6:80. 1885. Baker, Handb. Amaryll. 40. 1888; Spreng., Bull. Soc. Tosc. Ortic. 8:328. 1888; Worsley, Gard. Chron. ser. 3, 84:169. 1928; Makino, Illus. Fl. Jap. fig. 2165. 1949; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 175. 1949; Koyama, Baileya 7:5, fig. 2a. 1959; Ohwi, Fl. Jap. ed. 2, 384. 1978.

Lycoris cyrtanthiflora Hort. Worsley, Gard. Chron. ser. 3, 84:169. 1928; Grey, Hardy Bulbs 2:58. 1938; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 175. 1949.

6a. **Lycoris sanguinea var. sanguinea,** TYPE: Maximowicz listed two type specimens of this species in his type description. They were all from Japan: one near Yokohama (*Tschonoski* fl.), and the other between Kyoto and Maizuru (*Doederlein* fl., in Engler's Herb.). We have not been able to see these two specimens.

Leaves strap-shaped, 20–30 cm long, 10–12 mm broad, light green. Perigone apricot-orange. Tepaltube 1–1.5 cm long; tepals linear-oblong, acute, 6.4–7 cm long, ca. 3.8 cm broad, neither crisped-margined nor recurved. Stamens subequalling or slightly shorter than tepals. Style exceeding tepals.

Phenology: leaves appearing in spring, dying down and coming up again in next spring; scape produced in late July to late August.

Karyotype: $2n=22A=22$ (Inariyama 1931, 1937, 1951; Koyama 1954, 1962; Kurita 1989; Nakamura 1978; Nishiyama 1928; Sato 1942; Takemura 1961; Yoshida 1972); $2n=31A+1M=32$ (Kurita 1989).

Distribution: Japan (northern Honshu and southwestward, Shikoku, Kyushu). In moist places by streams and sparse woods; to 500 m.

Specimens examined: JAPAN. **Chiba Pref.:** Chiba, Noromachi, *S.Kurita 870810* (CBM). **Ehima Pref.:** Saijyoshi, Mt. Ishizuchi, *M.Takahashi 1790* (PE). **Kochi Pref.:** Takaoka-gun, Hayama-mura, *H.Ohashi 660203* (TI); Kami-gun, Tosayamada-cho, Ryuga-dou, *M.Takahashi 1786* (PE). **Kyoto Pref.:** Yamashiro, Yaze, *G.Koidzumi s.n.* (TI). **Niigata Pref.:** Awajima, *K.Mori 47* (TI). **Saitama Pref.:** Aganomachi, Hanagiri, *T.Yamazaki s.n.* (TI). **Shizuoka Pref.:** Ogasagun, Kikugawa-cho, *S.Kurita 860808* (CBM).

This species is characterized by its reddish orange or orange-colored flowers with stamens nearly equal to or slightly shorter than tepals. But there is a cultivar (var. *alba* Hort. Mill. & Bailey, Stand. Cycl. Hort. 2:1933. 1939) with white flowers and with the leaves appear in March.

6b. **Lycoris sanguinea** Maxim. var. **kiusiana** (Makino) Koyama, Baileya 7:5. 1959. Ohwi, Fl. Jap. ed. 2, 384. 1978. Type: JAPAN. **Hizen Pref.:** Mt. Tara in Kiusiu, cultivated in Oidzumi (*T. Makino s.n.*).

Lycoris kiusiana Makino, Makinoa 9:176. 1948; Komatzuzaki, J. Jap. Bot. 32:62. 1957.

Differs from *L. sanguinea* var. *sanguinea* by the larger-sized flowers (7–9 cm long) produced in July with the tepals distinctly recurved, the longer stamens distinctly exceeding the tepals, the broader leaves (10–13 mm wide), and the earlier anthesis.

Phenology: leaves appearing in February to May; scape produced in early July to early August.

Karyotype: $2n=22A=22$ (Kurita 1988b; Takemura 1965; Yoshida 1972); $2n=33A$ & $44A$ (Kurita 1988a).

Distribution: endemic to Japan (Central Honshu and westward, mainly in Kyushu). In shady slopes under forest trees.

Specimens examined: JAPAN. **Ooita Pref.:** Mt. Kyoyomi-dake, *I.Enomoto s.n.* (TI). **Nagasaki Pref.:** Mt. Tara-dake, *H.Hara s.n.* (TI). **Tokushima Pref.:** Miyoshi-gun, Nishisofuyama-mura, Zentoku, *Y.Momiyama 288* (TI). **Wakayama Pref.:** Hitaka, Kawakami-mura, Imoo, *T.Yamasaki s.n.* (TI). **Kyoto Pref.:** Kifune, *S.Kurita 860725* (CBM). **Tokyo Pref.:** Nishitama, Mt. Kagenobu, *S.Kurita 840715* (CBM).

6c. **Lycoris sanguinea** Maxim. var. **koreana** (Nakai) Koyama, Baileya 7:7. 1959. Type: KOREA. **Prov. Zennan:** Mt. Hakuyozan, *T.Nakai 164* (holotype: TI).

Lycoris koreana Nakai, Bot. Mag. Tokyo 44:516. 1930; Kim & Lee, Korean J. Pl. Taxon. 21:8. 1991.

This variety shows little difference in character from *L. sanguinea* var. *kiusiana*, from which it differs only by its smaller-sized perigone (5–6 cm long).

Phenology: leaves appearing in February to May; scape produced in August.

Karyotype: $2n=22A=22$ (Kurita 1988a; Tae et al. 1987; Takemura 1965).

Distribution: southern Korea and Kyushu and Tsushima Island of Japan. In moist places in the mountains; to 600 m.

Specimens examined: KOREA. Chollabuk-do, Baekyang-san, *T.Nakai 164* (TI); same locality, *S.Kurita 920815* (CBM).

7. **Lycoris anhuiensis** Y.Hsu & G.J.Fan, Acta Phytotax. Sin. 20:197. 1982. Hsu et al., Fl. Reipub. Pop. Sin. 16(1):25, pl.7. 1985. TYPE: CHINA. ANHUI: Langya Shan, *Y.Xu & G.J.Fan 2234* (HOLOTYPE: SHMI).

Leaves strap-shaped, ca. 35 cm long, 2–2.5 cm broad, green with a distinct whitish stripe in the center. Perigone yellow. Tepaltube 2–3.5 cm long; tepals ca. 6 cm long, 1.3–1.7 cm broad, slightly ruffle-margined, spreading and somewhat recurved. Stamens as long as tepals. Style somewhat exserted.

Phenology: leaves emerging in early spring; scape produced in August.

Karyotype: $2n=6M+10T=16$ (Hsu & Liu 1987).

Distribution: endemic to China (Jiangsu and Anhui). On stony slopes in the mountains.

Specimens Examined: CHINA. **Anhui:** Chuxian, *East China Bot. Station 3163* (PE).

This species is characterized by its yellow flowers and by its leaves possessing a whitish stripe in the center. It resembles *L. longituba* described below in both morphology and karyotype, but differs from that species in having smaller yellow flowers and shorter tepaltube.

8. **Lycoris longituba** Y.Hsu & G.J.Fan, Acta Phytotax. Sin. 12:299, pl.61. 1974. Hsu et al., Fl. Reipub. Pop. Sin. 16(1):27. 1985. TYPE: CHINA. Nanjing, Mt. Zijinshan, *F.X.Liu 1919* (HOLOTYPE: JSBI; ISOTYPE: SHMI). PARATYPES: Nanjing, Mt. Baohua Shan, *J.J.Gong 00869* (JSBI); Jiangning County, Mt. Dachenyishan, *M.Z.Chou 64244* (JSBI); Zhenjiang, Zhulinsi, *H.Migo s.n.* (JSBI).

8a. Lycoris longituba var. longituba

Leaves lanceolate, ca. 38 cm long and ca. 2.5 cm broad, with a distinct whitish stripe in the center. Perigone white with light reddish stripes or peach-colored in bud and opening pinkish. Tepaltube 4.2–6. 6 cm long; tepals 6–7 cm long, 1.5–2.1 cm broad, not ruffle-margined, somewhat recurved. Stamens slightly shorter than tepals. Style nearly equal to or slightly exceeding tepals.

Phenology: leaves appearing in early spring; scape produced in July to August.

Karyotype: $2n=6M+10T=16$ (Liu & Hsu 1989).

Distribution: endemic to China (Jiangsu and Anhui).

Specimens examined: CHINA. **Jiangsu:** Zhenjiang, *East China Bot. Station 2997* (PE); Nanjing, *F.X.Liu 1319* (PE); same locality, Sun Yat Sen Mem. Bot. Gard. cult., *Z.Z.Yu 024*, *Z.G.Mao 10501* (HZBG).

This distinctive species is characterized by its regular, large, white (or with reddish stripes) to pinkish flowers with long tepaltube (the longest in the genus). But the species shows much variation in the shape and color of flowers correlated with karyotype variation. A form with rather thick and greenish pale yellow tepals possesses $2n=7M+8T=15$; another form characterized by having shorter tepals possesses $2n=7M+6T+2A=15$. Since the short arm of this A type chromosome is revealed to be heterochromatic, it may be derived from an inversion of the T type chromosome.

8a. Lycoris longituba Y.Hsu & G.J.Fan var. **flava** Y.Hsu & X.L.Huang, Acta Phytotax. Sin. 20:198. 1982, and Fl. Reipub. Pop. Sin. 16(1):27. 1985. TYPE: CHINA. JIANGSU: Jiangning, Mt. Langshan, *Z.M.Zhou 64246* (HOLOTYPE: SHMI).

Flowers pale yellow.

Phenology: same as var. *longituba.*

Karyotype: $2n=6M+10T=16$ (Kurita et al. unpub.).

Distribution: endemic to China (Jiangsu). On slopes of hills of low elevation.

In Caldwell's (1979) reference, Fig. 11 (unidentified) No. *289* (left) undoubtedly belongs here. The plant was said to have been imported to Japan from China in the 1940s or even earlier. Caldwell got this plant from a Japanese hobby gardener, Dr. Shuichi Hirao of Kanagawa.

9. Lycoris caldwellii Traub, Pl. Life 13:46, pl.4. 1957. Caldwell, Pl. Life 13:55. 1957; Hsu et al., Fl. Reipub. Pop. Sin. 16(1):24. 1985. TYPE: UNITED STATES. TENNESSEE: Nashville (cult.), *S.Caldwell 552* (HOLOTYPE: TRA); same locality, *S.Caldwell 222* (PARATYPE: TRA). According to Caldwell's remark, the type material was probably taken to the United States from a shipment out of Shanghai, China, before 1949.

Leaves without a whitish stripe in the center. Flowers between the spiderlily-form and funnel-form, in bud peach-colored, opening to pale yellow, changing gradually to creamy white with age. Tepaltube 2–2.2 cm long; tepals oblanceolate, 7–7.5 cm long, slightly undulate margined, recurved, 1.2–1.4 cm broad. Stamens shorter than tepals. Style subequalling tepals.

Phenology: leaves appearing in early spring; scape produced in late August to September.

Karyotype: $2n=6M+10T+11A=27$ (Bose 1957; Liu & Hsu 1989).

Distribution: endemic to southeastern China (Jiangsu, Zhejiang and Jiangxi).

Specimens examined: CHINA. **Zhejiang:** Hangzhou, Hangzhou Bot. Gard. cult., *J.Z. Lin 011* (HZBG).

The leaves of this species lack a whitish stripe or band in the center, which is a distinctive feature of all the species of Subgen. *Lycoris*. Although the karyotype of this species is consistent with that of *L. squamigera*, the gross morphology is quite different from that species.

10. **Lycoris shaanxiensis** Y.Hsu & Z.B.Hu, Acta Phytotax. Sin. 20:196. 1982. Hsu et al., Fl. Reipub. Pop. Sin. 16(1):24. 1985. TYPE: CHINA. Shaanxi, Mt. Qingling, Nanwutaishan, *Z.B.Hu & S.C.Feng 3566* (HOLOTYPE: SHMI). But M.X.Qian of SHMI told the present authors that the type specimens of both *L. shaanxiensis* and *L. guanxiensis* were not in their herbarium.

Leaves strap-shaped, ca. 50 cm long and 0.8 cm broad, without a distinct whitish stripe in the center. Perigone white, with a few pinkish stripes inside and a reddish keel underside of each tepal. Tepaltube ca. 2 cm long; tepals slight ruffled–margined, recurved. Stamens shorter than tepals. Style somewhat exserted.

Phenology: leaves appearing in early spring; scape produced in August to September.

Karyotype: no reports.

Distribution: endemic to China (Shaanxi).

11. **Lycoris guangxiensis** Y.Hsu & G.J.Fan, Acta Phytotax. Sin. 20:196. 1982. Hsu et al., Fl. Reipub. Pop. Sin. 16(1):22, pl.6, fig. 1–2. 1985. TYPE: CHINA. Guangxi, Duan, *Y.Xu. & G.J.Fan s.n.* (HOLOTYPE: SHMI). The type specimen has not been found in SHMI.

Leaves narrow strap-shaped, 24–29 cm long, 1–1.2 cm broad, dark green with a distinct whitish stripe in the center. Perigone yellow, with reddish bands. Tepaltube 1.5–2 cm long; tepals obovate-oblanceolate to oblanceolate, ca. 7 cm long and 1.5 cm broad, narrowing to a claw at base, slightly ruffled-margined, recurved. Stamens subequalling tepals. Style exserted.

Phenology: leaves emerging in early spring; scape produced in July to August.

Karyotype: no reports.

Distribution: endemic to China (Guangxi).

No specimens of this species are available to the present authors. According to the type description, this species is most closely related to *L. chinensis* Traub but differs from that species in its perigone having reddish bands inside, and in its narrower, dark green leaves.

12. **Lycoris chinensis** Traub, Pl. Life 14:44. 1958. Hsu et al., Fl. Reipub. Pop. Sin. 16(1):22, pl.5, fig. 4. 1985; M.Kim & S.Lee, Korean. J. Pl. Taxon. 21:126, fig. 5–6. 1987. TYPE: UNITED STATES. CALIFORNIA: La Jolla, cultivated, *H.P.Traub 585* (HOLOTYPE: TRA). According to Traub's remark, the type plant was grown from a bulb (*P.I. 162443*) furnished by J.L.Creech originally obtained from Sun Yat Sen Memorial Garden in Nanjing, China, in 1948.

Leaves strap-shaped, round at the apex, ca. 35 cm long, ca. 2 cm broad, green with a distinct whitish stripe in the center. Perigone chrome yellow, with a yellowish midrib underside of each tepal. Tepaltube 1.5–2.5 cm long; tepals oblanceolate, 5.5–7.7 cm long, 7–13 mm broad, distinctly crisped-margined and strongly recurved. Stamens subequalling or somewhat exceeding tepals, filament yellowish. Style rose-colored in the upper part.

Phenology: leaves appearing in early spring; scape produced in late July to August. Fruits in September.

Karyotype: $2n=6M+10T=16$ (Bose 1960; Chen & Li 1985; Liu & Hsu 1989).

Distribution: China (Henan, Shaanxi, Sichuan, Zhejiang, and Jiangsu) and southern Korea. On moist slopes in the mountains; ca. 750 m.

Specimens examined: CHINA. **Jiangsu:** Jurong, Baohua Shan, *Jiangsu Natural Pl. Sources Exped. 5426* (HZBG); Yixing, *Y.L.Keng 2562* (PE). **Sichuan:** way from Daheba to Sanquan, *J.H.Xiong & Z.L.Zhou 92976* (SZ). **Zhejiang:** Ningbo, *Y.L.Keng 1117* (FUS); Tianmu Shan, *Y.Y.Ho 24601, 24687, 25259, 29332,* (HZBG); Hangzhou, *S.Y.Chang 858, 1327* (HZBG); same locality, *Hangzhou Bot. Gard.*, cult., *Z.Z.Yu 003, 006, 007, 011, 015, 017* (HZBG).

This species resembles *L. aurea* and *L. traubii* in general appearance, but differs remarkably from them in its foliage appearing in early spring instead of in autumn and winter, in the flowers having a chrome yellow color, and in the stamens subequalling or slightly surpassing the tepals. Both *L. aurea* and *L. traubii* bloom in September to October, later than that of *L. chinensis*.

The Korean plants, which Tae et al. (1987) have mistaken to be "*L. aurea*," are morphologically very similar to typical *L. chinensis*, and the chromosome number is also $2n=16$, but the karyotype is slightly different ($2n=6M+2SM+8T$). These SM type chromosome may have originated from an inversion of a T type chromosome. So the Korean taxon may be derived from the typical Chinese *L. chinensis*. Bose (1966) also reported a SM type chromosome of the same sort in a bulb of *L. chinensis*, but he did not mention the source of material that he examined. A cultivated form called "*L. sperryi*" has also $2n=6M+10T=16$.

13. **Lycoris aurea** (L'Hér.) Herb., Bot. Mag. 47:t.2113. 1821. Hance, J. Bot. 12:262. 1874; Franch. & Sav., Enum. Pl. Jap. 2:44. 1879; Maxim., Bot. Jahrb. 6:79. 1885; Baker, Handb. Amaryll. 40. 1888; Forest, Gard. Chron. Ser.3, 47:12, fig. 15. 1910; Diels, Notes Bot. Gard. Edinburgh 6:192. 1912; Hayward, Pl. Life 13:41. 1957; Koyama, Baileya 7:5. 1959; Icon. Cormophyt. Sin. 5:549, fig. 7928. 1976; Hsu et al., Fl. Reipub. Pop. Sin. 16(1):20, pl.5, fig. 1–3. 1985. TYPE: not cited. According to Alton's (1811) reference, this species was introduced to England from China by J. Fothergill in 1777.

Amaryllis aurea L'Hér., Sert. Angl. 14, pl.15. 1788, with descriptions in Hort. Kew 1:419. 1789; Bot. Mag. 12:t.409. 1798.

13a. Lycoris aurea var. aurea

Leaves ensiform, acutish at the apex, up to 76 cm long and to 2.5 cm broad, dull green, glaucous, with a conspicuous whitish stripe in the center. Scape up to 76 cm long. Spathe-valves lanceolate, 7–8 cm long. Pedicel 15–22 mm long.

Flowers somewhat upright. Perigone cadmium yellow, with a pale green stripe underside of each tepal. Tepaltube 1.2–1.5 cm long, straight; tepals narrowly elliptic, 5–6 cm long, 7–12 mm broad, decidedly crisped-margined, strongly recurved. Stamens yellowish, surpassing tepals about 1/6–1/3. Style exserted, reddish in the upper part.

Phenology: leaves appearing in autumn in flowering time; scape produced in August to September, before leaves.

Karyotype: $2n=10\mathrm{M}+2\mathrm{T}=12$ (Bose 1958); $2n=9\mathrm{M}+4\mathrm{T}=13$ (Bose & Flory 1963, Inariyama 1937); $2n=8\mathrm{M}+6\mathrm{T}=14$ (Liu & Hsu 1989); $2n=7\mathrm{M}+8\mathrm{T}=15$ (Bose & Flory 1963); $2n=7\mathrm{M}+1\mathrm{A}+7\mathrm{T}=15$ (Kurita 1987a); $2n=6\mathrm{M}+10\mathrm{T}=16$ (Liu & Hsu 1989).

Distribution: to China and Indochina; in China in southern Henan, Shaanxi, and Gansu, southern Jiangsu, Zhejiang, Jiangxi, Guangdong, Guangxi, Hunan, western Hubei, Sichuan, Guizhou, and Yunnan. Usually in sheltered moist rocky or grassy slopes along streams and at the edges of forests in the mountains; (110)500–2250 m.

Specimens examined: CHINA. **Gansu:** Wenxian, *Q.X.Li & X.C.Zhao 2420* (PE): Kangxian, *Z.Y.Zhang 16484* (PE). **Guangdong:** Guangzhou, cult. *Y.Tsiang 13268* (PE); Hongkong, Kadoorie farm, brought by Gloria Barretto, *S.Y.Hu 11050* (PE). **Guangxi:** no locality, *Guangxi Pl. Exped. 4034* (PE). **Guizhou:** Huaxi, cult. *Z.Y.Cao 2480* (PE); Jiangkou, southeast side of Mt. Fanjing Shan, *Sino-American Guizhou Bot. Exped. 217* (PE); Xingyi, *Z.S.Zhang & Y.T.Zhang 6516* (PE); Bijie, Baohuixiang, *P.H.Yu 321* (PE); near Panxian, *Anshun Exped. 1298* (PE); Yinjiang, *C.B.Jian 30598* (PE). **Henan:** Jigong Shan, *Forest. Depart. Henan Prov. 353* (PE); Tongyang, *X.Q.Zhang 20211* (PE). **Hubei:** Badong, Shennongjia, *G.X.Fu & Z.X.Zhang 1170* (PE); Fangxian, *C.L.Cheng 538* (FUS); *K.M.Liou 9065, 9092, 9123* (PE); Enshi, *L.Y.Dai & Z.H.Qian 620* (PE). **Hunan:** Yongshan, *L.H.Lui 9475* (PE); Anjiang, *Agri. School 1466* (PE); Nanyue, *Y.Liu 376* (PE); Qiangang, Xuefeng Shan, *Z.T.Li 2721* (PE). **Jiangsu:** Yixing, *W.Z.Fang et al. 248* (SZ). **Zhejiang**: Tianmu Shan, *Y.Y.Ho 25259* (PE); *T.Tang & W.Y.Hsia 500* (PE); *Zhejiang Pl. Sources Exped. 29332* (PE); Hangzhou, *S.Y.Chang 1327* (PE); Hangzhou Bot. Gard., cult. *Z.Z.Yu 009* (HZBG); no locality, *R.C.Ching 5256* (FUS); *5349* (PE). **Sichuan:** Wuxi, *K.L.Chu 1924* (PE); no locality, *T.Tang 23625* (PE); Wanyuan, *P.Y.Li 5584* (PE); Wenchuan, *S.Y.Chen et al. 5896* (SZ); Yaan, *Yaan Exped. 1125* (CDBI); Jieshan, *Jieshan Exped. 78-0751* (CDBI); Jiangjin, *Jiangjin Exped. 519* (CDBI); Huidong, *Huidong Exped. 341* (CDBI); Huili, *Taiping Exped. 414* (CDBI); Fengdu, *Fengdu Exped. 744* (CDBI); Youyang, *Youyang Exped. 506* (CDBI); Wulong, *Wulong Exped. 1302* (CDBI); Pengshui, *Pengshui Exped. 1185* (CDBI); Xiushan, *Xiushan Exped. 1177* (CDBI); Leibo, *Leibo Med. Exped. 967* (CDBI); Xuanhan, *Xuanhan Exped. 1175* (CDBI); Tongjiang, *Tongjiang Exped. 756* (CDBI); Lingshui, *Lingshui Exped. 965* (CDBI); Guanxian, Qingchen Shan, *Z.L.Wu 33955* (PE); Bushi, *Sichuan Econ. Pl. Exped. 5803* (PE); way from Daheba to Yuquan, *J.H.Xiong & Z.L.Zhou 92976* (PE); Chengkou, *T.L.Dai 102283* (PE); Jiange, *T.N.Liou & C.Wang 293* (PE); Mt. Emei, *T.Y.Chow & G.J.Xu 586* (PE); Hechuan, Huaging Shan, *T.H.Tu 5202* (PE); Huidong, *Q.S.Zhao 5799* (SZ); *H.N.Wang 79626* (FUS); without precise locality, *F.T.Wang 22305* (PE); Ebian, *C.W.Yao 3016* (PE). **Shaanxi:** Ziyang, near Liangshuang River, *P.Y.Li 6382* (PE); Taiba Shan, *T.S.Chen 3684* (FUS). **Yunnan:** Jianchuan, Mekong Divide, *G.Forrest 23567* (PE); Gongshan, *T.T.Yu 23023* (PE); Kunming, *T.N.Liou 16381* (PE); Shuangbai, *H.T.Tsai 54346, 54601* (KUN, PE, SZ); Qiujiang Valley, *T.T.Yu 19912* (PE); Jianchuan, *R.C.Ching 23103* (PE); Lunan, *B.Y.Qiu 55917* (PE); Yiliang, *Northeast Yunnan*

Exped. 944 (PE); Gongshan, *Qinghai-Xizang Exped. 9557* (PE); Jianchuan, *R.C.Ching 23103* (KUN); Qiubei, *Kunming Bot. Inst. 61–3777* (KUN); Anning, *C.Y.Wu 231* (KUN); Yiwu, *S.J.Pei 59-10108* (KUN).

Redouté (1822), followed later by Kunth (1850) and Traub and Moldenke (1949), treated *Amaryllis africana* Lam. (=*Lycoris africana* (Lam.), M.J.Roem.) as a synonym of *A. aurea* L'Hér. (=*L. aurea* (L'Hér.) Herb.). Recently, some authors (e.g., Bailey & Bailey 1976; Everett 1983) have adopted *Lycoris africana* (Lam.) M.J.Roem. as the valid name over *L. aurea* on the basis of the fact that *A. africana* Lam. (1783) antedates *A. aurea* L'Hér. (1788). But it should be noted that according to Lamarck's (1783) original description, *A. africana* was cultivated in a garden in Roi and was said to have been introduced from Africa and Madagascar, out of the range as so far known of *L. aurea*. From a morphological point of view, these two names may refer to the same entity. But we are not making the substitution at the present time pending further studies on type material of the taxa involved.

This subtropical species has a relatively wide distribution extending into southeastern Asia, China and Indochina. It is characterized by its long and broad ensiform leaves almost acute at the apex, its cadmium yellow flowers with strongly crisped and recurved tepals, and its moderately exserted stamens. But some of the collections from Sichuan (*F.T.Wang 22305* and *C.W.Yao 3016*) have long exserted stamens.

Five cytoraces ($2n=12, 13, 14, 15, 16$) under the name of *L. aurea* have been reported by various authors (Bose 1958; Bose and Flory 1963; Inariyama 1931, 1932, 1937; Kurita 1987a; Liu & Hsu 1989). But as a result of a reexamination of these cytoraces by Kurita (unpub.), only three of them have been confirmed: $2n=14=8M+6T$, $2n=15=7M+8T$, and $2n=16=6M+10T$. These cytoraces are morphologically distinguishable from one another. The $2n=15$ cytorace has ascending tepals and very narrow leaves acute at the apex. The description of *L. aurea* var. *surgens* Worsley ex Traub & Moldenke as well as the figures of *L. africana* (Lam.) M.J.Roem. published in *Encyclopedia of Horticulture* of New York Botanical Garden (Everett 1983) match well with this cytorace. Kurita (1987a) suggested that this highly sterile cytorace might have originated either from the cytorace having $2n=16$ through centromeric fusion between two T type chromosomes, or might have been produced by crossing between two fertile cytoraces or species having $2n=14$ and $2n=16$. In the $2n=16$ cytorace, the leaves are pendulous and are the largest among all cytoraces (60–80 cm long and 4–6 cm broad) with a blunt apex. This cytorace may be a rheophyte adapted to riverside habitats. The size and shape of leaves of the $2n=14$ cytorace are in the middle of the above two cytoraces, but the midrib on the under surface of leaves is reddish purple, and the central part of each tepal is greenish. Kurita (unpub.) suggested that these cytoraces might not be the simple products of Robertsonian changes of a single species.

For a long time, taxonomists have confused this species with *L. traubii* Hayward, which occurs only in Taiwan and southern Japan (Kurita 1980). Many specimens identified to be "*L. aurea*" in Japanese herbaria belong to *L. traubii*. Hayward (1957) and Kurita (1980) made morphological comparisons of these two species. Kurita et al. (unpub.) recently added that the remains of leaf-bases is prominent at the base of scapes of *L. aurea*, whereas in *L. traubii* there is no such residue.

13b. **Lycoris aurea** (L'Hér.) Herb. var. **surgens** Worsley ex Traub & Moldenke, Amaryllidac.: Amaryll. 180. 1949. TYPE: UPPER BURMA: cultivated at the Royal Hortiucltural Society of England, *Clapham Jukes*, Oct 1904 (Worsley 1928).

All of the tepals ascending.

Karyotype: no reports.

Distribution: Upper Burma.

No specimens of this variety are available to the present authors. Worsley (1928) and Traub and Moldenke (1949) remarked that the foliage is distinct, but they gave no further descriptions. This variety is probably in accord with the cytorace of *L. aurea* having $2n=15$.

13c. **Lycoris aurea** (L'Her.) Herb. var. **angustitepala** Hsu, Kurita, Yu, & Lin, var. nov.

A varietate *aurea* tepalis angustioribus 4–8 mm latis, staminibus longioribus tepalum 1/3–1/2 superantibus differt.

This variety differs from var. *aurea* mainly in having narrower tepals and long-exserted stamens.

TYPE: CHINA. HUBEI: Fengxian, Guanyindong, 88 m, in rock crevices, flowers pale yellow, rare, *K.M.Liou 9230*, 17 Aug 1938 (HOLOTYPE: PE).

Specimens examined: CHINA. **Gansu:** Kangxian, on way from Yangba to Xiaoheba, in rock crevices by a river, alt. 1000 m, scape 0.5 m high, purplish at the base, flowers yellow with black anthers, frequent, 9 Aug 1963, *Z.Y.Zhang 16484* (PE).

14. **Lycoris traubii** Hayward, Pl. Life 13:40. 1957. Traub, Pl. Life 13:44. 1957, and 14:43. 1958, in clavis; Ohwi, Fl. Jap. ed. 2, 384. 1978. TYPE: UNITED STATES. CALIFORNIA: La Jolla, cult., *Hamilton P. Traub 558a* (HOLOTYPE: MO). There is a note on the type specimen that the bulbs of this plant were imported from Japan in 1952 by Sam W. Sayler, Fernandina Beach, Florida.

Lycoris aurea auct. non (L'Hér.) Herb.: Masam. & Hayata, J. Coll. Sci. Univ. Tokyo 22:431. 1906; C.F.Hsieh, Fl. Taiwan 5:94, pl.1289, sub 93. 1978.

Leaves lorate-lanceolate, to ca. 22.5 cm long, 1.2–2.1 cm broad, obtuse at apex, glabrous, not glaucous, with a distinct whitish stripe in the center. Scape to 50 cm long. Spathe-valves ovate, 3–5 cm long. Pedicels 8–9 mm long. Flowers more or less horizontally spreading. Perigone rich orange-yellow, with a deeper band in the center. Tepaltube 1.5–2 cm long, recurved downwards; tepals narrowly oblanceolate, 6.8–7 cm long, 1.3–1.6 cm broad, strongly recurved. Stamens slightly exserted. Style longer than stamens, reddish only on tip.

Phenology: leaves appearing in autumn, about a month later than in *L. aurea;* scape produced in early September to October.

Karyotype: $2n=10M+2T=12$ (Bose 1958; Bose & Flory 1963; Kurita 1987b); $2n=9M+4T=13$ (Bose 1958; Bose & Flory 1963; Kurita 1987b); $2n=8M+6T=14$ (Kurita 1987b).

Distribution: Taiwan and southernmost Japan, including southern Kiushu and Loochoo Islands. On slopes where moisture is sufficient and at edges of forests; to 100 m.

Specimens examined: JAPAN. **Kagoshima Pref.:** Ibusuki, *S. Kurita 891015* (CBM). **Okinawa Pref.:** Yonagunijima Isl., west of Sonai, *K.Schimabukuro & Y.Miyagi 5198* (TI); Okinawa Isl., Kuganiimu, *S.Kurita 931020* (CBM).

CHINA. TAIWAN: Keelung, *S.Inariyama s.n.* (TI).

Kurita (1987b) detected two cytoraces having $2n=12$ and 14 respectively with distinguishable morphological characteristics. The leaves of the race with $2n=12$ are somewhat dark blue-green and the tepals are strongly recurved; in the race having $2n=14$ the leaves are lustrous yellow-green and the tepals are moderately recurved. Based on C-banding pattern, Kurita (1987b) suggested that the sterile cytorace having $2n=13$ may be a hybrid between the two fertile cytoraces having even chromosome numbers.

15. **Lycoris ×albiflora** Koidz. (pro sp.), Bot. Mag. Tokyo 38:100. 1924. Makino, Acta Phytotax. Geobot. 13:18, pl.2. 1943; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 178. 1949; Koyama, Baileya 7:4. 1959; Traub, Pl. Life 22:59. 1966; Ohwi, Fl. Jap. ed. 2, 384. 1978; Hsu et al., Fl. Reipub. Pop. Sin. 16(1):22. 1985. TYPE: Not indicated. Koidzumi remarked that this species was cultivated in Japan and was perhaps spontaneous in the Amamiohshima Island of that country.

Leaves up to 35 cm long, 1.2–1.5 cm broad, somewhat yellowish green with a rather inconspicuous whitish stripe in the center. Flowers pink in bud, opening creamy white, changing to white with age, with a very light orange-yellow stripe in the center of each tepal. Tepaltube ca. 2 cm long; tepals 6.5–7.5 cm long, 1–2.2 cm broad, moderately ruffled-margined, strongly recurved. Stamens long, far exceeding tepals. Style slightly exserted.

Phenology: leaves emerging in autumn; scape produced in mid September to early October.

Karyotype: $2n=5M+1T+11A=17$ (Bose 1960; Kurita 1987a); $2n=5M+1T+11A+1m=18$ (Kurita 1987a).

Distribution: southwestern Japan, mainly in Kyushu. In moist places by streams and hillsides, and disturbed places near human habitation and in graveyards; 30–500 m. Also cultivated as an ornamental in Japan.

Specimens examined: JAPAN. **Kagoshima Pref.:** Kaseda, Tojinbaru, *H.Ohba & S.Akiyama 2627* (TI). **Kumamoto Pref.:** Amakusa, Kawaura, *M.Yamada 2645* (CBM). **Okinawa Pref.:** Iejima Island, *M.Tashiro s.n.* (TI). **Shizuoka Pref.:** Odawara, cult., *S.Kurita s.n.* (CBM).

This species is characterized by the creamy white flowers with long exserted stamens. It is somewhat comparable to *L. radiata*, but that species possesses crimson flowers with narrower tepals and narrower leaves, and leaves with a distinct whitish band in the center.

The karyotype of *L.* ×*albiflora* is very variable. Besides $2n=17$ & 18, complements possessing $2n=16$ (Inariyama 1931) and 19 (3M+5T+11A) have been found in Japan and China. The cytotype having $2n=19$ has been attributed to "*L.* aff. *albiflora* Koidz." by Lin & Hsu (1989) and to "*L.* ×*elegans*" by Lin et al. (1990). *L.* ×*elegans* Liu & Hsu, ined. resembles *L.* aff. *straminea* Lindl. (Lin et al. 1990, Xu et al. 1986,) or "*L. straminea*" (Liu & Xu 1990) very much in gross morphology as well as in karyotype. This has caused much difficulty in identification.

The origin of this highly sterile species with $2n=17$ or 18 is problematical. Inariyama (1932, 1933, 1937) once considered it to be a hybrid between *L. traubii* (mistaken to be *L. aurea*) and *L. sanguinea* in the light of cytological point of view. Based on gross morphology, Makino (1943) supposed it to be a hybrid between *L. radiata* and *L. aurea*. Inariyama (1944), however, had changed his opinion and advocated strongly that the species originated from hybridization between *L. traubii* and *L. radiata* var. *pumila*. This was supported by Takemura (1962a), and especially by Caldwell (1981), who made crossing tests between the said species and as a result brought forth hybrids that were very similar to or almost exactly like *L.* ×*albiflora* in gross morphology. But since *L. radiata* var. *pumila* does not occur in Japan, Kurita (1987a) suggested that the putative parents of *L.* ×*albiflora* (5M+1T+11A) were *L. radiata* (11A) and *L. traubii* (5M+1T). He argued that despite being a triploid sterile plant, *L. radiata* produces some viable pollen occasionally (Koyama 1959). Moreover, the flowering period of the two species overlaps at times. The m type chromosome in the complement of $2n=18$ might come from a race of *L. radiata* possessing such a chromosome together with the other 11 A type chromosomes.

The origination of the cytotype $2n=3M+5T+11A=19$ of *L.* ×*albiflora* is interesting. This cytotype in China probably occurs only in cultivation. It has broader and less wrinkled tepals and shorter stamens. According to Kurita's (1987a) suggestion, it is a hybrid between two diploid species, one with $2n=16$, which produces gametes having 3M+5T, and the other with $2n=22A$, which gives rise to genomes consisting of 11A. Based upon crossing tests, Lin et al. (1990) proved that both *L.* aff. *albiflora* ($2n=19$) and *L.* aff. *straminea* are segregates in the F_1 progeny of the *L. haywardii* × *L. chinensis* combination.

16. **Lycoris** ×**houdyshelii** Traub (pro sp.), Pl. Life 13:45, pl.3. 1957. Hsu et al., Fl. Reipub. Pop. Sin. 16(1):20. 1985. TYPE: UNITED STATES. TENNESSEE: Nashville

(cult.), *S.Caldwell 549* (HOLOTYPE: TRA); same locality, *S.Caldwell 550, 551* (PARATYPE: TRA). Traub remarked that the type material was imported from a Chinese nurseryman in Shanghai, China, in 1948.

Leaves strap-shaped, 30–42 cm long, 1–1.3 cm broad, rounded at the apex, deep green with a slightly distinct whitish midrib. Perigone creamy white, turning whitish with age, sometimes with reddish lines running along tepals or may develop a rose flush, with a greenish midrib underside. Tepaltube 8.5–12 mm long; tepals linear-oblanceolate, up to 5 cm long, 8–10 mm broad, slightly ruffled-margined, recurved. Stamens exceeding tepals ca. 1/3, filaments creamy white, sometimes tinged with pink. Style exceeding the stamens, pink tipped.

Phenology: leaves appearing in autumn, persisting to spring; scape produced in late July to August.

Karyotype: $2n=3M+6T+21A=30$ (Bose 1957); $2n=3M+5T+22A=30$ (Kurita 1987a).

Distribution: endemic to China (Zhejiang, known only in cultivation).

Specimens examined: CHINA. **Zhejiang:** Hangzhou, Hangzhou Bot. Gard., cult., *Z.Z.Yu 008* (HZBG).

A specimen in PE collected in a garden called "Caojiahuayuan" in Shanghai without notes of collector and field number also belongs here.

Kurita (1987a) suggested that this sterile species is a triploid hybrid between *L. longituba*, which produced the gamete having 3M+5T, and another species with an unreduced 22A, which was one of the following: *L. radiata* var. *pumila*, *L. rosea*, *L.* ×*haywardii,* or *L. sprengeri*.

17. **Lycoris straminea** Lindl., J. Hort. Soc. London. 3:76. 1848, nomen subnud., and emend. Traub, Pl. Life 12:42. 1956; Walp., Ann. Bot. Syst. 1:834. 1848–49; Kunth, Enum. Pl. 5:546. 1850; Baker, Handb. Amaryll. 40. 1888; Spreng., Bull. Soc. Tosc. Ortic. 8:326. 1888; Worsley, Gard. Chron. ser. 3, 84:169. 1928; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 178. 1949; Traub, Pl. Life 13:43. 1957, in clavis; Hsu et al., Fl. Reipub. Pop. Sin. 16(1):18, pl.4, fig. 4. 1985. TYPE: CHINA. *Robert Fortune 148* (HOLOTYPE: MO). According to Traub (1956), this species was sent to the Kew Botanical Gardens by Robert Fortune from China in 1845. The first author of the present paper, however, has been able to examine the type specimen of this species at the herbarium of Missouri Botanical Garden. The sheet (MO herb. no. 3149486) actually consisted of two different specimens. Traub's emendation description of *L. straminea* was based on the left hand one, while the right hand one was much slenderer in shape with narrower tepals (ca. 4 mm wide) and longer tepaltube (5.3–5.5 mm).

Leaves strap-shaped, 24–49 cm long, 1.3–2 cm broad, obtuse at the apex, green with an inconspicuous whitish band in the center. Scape up to 22.1 cm long. Perigone with tepals pale straw-colored, with a pink band and a few scattered red dots on the upper surface, changing to white in full blossom. Tepaltube 4–5.5 mm long; tepals linear-oblong, 3.5–4.1 cm long, 5.2–12 mm broad, undulate margined and strongly recurved. Stamens exceeding tepals ca. 1/3. Style long exserted.

Phenology: leaves appearing in autumn; scape produced in August.

Karyotype: no reports.

Distribution: endemic to China (Jiangsu and Zhejiang). In shady places in sparse woods; ca. 100 m.

Specimens examined: CHINA. **Jiangsu:** Nanjing, *Z.P. Wu s.n.* (JSBI). **Zhejiang:** Hangzhou, Feilaifeng, *H.Q.Zhu 859 & 1328* (HZBG); same locality, Hangzhou Bot. Gard., cult., *J.Z.Lin 001* (HZBG). **No locality:** *Z.B.Wang 11602* (PE).

This species seems somewhat like *L.* ×*albiflora*, but differs from that species in that the foliage appears in autumn, as well as by its smaller, pale-straw-colored flowers with pink stripes and red dots, and by its shorter tepaltube.

This species may also be of hybrid origin, and the type specimens were probably from segregates of the F_1 progeny of *L. radiata* var. *pumila* and a species with $2n=16$ combination. Lin et al. (1990) brought forth a hybrid between *L.* ×*haywardii* ♀ and *L. chinensis* ♂, and they have named the hybrid *L.* aff. *straminea*. It matches typical *L. straminea* in many respects in gross morphology and possesses $2n=3M+11T+5A=19$. Their investigation has shown that as much as 81.9% of the pollen of this sterile hybrid is shriveled. Besides, this hybrid not only failed to set seed under natural conditions, but failed to do so even under conditions of artificial pollination.

18. **Lycoris elsiae** Traub, Pl. Life 14:43. 1958. TYPE: UNITED STATES. TENNESSEE: Nashville, cult., *S.Caldwell 593* (HOLOTYPE: TRA); same locality, *S.Caldwell 594* (PARATYPE: TRA). Traub remarked that the type material was sent to the United States from Japan. There are two specimens (*W.H.Preston,Jr. 964, 965*) in MO (Herb. nos. 628, 629) transferred from Traub Herbarium of the American Plant Life Society under the name of *L. elsiae* Traub collected from Japan. Both specimens have flowers "white, slightly yellow-pink-tinged," and are not in accord with the type description of the species.

Leaves linear, 32–36.5 cm long, 1.2–1.3 cm broad, rounded at the apex, dark green. Scape 30–70 cm long. Perigone soft salmon-colored, finally fading to a flesh color, with a deep pinkish band tinged with creamy and yellow along the center of each tepal. Tepaltube 1.2–1.3 cm long; tepals oblanceolate, ca. 4 cm long, up to 7 mm broad. Stamens exceeding the perigone. Style longer than stamens.

Phenology: leaves appearing in autumn; scape produced in August to early September.

Karyotype: $2n=17$ (Bose 1960; Bose & Flory 1963).

Distribution: endemic to Japan.

The identity of this Japanese species is not yet clear. It has scarcely been included in any published Japanese floras. It is morphologically somewhat comparable to *L.* ×*houdyshelii*, but differs from that species in flower color and a longer tepaltube. It may be a hybrid between *L. traubii* and *L. sanguinea* var. *kiusiana*, both of which occur in the southern part of Kyushu.

19. Lycoris radiata (L'Hér.) Herb., Bot. Mag. 47:t.2113. 1821. Bot. Reg. 4, Append. 20, pl.596. 1821; Hance, J. Bot. 12:262. 1874; Franch. & Sav., Enum. Pl. Jap. 2:44. 1878; Maxim., Bot. Jahrb. 6:78. 1885; Baker, Handb. Amaryll. 40. 1888; Spreng., Bull. Soc. Tosc. Ortic. 8:326. 1888; Bretschneider, Hist. Eur. Bot. Disc. China 1:509. 1898; Yashiroda, Gard. Chron. ser. 3, 38:9, fig. 4. 1930; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 177. 1949; Koyama, Baileya 7:2. 1959; Icon. Cormophyt. Sin. 5:549, fig. 792. 1976; Ohwi, Fl. Jap. ed.2, 384. 1978; M.Kim & S.Lee, Korean. J. Pl. Taxon. 21:11. 1991.

Amaryllis radiata L'Hér., Sert. Angl. 15. 1788.
Nerine japonica Miq., Ann. Mus. Bot. Lagduno-Batavum. 2:139. 1865–66.
Lycoris terracciani Dammann, Cat.44:4. 1889.
Lycoris radiata (L'Hér.) Herb. var. *terracciani* Dammann, l.c.

19a. Lycoris radiata var. **radiata** Type: not indicated. Baker (1988) remarked that this species was observed by Kaempfer as early as 1712 and was introduced to English gardens in 1750. The type material was most probably from China.

Leaves narrow strap-shaped, up to 50 cm long, 3–8 mm broad, obtuse at apex, deep green with a whitish stripe in the center. Scape 30–60 cm long. Perigone bright red. Tepaltube 5–8 mm long; tepals narrow oblanceolate, 4–4.5 cm long, 5–6 mm broad, strongly crisped-margined and recurved. Stamens 2–2.5 times the length of tepals. Style long exserted.

Phenology: leaves appear in autumn and wither in April; scape produced in late September to early October.

Karyotype: $2n=33\mathrm{A}=33$ (Bose 1959; Bose & Flory 1963; Fukuda et al. 1980; Inariyama 1931, 1933, 1937, 1951; Koyama 1962; Kurita 1987c; Liu & Hsu 1989; Nishikawa et al. 1979; Nishiyama 1928); $2n=1\mathrm{M}+31\mathrm{A}+1\mathrm{m}=33$ (Bose 1963; Kurita 1987c); $2n=31\mathrm{A}+1\mathrm{M}'=32$ (Kurita 1987c).

Distribution: Japan (Aomori and southwestward), Korea, China, and Nepal. In moist, often disturbed places such as edges of paddy fields, margins of plantations, waste places around dwellings, and graveyards; to 800 m in Japan. Extensively naturalized in southeastern United States.

Specimens examined: CHINA. **Anhui:** Chuxian, Langya Shan, *Z.Z.Ding & J.S.Yue 0681* (PE); Jinzhai, *S.X.Shen 1101* (ACE); Huang Shan, *L.G.Fu 520* (JSBI); *R.C.Ching s.n.* (NJU); Shucheng, *East China Bot.Station 4620* (JSBI); Jixi, *X.L.Liu 057* (PE). **Fujian:** Shanghang, *L.G.Lin 6960* (PE); *Amoy Univ. Fujian Exped. 1195* (PE); Nanjing, *Amoy Univ. Fujian Exped. 64564* (FUS); Ninghua, *Fudan Univ. Fujian Exped. 91974* (FUS); Shaxian, *Fudan Univ. Fujian Exped. 53473* (FUS); no locality, *Y.Ling 2585* (PE); Shucheng, *East China Bot. Stat. 4620* (PE). **Guangdong:** Liannan, *P.X.Tan 59386* (PE); Xinfeng, *L.Deng 8147* (PE). **Guangxi:** no locality, *Inst. Bot. Guangxi Exped. 3965* (PE). **Guizhou:** Jiangkou, Xuefeng Shan, on the south side of Mt. Fanjing Shan, *Sino-American Guizhou Bot. Exped. 844* (PE); same locality, Daiyenfeng along the Kaitu River on the southwest side of Mt. Fanjing Shan, *Sino-American Guizhou Bot. Exped. 1133* (PE); Xishui, *Bijie Exped. 1577, 1712* (PE); Hexian, *Anshun Exped. 1299* (PE). **Hubei:** Lichuan, *R.Y.Dai & Z.H.Qian 920* (PE); *G.X.Fu & Z.S.Zhang 1745* (PE); Qianshih, *C.C.Ho s.n.* (PE); Xuanan, *H.J.Li 4662* (PE); Fangxian, *K.M.Liou 8972, 9231* (PE); *C.L.Cheng 509* (FUS); *G.B.Hu 537* (FUS); no locality, P.Y.Li *5052* (PE); Zhuxi, *P.Y.Li 9504* (SZ). **Hunan:** Baojing, *L.H.Liu 9762* (PE); Yizhang, *S.Q.Chen 1987* (PE, SZ). **Jiangsu:** Nanjing, *K.L.Chu 318* (PE); *W.Z.Fang* et al. *352* (SZ); *Z.R.Wang 80* (FUS); *X.C.Sun 5* (PE); Jiangning, *J.S.Yue 0561* (PE); Yixing, *W.Z.Fang 196* (PE); Shanghai, Jiangwan, *T.N.Yan 10412* (FUS). **Jiangxi:** Shangrao, *S.S.Lai & M.X.Nie 4750* (FUS, PE); Lushan, *H.C.Cheo 98* (NJU); *F.T.Wang s.n.* (PE); *K.C.Kuan 74250* (PE); *H.H.Hu 2212* (PE); Nanchang, *S.H.Hsiung* 666 (PE); Anju, Wugong Shan, *J.S.Yue 3285* (PE); Yingtan, *Jiangxi Med. Exped. s.n.* (PE); Shangyou, *Jiangxi Exped. 0638* (PE); Jinggang Shan, *S.S.Lai 5025* (FUS); Xinning, *Y.B.Luo 3233* (PE). **Shaanxi:** way from Longwan to Shiquan, *B.Z.Guo 2133* (PE); Xixiang, *T.N.Liou & P.C.Tsoong 3969* (PE); Mianxian, *K.T.Fu 3936* (PE). **Sichuan:** Xiushan, *Xiushan Exped. 1136* (CDBI); Yaan, *Yaan Exped. 1047* (CDBI); Rongjing, *Rongjing Exped. 78-0724* (CDBI); Tianquan, *Tianquan Exped. 78–754* (CDBI); *W.P.Fang 3413* (PE); *K.C.Guan & W.T.Wang 3451* (PE); Hanyuan, *Hanyuan Exped. 0923* (CDBI); Eazu, *Dazu Exped. 0858* (CDBI); Dazhu, *Dazhu Exped. 0818* (CDBI); Xuanhan, X*uanhan Exped. 0467, 0845* (CDBI); Kaijiang, *Kaijiang Exped. 0824* (CDBI); Daxian, *Daxian Exped. 0874* (CDBI); Youyang, *Youyang Exped. 1153* (CDBI); Wulong, *Wulong Exped. 1347* (CDBI); Pengshui, *Pengshui Exped. 1104* (CDBI); Mt. Emei, *T.T.Yu 23023* (PE); *G.H.Yang 57300* (PE); *C.W.Yao 5121* (PE, SZ); *W.P.Fang 3381* (PE); *14867* (SZ); *G.X.Xing & K.Y.Lang 1712* (PE); *W.P.Fang et al. 33431* (PE); *Y.H.Tao 51912* (SZ); Wuxi, *G.H.Yang 59502* (FUS, PE); Baoxing, *K.L.Chu 3821* (PE); *C.Pei 8245* (PE); Nanchuan, Jinfu Shan, *J.H.Xiong & Z.L.Zhou 93652* (PE, SZ); Guanxian, Qingchen Shan, *Z.R.Wu 33956* (PE); Zhaohua, *Y.Q.He 1704* (PE); Jincheng Shan, *Sichuan Econ. Pl. Exped. south group 89* (PE); Hefeng, *H.J.Li 8018* (PE); Leshan, *Z.T.Guan 6301* (PE); Chongqing, Beibei, *Z.L.Chou & Z.He 1392* (SZ); Fengjie, *Z.X.Gao & H.F.Zhou 26975* (SZ); Xuanen, *H.J.Li 4662* (SZ); no locality, *T.T.Yu 2565* (FUS); Chengkou, *T.R.Dai 102283* (FUS). **Zhejiang:** Lishui, *S.Y.Chang 6356* (FUS, HZBG, PE); Panshan, *T.N.Liou 8019* (PE); Siming Shan, *Y.Y.Ho 27528* (HZBG, PE); *27746* (PE); Changhua, *Y.Y.Ho 26318* (HZBG, PE); Tianmu Shan, *H.Q.Zhu 00377* (HZBG); *Y.Y.Ho 25368, 26318* (HZBG, PE); *25609* (HZBG); *Zhejiang Pl. Resources Exped. 28860* (HZBG,PE); Yandang Shan, *S.G.Chen 461* (FUS); Pingyang, *Y.Y.Ho 24736* (HZBG); *D.X.Zuo et al. 24644* (JSBI); Tiantai Shan, *Y.Y.Ho 27746* (HZBG); Suichang, *Zhejiang Pl. Resources Exped. 26878* (HZBG); Longquan, *Y.Y.Ho 21682* (HZBG); Jingning, *Y.Y.Ho 24289* (HZBG); Hangzhou, *S.Y.Chang 0659, 0857, 1202, 1448* (HZBG); Hangzhou Bot. Gard., cult., *J.Z.Lin 005, Z.Z.Yu 030* (HZBG).

JAPAN. **Chiba Pref.:** Awaamatsu, Kiyosumi-yama, *S.Kurita 84925* (CBM). **Kanagawa Pref.:** Hakone, *T.Sawada 2340* (TI). **Kyoto Pref.:** Yagi-cho, Hunai-gun, *G.Murata 19657* (PE). **Miyagi Pref.:** Sendai, Tomioka, *H.Hara s.n.* (TI). **Sagami Pref.:** Enoshima, *S.Momose 354* (PE). **Wakayama Pref.:** Nishimuroo-gun, Tanabe-cho, *J. Nakajima 15923* (TI); **Ooita Pref.**, Yabakei, *M.Togashi 7451* (TI); **Shiga Pref.**, Kohga-gun, Shigarakimachi, Asamiya, *H.Ohba et al. 9048* (TI). **Yamaguchi Pref.:** Kuniyoshiki-gun, Oouchimura, Yada, *S.Nikaido 107* (TI).

This distinctive species is characterized by its very narrow leaves, bright red flowers possessing narrow, strongly crisped-margined and recurved tepals, and the very much exserted stamens and styles.

This is probably the most widespread species of *Lycoris*. It occupies a large distribution area in China, mainly in the southern part of the Yangtze River. In Japan, it occurs everywhere except Hokkaido. The broad distribution of this sterile triploid is largely due to its strong vegetative reproduction-propagation carried on by the rapid formation of new lateral bulbs.

But this triploid *L. radiata* var. *radiata* resembles the diploid var. *pumila* Grey (see below) very much in gross morphology; they are difficult to differentiate one from another in the field or in herbarium. Accordingly, many of specimens under the name *L. radiata* may actually be *L. radiata* var. *pumila*. The ecological preference of these two taxa, however, is quite different: *L. radiata* var. *radiata* grows usually in disturbed habitats such as edges of paddy fields, margins of plantations, waste places around dwellings, and graveyards, whereas *L. radiata* var. *pumila* grows in more natural habitats such as open slopes, shaded places by streams, sparse woods, etc.

With regard to the origin of this triploid *L. radiata* ($2n=33$), the most common way would be the hybridization of a diploid with a tetraploid. But because tetraploids have never been found in this species, Liu & Hsu (1989) suggested that *L. radiata* originated from the combination of an unreduced gamete of a diploid with a normal gamete of another diploid of *L. radiata* var. *pumila* ($2n=22$).

This sterile species was supposed to be an autotriploid (Inariyama 1951; Nishiyama 1928). Kihara & Koyama (1954) indeed obtained triploid offspring of *L. radiata* by self-pollination. But Kurita (1987c) argued that it is structurally heterozygous at least with regard to the satellite chromosomes and the four chromosomes carrying rather smaller short arms so far as somatic karyotype is concerned.

Koyama (1959), Kurita (1987c), and Maekawa (1943), suggested strongly that *L. radiata* var. *radiata* must have been originated in China and was introduced into Japan by people. The diploid *L. radiata* var. *pumila* occurs only in China and has never been found in Japan and elsewhere. *L. radiata* var. *radiata* has long been known as a hardy plant since ancient time, and usually occurs in habitats disturbed by people in both China and Japan. In America, it is cultivated outdoors in the southeastern states and on the Pacific coast.

A cultivar with white flowers has been reported. There is a picture of this cultivar in Creech's (1952) paper. Recently, a new form of *L. radiata* var. *radiata* was proposed by Yonezawa (1989): forma *bicolor*, the tepals of which were rose-colored and white-margined. The type specimens of this new form were all collected from Kyoto City of Honshu, Japan.

19b. Lycoris radiata (L'Hér.) Herb. var. **pumila** Grey, Hardy Bulbs 2:58. 1938. Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 178. 1949. Type: not indicated.

This fertile diploid taxon resembles var. *radiata* in external morphology and is very difficult to discriminate from it. So it is quite evident that many specimens cited under *L. radiata* var. *radiata* actually belong here.

Karyotype: $2n=22A=22$ (Bose 1958; Hsu et al. 1984; Inariyama 1951; Koyama 1962; Kurita 1987a; Liu & Hsu 1989; Nishikawa et al. 1979; Takemura 1962a; Yoshida 1972).

Distribution: endemic to China (Shaanxi, Henan, Anhui, Jiangsu, Zhejiang, Jiangxi, Fujian, Guangdong, Guangxi, Hunan, Hubei, Sichuan, Guizhou, and Yunnan). Often in open moist slopes, shaded wet places by streams, sparse woods, and sandy flood lands; 50–1000 m in eastern, central, and southern China; to 2500 m in southwestern China.

This variety hybridizes with many other species of *Lycoris* and gives rise to fertile hybrids. According to Kurita (1987a), hybrids between this variety and *L. sprengeri* have been called "*L.* cv. *Sprenpumila*" and are well known to be fully fertile in spite of the morphological disparity of the parental taxa. Hybrids between *L. radiata* var. *pumila* and *L. chinensis*, *L. longituba*, or *L.* aff. *straminea*, have various rates of fertility (Lin et al. unpub.).

19c. **Lycoris radiata** (L'Her.) Herb. var. **kazukoana** Yonezawa, J. Phytogeogr. Tax. 37(2):73, fig. 1, 1989. TYPE: JAPAN. KYOTO PREF.: Honshu, Matsugasaki, Sakyoku, Kyoto City, *K. Yonezawa & N. Yonezawa s.n.* (HOLOTYPE: in Kana no. 130006); same locality, *N. Yonezawa 10100, 10120* (paratypes: in Kana nos. 130005, 130006).

This variety differs from var. *radiata* in its flowers being smaller and pale red or becoming whitish in color, and the tepals 1.5–3.2 cm long and 2–5 mm broad, only slightly reflexed.

Phenology: scape produced in late September to October.

Karyotype: no reports.

Distribution: endemic to Japan; 70–250 m.

20. **Lycoris** ×**rosea** Traub & Moldenke (pro sp.), Amaryllidac.: Tribe Amaryll. 178. 1949. Hsu et al., Fl. Reipub. Pop. Sin. 16(1):20, pl.4, fig. 5–6. 1985. TYPE: CHINA? Not cited or mention by Traub and Moldenke (l.c.).

Leaves strap-shaped, up to 44 cm long, 7–11 mm broad, rounded at apex, light green with an indistinct whitish stripe in the center. Scape 30–60 cm long. Perigone rose-colored. Tepaltube 1–1.2 cm long; tepals oblanceolate, 4–6 cm long, 7–8 mm broad, ruffled at the base, slightly recurved. Stamens exceeding tepals ca. 1/6.

Phenology: leaves emerging in autumn; scape produced in September.

Karyotype: $2n=22A=22$ (Hsu & Huang 1984; Liu & Hsu 1989).

Distribution: endemic to China (Jiangsu). In sparse second growth forest of low hills.

Specimens examined: CHINA. **Jiangsu:** Shanghai, Sheshan, *G.J.Fan s.n.* (PE); same locality, Hengshan, *Y. Hsu et al. 63918* (SHMI). **Zhejiang:** Hangzhou Bot. Gard., cult., *J.Z.Lin 004*(HZBG).

This species is characterized by its rose-colored flowers and by its stamens only 1/6 longer than the tepals. It is somewhat comparable to *L. radiata* var. *radiata* and var. *pumila*, but in those taxa the flowers are bright red and the tepals are narrower and strongly crisped-margined and recurved.

Lycoris ×*rosea* is most probably a natural hybrid. From the karyological point of view, Kurita is of the opinion that this species must be the hybrid of *L.*

radiata var. *pumila* ($2n=22A$) and *L. sprengeri* ($2n=22A$). His advocation is supported by Lin et al. (unpub.), who have made a crossing between the two taxa and as a result have brought forth a hybrid that is fertile and accords well in gross morphology with *L.* ×*rosea*.

EXCLUDED TAXA

Lycoris albiflora Koidz. cv. *Lactiflora*
Belongs to *L.* ×*albiflora* in its broad sense.

Lycoris "*cinnabarina*" (sphal. "*cinnabarinum*," a "catalog" name)
This species, reported only in cultivation, is very similar to *L. sanguinea* Maxim. Hunt (1963) referred it to be *L. sanguinea* var. *cyrtanthiflora* Hort. Caldwell (cf. Easterly 1969) said that it might turn out to be *L. kiusiana* Makino (= *L. sanguinea* Maxim. var. *kiusiana* (Makino) Koyama). Easterly (1969) reported the karyotype of *L.* "*cinnabarina*" to be $2n=21A+1M$, slight different from that of *L. sanguinea*. Williams (1983), however, suggested that it was most likely to be a hybrid between *L. sanguinea* × *L. traubii*, with a karyotype of $2n=14T+4M=18$.

Lycoris ×*elegans* Lin, Yu, & Hsu in S.A.He et al. (ed.), Proc. Intern. Symp. Bot. Gard. 565. 1990, nom. nud. =*L. sprengeri* ♀ × *L. chinensis* ♂ belongs to *L.* ×*albiflora* in its broad sense.

Lycoris flavescens M.Kim & S.Lee, Korean J. Pl. Taxon. 21:127. 1991.
This species is probably a hybrid between *L. sanguinea* var. *koreana* and *L. chinensis*.

Lycoris hyacinthina Herb., Bot. Mag. 47:t.2113. 1819 = *Griffinia hyacinthina* Ker-Gawl.

Lycoris ×*jacksoniana* Traub, Pl. Life 20:52. 1964 = *L. sprengeri* × *L. radiata* (probably var. *pumila*)

Lycoris josephinae Traub, Pl. Life 21:63. 1965, and 22:60. 1966.
The type material (*Traub* 792, holotype) was collected in Sichuan, China. According to the type description, there seems little difference in morphological characters deserving specific consideration between *L. josephinae* and *L. radiata*.

Lycoris ×*lajolla* Traub, Pl. Life 19:50. 1963 = *L. aurea* × *L. traubii*.

Lycoris radiata Miq., Ann. Mus. Bot. Lugduno-Batavum 2:139. 1865–66 = *Ungernia trisphaera* Bunge.

Lycoris sewerzowii Regel, Bull. Soc. Not. Moscou. 41:435. 1868 = *Ungernia sewerzowii* (Regel) Fedtsch. ex Vvedensky.

Lycoris ×*woodii* Traub & Moldenke, Pl. Life 13:85. 1957 = *L. radiata* ♀ × *L. traubii* ♂.

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NOTES ON THE GENUS *CYBIANTHUS* SUBGENUS *CYBIANTHUS* (MYRSINACEAE) IN COLOMBIAN AMAZONIA

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ABSTRACT

Studies of Myrsinaceae in Colombian Amazonia have revealed two new species in the genus *Cybianthus* subgenus *Cybianthus*: *C. barbosae* Pipoly and *C. ruforamulus* Pipoly. They are described and illustrated herein, and their phylogenetic relationships are discussed.

RESUMEN

Al estudiar las *Myrsinaceae* de la amazonía colombiana, se descubrieron dos especies nuevas, pertenecientes al genero *Cybianthus* subgénero *Cybianthus*. Se describen *Cybianthus barbosae* Pipoly y *C. ruforamulus* Pipoly, así mismo se ilustran y se discute su parentesco.

The genus *Cybianthus* Martius contains ten subgenera and perhaps 150 species (Pipoly 1987, 1991, 1992). Subgenus *Cybianthus* contains approximately 52 species, including 7 Peruvian ones as yet undescribed. The subgenus is distributed in the Andes from Colombia to Bolivia, thence eastward through the Guayana Floristic Province (sensu Maguire 1979) to French Guiana and southeastward through Amazonia to southeastern Brazil. The subgenus is defined by a vestigial pistillode in staminate flowers, basifixed anthers as wide or wider than long, and a staminal tube which is developmentally fused to the corolla tube; the stamens thus appearing epipetalous.

During phytodiversity studies in the Amazon Basin of Colombia, concomitant with floristic and monographic studies of the genus *Cybianthus* for *Flora Neotropica* and *Flora de Colombia*, I have encountered the following new species, described herewith.

Cybianthus barbosae Pipoly, sp. nov. (Fig. 1)

Propter ramulos angulatos rufo-stellato-tomentosos, folia pseudoverticillata, lobos calycinos late ovatos vel suborbiculares ad apicem rotundatos vel truncatos, antheras latiores quam longiores ad apicem obtusas vel truncatas *C. venezuelanum* arcte affinis, sed ab eo ramulis dense rufo-stellato-tomentosis et glanduloso-lepidotis (non solum rufo-stellato-tomentosis), laminis membranaceis (non chartaceis), petiolis marginatis aliquantum pulvinatis (non canaliculatis attenuatis) 0.5–1 (nec 1.5–2.5) cm longis, calyce chartaceo (non carnoso) 1.2–1.4 (nec 0.9–1.1) mm longo, corolla chartacea (non carnosa) 1.8–2.5 (nec 1.6–1.8) mm longa, corollae tubo

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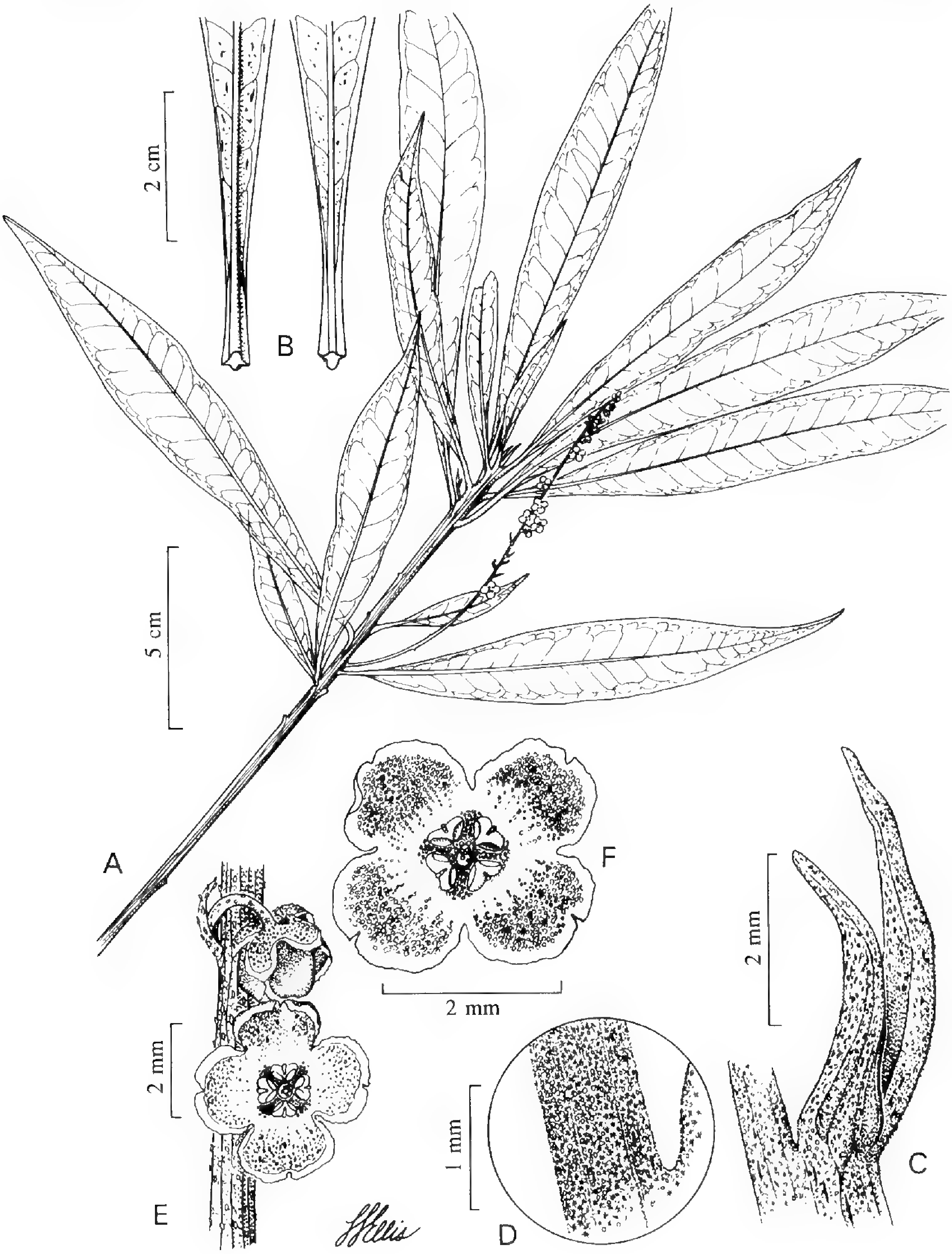

FIG. 1. *Cybianthus barbosae* Pipoly. A. Habit. B. Adaxial and abaxial leaf bases, showing marginate, pulvinate petiole, punctations and decurrent leaf base. C. Branchlet apex, showing tomentum. D. Branchlet close-up, showing stellate tomentum and translucent glandular-lepidote scales. E. Portion of inflorescence, showing floral habit, linear floral bracts, cylindrical pedicels, hyaline calyx lobe margins, and notched apex of corolla lobes. F. Staminate flower, showing glandular granules on corolla tube and lobes, quadrate corolla tube, and prominent ventral punctations on anther connectives. A–F. drawn from holotype.

quadrato (nec tereti), lobis corollinis depresso-ovatis (nec late triangularibus), denique antheris late triangularibus (non quadratis) statim separabilis.

Shrub or small tree to 2 m tall; growth following Rauh's architectural model. Branchlets angulate, 3–4 mm diam., with prominent, narrow longitudinal ridges, densely rufous-stellate and translucently glandular-lepidote, the tomentum persistent. Leaves pseudoverticillate; leaf blades membranaceous, linear-lanceolate, very narrowly oblanceolate or rarely oblong, (10–)15–22(–27) cm long, 2–3.5 cm wide, apex long-attenuate or acuminate, the acumen 1.5–2.5 cm long, base long attenuate and cuneate, decurrent on the petiole, the blade bullate when fresh, subbullate when dry, nitid, minutely and sparsely orange-punctate above, below densely pellucid-punctate, sparsely black-punctate-lineate and with scattered stellate trichomes below, venation brochidodromous, costa slightly raised above, prominently raised below; secondary veins 18–24 pairs, deeply impressed above, prominently raised below, the margin irregular, undulating, flat; petioles marginate, 0.5–1 cm long, sparsely stellate above, densely stellate below, slightly pulvinate at base, glabrescent. Staminate inflorescence a simple, erect raceme 8–11 cm long at maturity, the rachis and pedicels densely rufous-glandular-granulose and rufous-stellate-puberulent; inflorescence bract unknown; floral bracts membranaceous, linear, (1.5–)2–2.4 mm long, 0.2–0.3 mm wide, equal to or longer than the pedicel, apex subulate, glabrous above, densely stellate below, carinate, the margin entire, with scattered stellate hairs; pedicel cylindrical, thin, (1.5–)2–2.3 mm long, densely glandular-granulose and with a few scattered stellate hairs, glabrescent. Flowers chartaceous, 4-merous, green, pendent at maturity; calyx 1.2–1.4 mm long, deeply divided, tube 0.3–0.4 mm long, lobes very widely obovate to suborbicular, symmetric, 0.9–1.1 mm long, 0.8–1.1 mm wide, translucent, apex broadly rounded to truncate, thickened medially, densely and prominently orange-punctate, abruptly constricted basally, the margin white to hyaline, irregularly erose, sparsely glandular-ciliate; corolla subrotate, 1.8–2.5 mm long, translucent, the tube quadrate in cross-section, 1–1.1 mm long, densely rufous-glandular-granulose and rugose without, especially on the surface alternate with the calyx lobes, densely translucent-glandular-granulose within on surface alternate with anthers, the lobes depressed-ovate, 0.8–1.4 mm long, 1.8–2.2 mm wide, apex very broadly rounded to truncate, with at least one apical notch, densely and prominently orange-punctate and rufous-glandular-granulose without, densely translucent glandular-granulose within except near base; anthers widely triangular, apparently sessile and epipetalous (the staminal tube not easily discernible from corolla tube), 0.4–0.6 mm long, 0.8–1 mm wide, apex obtuse, base truncate, appearing truncate at anthesis, birimose, dehiscent by large terminal pores opening into wide longitudinal slits for ca. 3/4 anther length, connective adnate to corolla tube adaxially, densely red-punctate abaxially; pistillode conic, 0.3–0.6 mm long, 0.2–0.4 mm diam., terete, hollow, apex translucent-glandular-granulose. Pistillate inflorescence unknown. Fruit unknown.

TYPE: COLOMBIA. AMAZONAS. Municipo de Leticia: Parque Nacional Natural Amacayacu, Quebrada Agua Pudre, ca. 1.5 km NE of Quebrada mouth at río Amacayacu, permanent 25-hectare plot, 03°47'S, 70°15'W, 200–220 m, 18 Nov 1991 (stam. fl), *J. Pipoly et al. 16450* (HOLOTYPE: COL; ISOTYPES: BRIT, MO, K, TEX, US).

PARATYPES: COLOMBIA. AMAZONAS. Municipio de Leticia: Parque Nacional Natural Amacayacu, Quebrada Agua Pudre, ca. 1.5 km NE of Quebrada mouth at río Amacayacu, permanent 25-hectare plot, 03°47'S, 70°15'W, 200–220 m, 18 Nov 1991 (ster.), *J. Pipoly et al. 15790* (COL, FMB, MO); (ster.), *J. Pipoly et al. 16509* (BRIT, COL, FMB, MO, TEX); (stam. fl), *J. Pipoly et al. 16513* (BRIT, COL, F, FMB, MO, TEX); (stam. fl), *J. Pipoly 16528* (BRIT, COL, FMB, MO).

Distribution, ecology and conservation status: Cybianthus barbosae grows in tall wet forest on lateritic soils and is presumably endemic to the Leticia area. The canopy of the forest in which it occurs is approximately 35 m in height, and the dominants include *Virola*, *Osteophloem* and *Iryanthera* (Myristicaceae), *Eschweilera* (Lecythidaceae), *Licania* (Chrysobalanaceae), and *Parkia* (Mimosaceae). *Cybianthus barbosae* grows specifically along small streambanks on rotten logs, at 200–220 m elevation. In the area of a quantitative inventory in the park, I observed six individuals of *C. barbosae* per hectare, a relatively high frequency for a species of Myrsinaceae.

Etymology: This species is dedicated to César Eduardo Barbosa Castillo, Director of the Herbarium, Unidad Investigativa Federico Menem (FMB), Mininstry of Environment, Colombia. César Barbosa is a specialist in *Pithecellobium* and Rhizophoraceae of Colombia, and a keen student of the Amazonian flora. He first spotted *Cybianthus barbosae* growing next to a 40 meter tree of *Sterigmapetalum* (Rhizophoraceae) sp. nov.

Widely ovate or suborbicular calyx lobes, rounded or truncate apically, anthers as wide as long and obtuse or truncate at apex, and rufous-stellate-tomentose, angulate branchlets indicate that *Cybianthus barbosae* is most closely related to *C. venezuelanus*, a taxon dispersed from Guyana west through Amazonian Brazil and Venezuela to Colombia, thence south through the Andes to Peru. The widely trangular anthers, quadrate corolla tube, glandular granules interspersed with rufous stellate hairs on the branches, marginate and somewhat pulvinate petioles, and the chartaceous and longer perianth, immediately separate *C. barbose* from *C. venezuelanus*.

Cybianthus ruforamulus Pipoly, sp. nov. (Fig. 2)

Ob folia late oblanceolata, flores subsessiles, antheras sessiles subdeltatas, calycis corollaeque lobos latiores quam longiores *C. minutiflorum* simulans, sed ab eo laminis chartaceis (non membranaceis) rufo-hirtello-(nec stellato-) tomentosis, petiolis 1.7–2 (non 2–3) cm longis, perianthio chartaceo marronino-viridi (non carnoso flavido), denique antheris subdeltatis (non obcordatis) glabris (nec citreo-glanduloso-granulosis) facile cognoscitur.

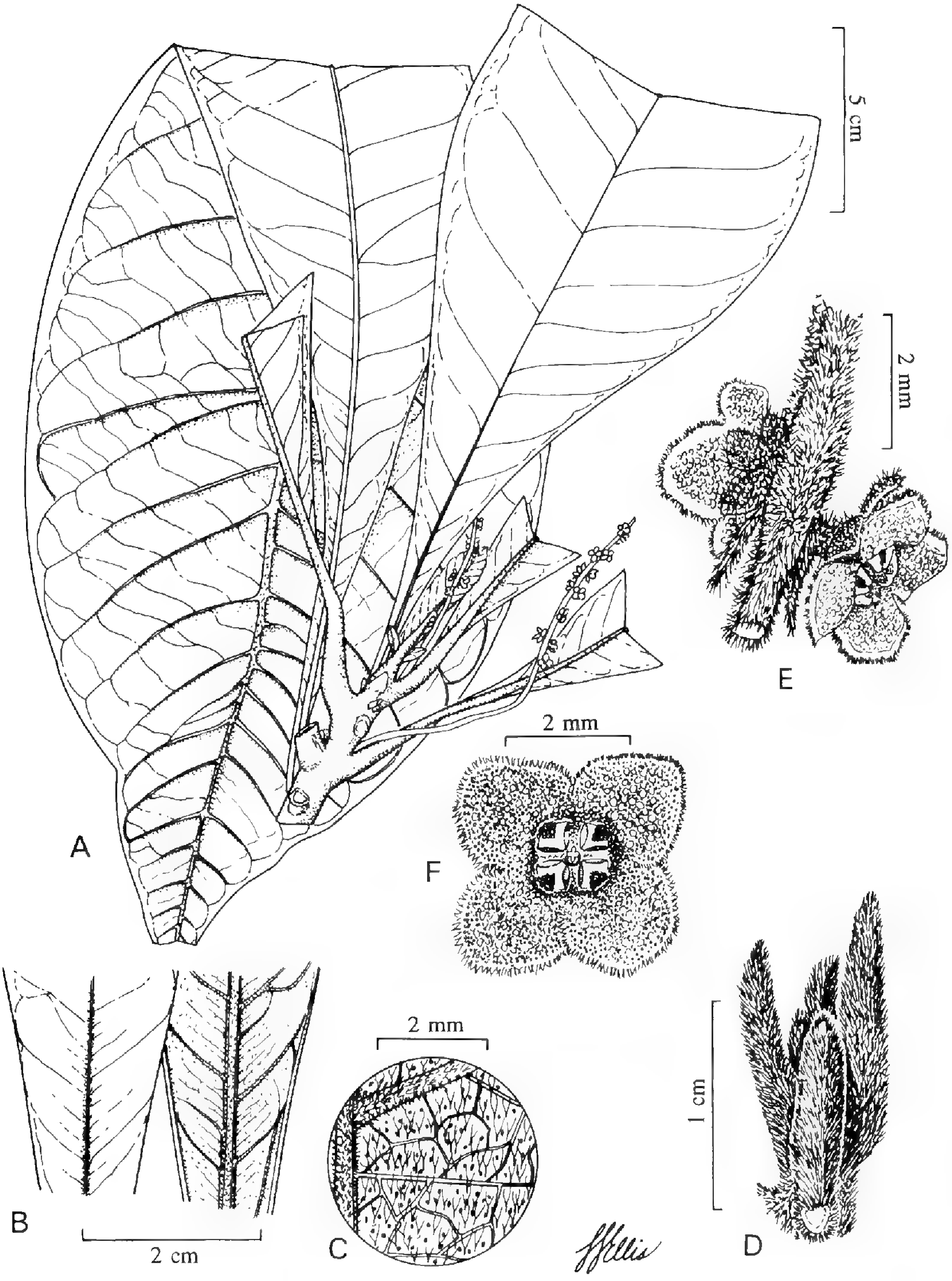

Fig. 2. *Cybianthus ruforamulus* Pipoly. A. Habit, showing terete branchlets. B. Adaxial and abaxial leaf bases, showing hirtellous tomentum. C. Abaxial leaf surface, showing biramose hirtellous trichomes. D. Branchlet apex, showing hirtellous tomentum. E. Portion of staminate inflorescence rachis, showing subsessile flowers, tomentum, prominent punctations that appear verrucose and hyaline, and tomentose margins.

Tree to 8 m tall; growth following Rauh's architectural model; all vegetative portions densely rufous hirtellous-tomentose, the trichomes biramose, branched just above base (Y-shaped), stiff, persistent. Branchlets terete, 8–10 mm diam. Leaves alternate; leaf blades chartaceous, oblanceolate, (34–)38–46(–52) cm long, (9–)11–13(–16) cm wide, apex acute to short-acuminate, the acumen 0.3–0.5 cm, base long-attenuate and cuneate, decurrent on the petiole, subbullate, sordid above, pallid below, densely prominently and minutely black punctate above and below, more densely tomentose along the costa and veins below, venation brochidodromous, the costa impressed and hirtellous-tomentose above, prominently raised and densely hirtellous-tomentose below, secondary veins (15–)20–24 pairs, deeply impressed above, prominently raised below, the margin entire, flat; petiole deeply canaliculate, pulvinate, 2–3 cm long, densely tomentose, persistent. Staminate inflorescence a simple, erect raceme 8–10 cm long, the rachis, pedicels, and calyx densely tomentose; inflorescence bract unknown; floral bracts linear, 1.3–1.5 mm long, 0.2–0.3 mm wide, apex subulate, hyaline, densely long-hirsute abaxially, glabrous adaxially, margin entire; pedicel cylindrical, 0.4–0.6 mm long, densely tomentose, persistent. Flowers chartaceous, 4-merous, greenish-maroon, translucent, pendent at maturity; calyx cotyliform, deeply divided, 1.1–1.4 mm long, tube 0.2–0.3 mm long, lobes widely ovate to suborbicular, 0.9–1.1 mm long, 0.7–0.9 mm wide, apex obtuse, densely and prominently red punctate, the punctations crowded and appearing verrucose throughout except at scarious margin, tomentellous alternating with the calyx lobes, margin irregular, entire, bifid-hirtellous; corolla subrotate, 1.3–1.7 mm long, the tube 0.3–0.5 mm long, the lobes depressed-ovate 0.9–1.2 mm long, 1.3–1.5 mm wide, apex broadly rounded, not notched, densely and prominently red-punctate and appearing verrucose and tomentose on areas between calyx lobes abaxially, densely glandular-granulose throughout within, the margin entire, hyaline, tomentose; anthers subsessile, subdeltate, 0.3–0.4 mm long, 0.4–0.5 mm wide, apex acute, base truncate, apically dehiscent by pores, the pores not birimose, opening ca. 3/4 anther length, the connective densely and prominently punctate dorsally; pistillode lageniform to obturbinate, 0.5–0.7 mm long, 0.1–0.2 mm, glabrous, style short, stigma subcapitate. Pistillate inflorescence: like the staminate but 6–9 cm long. Fruit sessile, calyx 1.3–1.5 mm long, the tube ca. 0.1 mm long, the lobes widely ovate, 1.2–1.3 mm long, 0.7–0.9 mm wide, apex obtuse, margin as in staminate. Fruit globose, 8–10 mm diam., orange, then purple, then black at maturity, rugose, inconspicuously black-punctate, exocarp thick, juicy.

TYPE: COLOMBIA. AMAZONAS: along río Yarí, near mouth of Quebrada El Mochilero, ca. 00°30'N, 72°53'W, 120–200 m, 23 Apr 1986 (stam. fl), *G. Galeano, J. H. Torres, J. Huitoto, & B. Plazas 1105* (HOLOTYPE: COL). Fig. 2.

PARATYPES: COLOMBIA. AMAZONAS: Quebrada Aduche, 200 m, 5 Aug 1977 (fr), *J. M. Idrobo 8908* (COL). BRAZIL. ACRE: Estrada Alemanha, Cruzeiro do Sul, 14 Apr 1971 (fr), *G.*

Prance et al. 11908 (IAN, INPA, K, MG, NY); 6 May 1971 (fr), *P. Maas et al. P12737* (F, IAN, INPA, K, NY).

Distribution, ecology and conservation status: Cybianthus ruforamulus is known from *terra firme* forests, near 200 m, in Amazonas, Colombia and Acre, Brazil. According to one collector (Galeano, pers. comm.), it grows along small brooks and other minor watercourses in primary forests, and may be considered an indicator of environmental quality.

Etymology: The specific epithet describes the rufous tomentum of the branchlets, composed of forked trichomes unique within the genus.

Cybianthus ruforamulus appears to be closely related to *C. minutiflorus*, a poorly known taxon from the rim of the Amazon Basin in Peru, but is easily recognized by the biramose-hirtellous tomentum of the branchlets, leaves and inflorescence, the shorter petioles, the chartaceous, greenish-maroon perianth, and the subdeltate, glabrous anthers. The tomentum of Y-shaped hairs (Fig. 2C) is the first of its kind reported for the genus and should not be confused with the malpighiaceous trichomes unique in *Cybianthus* to subgenus *Triadophora*.

ACKNOWLEDGMENTS

Research for this paper was completed at the Missouri Botanical Garden, where my studies in Amazonian biological diversity were supported by grants from the John D. and Catherine T. MacArthur Foundation. *Cybianthus barbosae* was found during my course in forest inventory and tropical tree architecture offered to graduate students of the Universidad Nacional de Colombia, Instituto de Ciencias Naturales, in Parque Nacional Natural Amacayacu. I thank my Colombian counterpart, Agustín Rudas Ll. for logistical support. I also owe special thanks to Oscar Pinto, former regional director of INDERENA, César Barbosa, Jaime Aguirre, Clara Inés Orozco, Pilar Franco, Adriana Prieto, Pablo Palacios, Santiago Duque, José Murillo, Roscío Cortés, Marta González, Roberto Sanchez, and Hector Esquivél, for attending the course or facilitating arrangements. Linda Ellis executed the fine line drawings of the taxa.

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A NEW SPECIES OF *CAREX* (CYPERACEAE: *PHAESTOGLOCHIN*) FROM OKLAHOMA AND TEXAS; TYPIFICATION OF SECTION *PHAESTOGLOCHIN*, AND NOTES ON SECTIONS *BRACTEOSAE* AND *PHAESTOGLOCHIN*

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ABSTRACT

Carex perdentata, is described from Palo Pinto County, Texas. A key to the species of section *Phaestoglochin* occurring in Arkansas, Louisiana, Oklahoma, and Texas is included. *Carex*, section *Phaestoglochin* is here with lecto-typified with *C. muricata*. The South American section *Bracteosae*, often considered synonymous with section *Phaestoglochin*, is considered distinct.

RESUMEN

Se describe *Carex perdentata*, sección *Phaestoglochin* del condado de Palo Alto, Texas. Se incluye una clave para las especies de la sección *Phaestoglochin* que viven en Arkansas, Louisiana, Oklahoma y Texas. Se lectotipifica la sección *Phaestoglochin* del género *Carex* con *C. muricata*. La sección sudamericana *Bracteosae*, considerada a menudo como sinónima de la sección *Phaestoglochin* se considera distinta.

Carex section *Phaestoglochin* [Sy = section *Bracteosae sensu* Mackenizie (1931), non Pax], subgenus *Vignea* (P. de Beauvois *ex* Lestiboudois f.) W. Petermann was described from Europe by Dumortier in 1827. This section now includes 27 species. However, most of the taxa are native to the New World. Today, all of the European species have been introduced into North America. Their distribution in the New World is primarily in temperate North America. However one species, *C. xalapensis* C. Kunth, is found in México and northern Guatemala. Section *Phaestoglochin* is characterized by 1) an inflorescence with 3–25 sessile spicate branches, frequently with ten or less branches, the lower branches occasionally being compound in certain taxa (especially *C. muehlenbergii* C. Schkuhr *ex* C. Willdenow var. *enervis* W. Boott); 2) spikes androgynous, rarely pistillate, or having short staminate spikelets arising laterally from an androgynous or pistillate spike; 3) perigynia plano-convex or unequally biconvex, with the bodies of the perigynia more or less abruptly contracted into a beak; 4) achenes two-sided, either lenticular or slightly biconvexed; 5) style jointed with the achene; 6) stigmas two. Since section *Phaestoglochin* has never been typified, *C. muricata*

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L. is here designated as the type for section *Phaestoglochin*. The typification of *C. muricata* has been reviewed by Reznicek and Ball (1980).

Section *Bracteosae* F. Pax differs from section *Phaestoglochin* by 1) a denser inflorescence with more spikes; 2) perigynia with a spongy area at the basal end of the ventral surface, occasionally on the dorsal surface as well; 3) and usually with wart-like bumps over the lower part of the ventral surface and sometimes across the dorsal surface of the perigynia. Kunth (1837) was the first to use the name *Bracteosae* as an infrageneric category, but without rank or description. Pax (1889) published *Bracteosae* at the sectional rank and provided a scant and ambiguous, but valid description. Pax did not cite Kunth, giving authorship of section *Bracteosae* solely to himself. Pax cited *Carex cephalophora* Muhlenberg *ex* Willdenow of North America as belonging to this section. This is undoubtedly where Mackenzie (1931) got his concept that the North American taxa that he treated belonged to section *Bracteosae*. Kükenthal (1909) recognized the North American taxa that Mackenzie (1931) recognized as section *Bracteosae* as section *Mulhlenbergianae,* a superfluous name for section *Phaestoglochin*, and recognized the South American taxa as belonging in a section distinct from those in North America.

While researching the following complex of species in section *Phaestoglochin*; *C. austrina* (J. Small) K. Mackenzie, *C. cephalophora* H. Muhlenberg ex C. Willdenow, *C. leavenworthii* C. Dewey, *C. mesochorea* K. Mackenzie, *C. muehlenbergii* Schkuhr *ex* Willdenow var. *enervis* W. Boott, and *C. muehlenbergii* C. Schkuhr ex C. Willdenow var. *muehlenbergii*, a new species of *Carex* (*C. perdentata* S.D. Jones) was discovered.

Means, variances, standard deviations, and ranges were measured for nine populations consisting of 10 plants per population. Additional specimens were examined but no measurements were found to lie outside of the range recorded for the nine populations. The mean, plus and minus two standard deviations, for all parametric data is presented in the species description. If the ranges extend beyond the mean, plus or minus two standard deviations, then the extension is listed as parenthetical. Fruiting dates are based on a statistical mean, plus and minus two standard deviations. Ranges greater than and/or lesser than the two standard deviations are listed as parenthetical.

Carex perdentata S.D. Jones, sp. nov. (Fig. 1)

Plantae cespitosae: culmis fertilis (17–0–)26.8–74.2(–90.0) cm altis. Foliis (4–)5–9, laminis (18.0–)20.6–46.4(–55.5) cm longis, 2.2–4.5(–4.6) mm latis; paginis adaxialibus papillosis; vaginis arctis. Inflorescentiis (5–)6–12(–14) androgyniis spicis, 13.5–25.3(–28.0) mm longis, (9.0–)9.5–14.5 mm latis. Perigynio (3.3–)3.4–5.2(–5.6) mm longo, 1.9–2.7(–2.8) mm lato, lenticularis, sine venae vel 1–5(–8) tenuis venae ventraliter; sine venae vel 1–10(–11) tenuis venae dorsaliter. Achaeniis 1.8–2.6(–2.8) mm longis, 1.5–2.1(–2.2) mm latis, lenticularis, ovatis. Stigmatibus 2, rubellus-brunneis, brevis; antheris (1.3–)1.4–1.8(1.9) mm longis.

FIG. 1. *Carex perdentata* (*S.&G. Jones 8349*, holotype and isotypes). A. Habit. B. Perigynium, dorsal view. C. Perigynium, ventral view. D. Achene. E. Spke bract. F. Pistillate scale. G. Anther. H. Sheath and ligule. Bar equals 5 cm in A, 5 mm in E, 1 mm in B, C, D, F, G, and H.

Habit perennial, cespitose; *rhizomes* short to long, dark brown to black, fibrillose; *fertile culms* (17.0–)26.8–74.2(–90.0) cm tall, erect, stiff, 2.0–3.2 (–3.8) mm wide ca. 2 cm above rootstock, sharply triangular, scaberulous above, leafy on lower third, conspicuously exceeding leaves; *leaves* with well-developed blades (4–)5–9 per fertile culm; hypostomous; *blades* (18.0–)20.6–46.4(–55.5) cm long, 2.2–4.5(–4.6) mm wide, erect-ascending to slightly arching, thick, light green, flat, long-acuminate, margins antrorsely serrulate; *abaxial surface* without papillae or papillose distally; midvein raised, becoming increasingly more antrorsely scabrous distally; epidermal cells rectangular and raised above the braided patterned cell walls; *adaxial surface* papillose, papillae arising perpendicular from distal end of embedded clavate shaped epidermal cells (Fig. 2); *stomata* narrowly elliptic-oblong, paracytic with subsidiary cells mostly triangular with some semicircular in shape; sunken below adjacent epidermal cells, restricted to intercostal zones on abaxial surface; *sheaths* tight around culm; *dorsal sheath surface* not septate-nodulose or rarely inconspicuously septate, papillose, pale green; *ventral sheath surface* whitish-hyaline, striate, papillose (at least proximally), deeply concave and more or less callused at apex of distal end, yellowish-brown tinged; *ligule* 0.4–1.9(–2.5) mm long, membranous, more or less linguiform, or infrequently acute at apex; *inflorescences* of (5–)6–12(–14) androgynous spikes, 13.5–25.3(–28.0) mm long, (9.0–)9.5–14.5 mm wide, usually 0.5–2.5(–3) times as long as wide, but occasionally as wide as long; *lateral spike* second from bottom (4.5–)4.7–7.9(–8.0) mm long; *staminate* flowers few, with ovate-lanceolate cuspidate scales; *lowest inflorescence bract* 7.0–56.6(–105.0) mm long including awn, pistillate scale-like but with larger and conspicuously longer awns; *upper bracts* pistillate scale-like but with longer awns, mid-point of awns 0.1–0.5(–0.9) mm) wide; *lateral branch*, second from bottom (spike) (4.5–)4.7–7.9(–8.0) mm long; *gap* (internode) between the lowest two spikes (0.5–)0.7–3.5(–4.2) mm; *pistillate scales* (1.6–)1.8–3.1 mm long, 1.4–2.0(–2.2) mm wide, 1-veined, rarely 3-veined, ovate, brownish or greenish-hyaline, narrower than and (excluding awn) about length of bodies of perigynia, apex usually conspicuously awned (rarely acuminate), awn (0–)0.1–3.6 mm long , green mid-stripe, 0.2–0.4(–0.5) mm wide; *perigynia* (3.3–)3.4–5.2(–5.6) mm long, 1.9–2.7(–2.8) mm wide, (2–)4–19(–24) per spike, ascending or at maturity spreading, flattened-plano-convex, ovate, round-tapering and often slightly spongy at base, ventral perigynia surface veinless, or 1–5(–8) fine veins, dorsal perigynia surface veinless or 1–10(–11) fine veins, submembranous, sharp-edged to base, serrulate above middle, tapering or abruptly contracted into a serrulate beak, beak bidentate, sutures conspicuous; *teeth* (1.0–)1.4–1.7(–1.8) mm long, narrowly-triangular; *achenes* 1.8–2.6(–2.8) mm long, 1.5–2.1(–2.2) mm wide, lenticular, strongly flattened, ovate (Fig. 3) to suborbicular, substipitate 0.1–0.3 mm long, minutely apiculate, occasionally retuse at apical end; epidermal cells are nonisodymetric; single

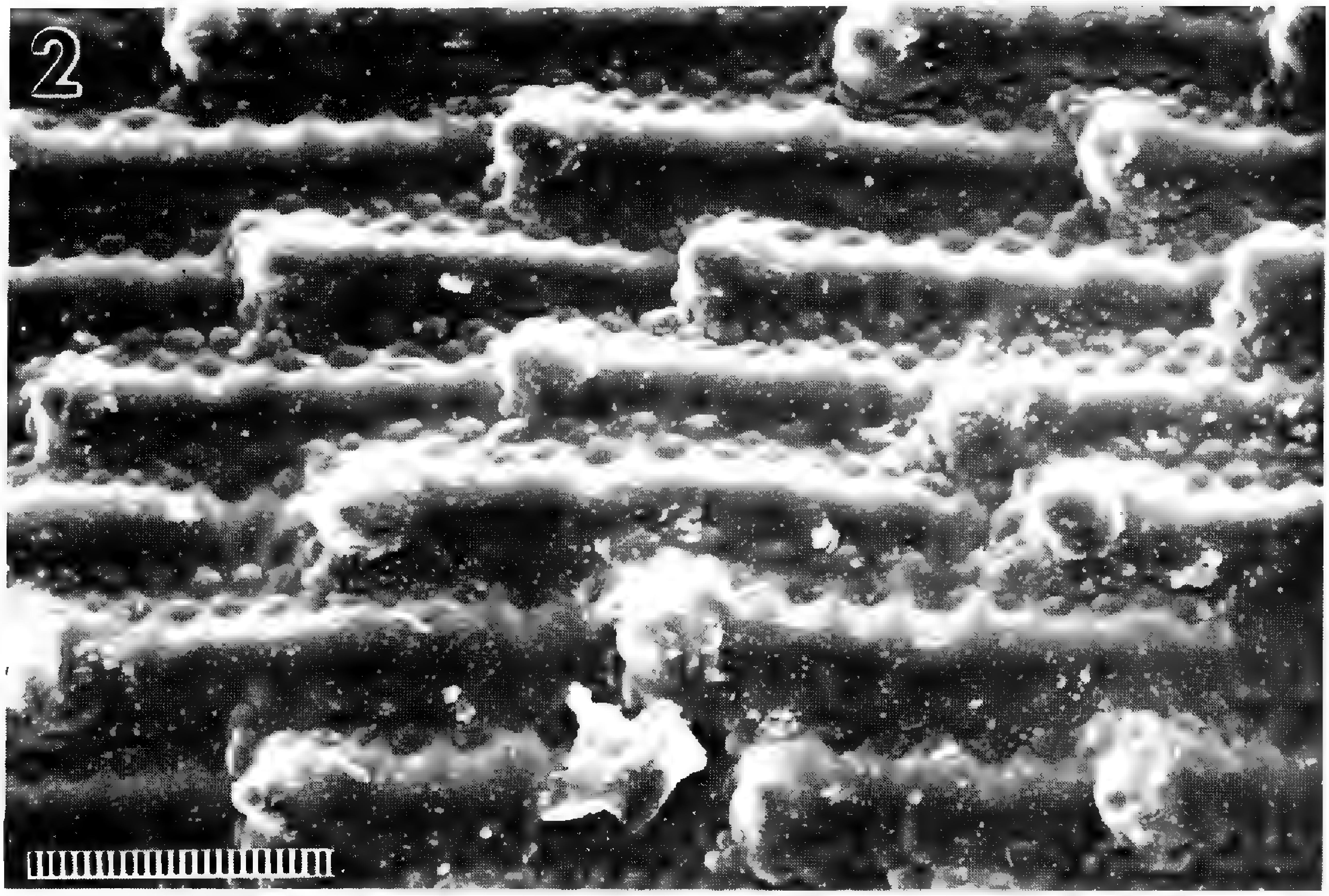

FIG. 2. *Carex perdentata*, SEM micrograph (*S.& G. Jones 8349*, isotype: TAES). Adaxial leaf surface showing papillae arising perpendicular from the distal end of embedded clavate shaped epidermal cells. Bar equals 50 m.

large central silica body and no satellites perched on edge of silica platform (Fig. 4); central body occasionally composed of two fused bodies; *style* straight, short, slender, enlarged at base, jointed with achene; *stigmas* two, reddish-brown, short; *anthers* (1.3–)1.4–1.8(–1.9) mm long; *chromosome number* unknown; *fruiting* (13 Mar-) 21 Mar - 1 Jun (-12 Jun); *ecology* a facultative sciophyte, primarily in alfisols or inceptisols with sandy or sandy loam soil, sandstone outcrops, granitic outcrops, or thin soil over limestone, open mesic to submesic hardwood forests, or open hardwood-juniper forests, or woodlands in savannas in granite outcrops; elevation 175–525 m; *distribution* (Fig. 5), central Texas north to Oklahoma; *economic importance* forage value for livestock is low in palatability but is of use for wildlife, especially for rabbits, rodents, deer, and birds; it is also important in soil erosion.

TYPUS: U.S.A. TEXAS. Palo Pinto Co.: 2.3 mi S on FR 4 from its jct. with FR 3137, S of Palo Pinto, mesic to submesic live oak dominated W-facing slope with reddish sandy loam soil and sandstone, 23 Apr 1992, *S. & G. Jones 8349* (HOLOTYPE: MICH; ISOTYPES: BRIT, MO, OKL, SAT, TAES, TEX, US, VDB, WARM).

Additional specimens: OKLAHOMA. **Comanche Co**: 1.3 mi N of Meers along W side of Rt. 115, lightly shaded, moist soil along trail through deciduous forest, frequent, 15 May 1990, *Naczi 2414 B* (MICH). **Cleveland Co.**: low, damp, ground, 28 May 1939, *Bebb 4085*

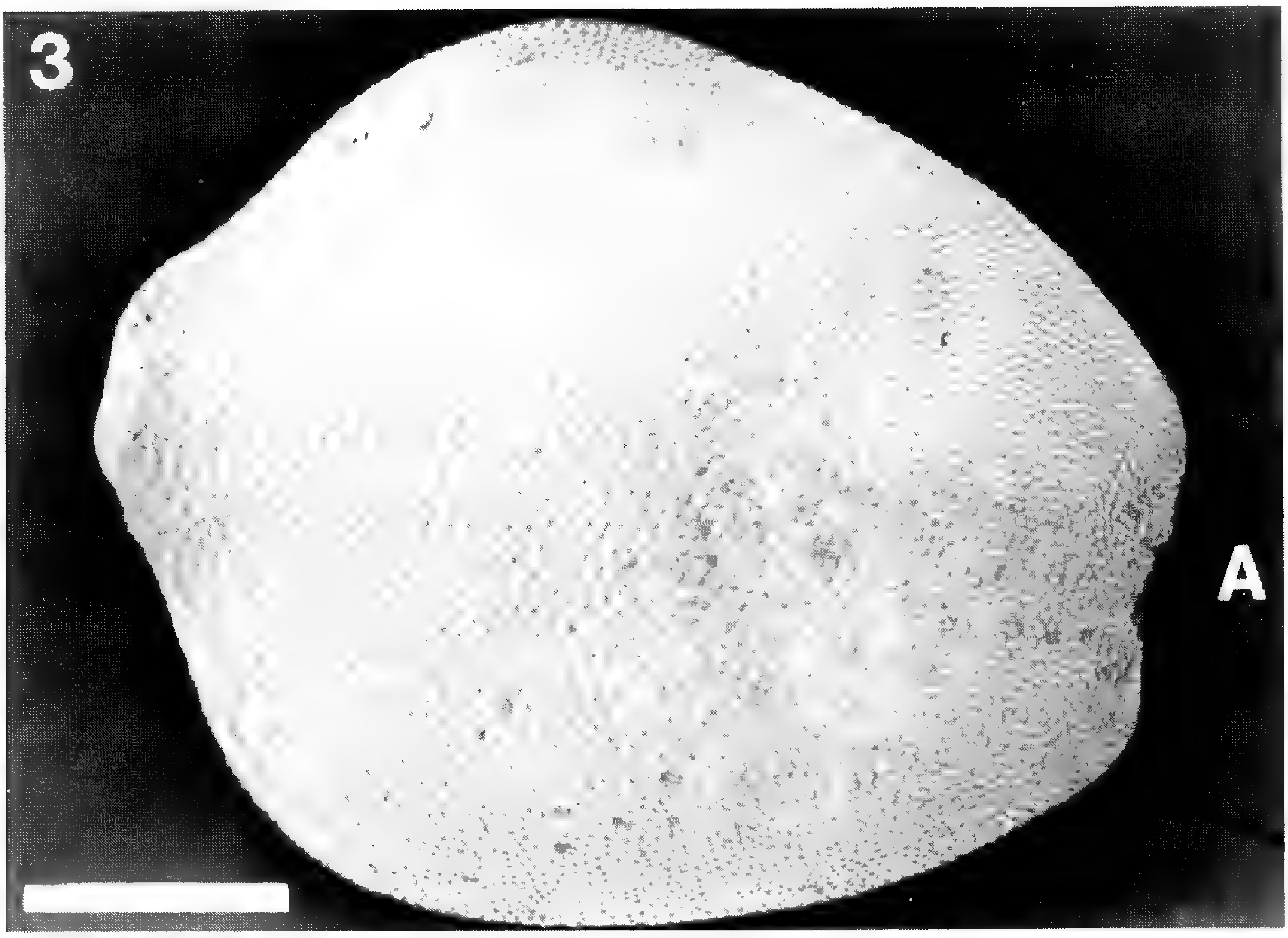

FIG. 3. *Carex perdentata*, achene, SEM micrograph (*S.&G. Jones 8349,* isotype: TAES). A. Apical end. Bar equals 0.5 mm.

(OKL). Sequoyah Co.: below Dwight Mission, 6 mi NE of Sallisaw; creek woods, 7 May 1955, *Wallis 2058* (BEBB).

TEXAS. **Bell Co.**: 2.1 mi N on TX 95 from its jct. with FR 228, then 2.8 mi NE on Sunshine Rd. from its jct. with TX 95, mesic open to wooded roadside with graveley clay soil, 14 Apr 1990, *S. & G. Jones 4340* (BRIT/SMU, ctb, MICH, MO, SAT, TAES, TEX, US, VDB, WARM). **Bexar Co.**: San Antonio, 22 Apr 1911, *Clemens and Clemens 386* (CAS). **Bosque Co.**: 3.3 mi NW of Clifton, limestone gravel and silt, Meridian Creek bank, under trees, 16 Apr 1953, *Shinners 14241* (BRIT/SMU). **Burnet Co.**: NE corner of US 281 and RR 2147 in Marble Falls, mesic roadside roadcut and adjacent oak savanna with granitic soil, 30 Mar 1992, *S. & G. Jones 8213* (BRIT/SMU, ctb, MICH, MO, SAT, TAES, TEX, US, VDB, WARM). **Colorado Co.**: 3/4 mi NW of Columbus, frequent in open woods on terrace of Colorado River, 9 Apr 1948, *Cory 54275* (BRIT/SMU). **Comal Co.**: 1850, *Lindheimer 8100 and Dapprube* (BRIT/SMU). **Cooke Co.**: N of Leo near Dickson Creek, Western Cross Timbers, alluvial soil, 4 May 1946, *Whitehouse 15651* (BRIT/SMU). **Dallas Co.**: SW corner of Coit Rd. and Belt Line Rd., Stults Prairie, in depressions, 3 May 1960, *Correll 23374* (BRIT/SMU). **Erath Co.**: Morgan Mill, 12 Jun 1941, *Tharp 43330* (UC). **Fayette Co.**: E of Kreiche House, Monument Hill State Park, La Grange West Quad., in moist sandy loam soil over calcareous sandstone on mown lawn, 15 Mar 1986, *Carr 7169 and Kutac* (TAES). **Frio Co.**: Rt. 1581 from Pearsall to Divot at Frio River crossing, dense herbaceous growth in shade of trees, loam soil, elev. ca. 151 m, 13 Mar 1985, *Ertter 5570 and Bear* (CAS). **Gillespie Co.**: along stream in NE corner of county W of Coal Creek, common on N slope under oaks, 29 Apr 1959, *Correll 21168 and Johnston* (BRIT/SMU, MO, UC). **Hayes Co.**: San Marcos, dry rocky ground, 17 Apr 1917, *Palmer 11587* (UC). **Hill Co.**: 7 mi WSW of Whitney, in detritus under limestone cliffs above dam, in tufts, 15 Apr

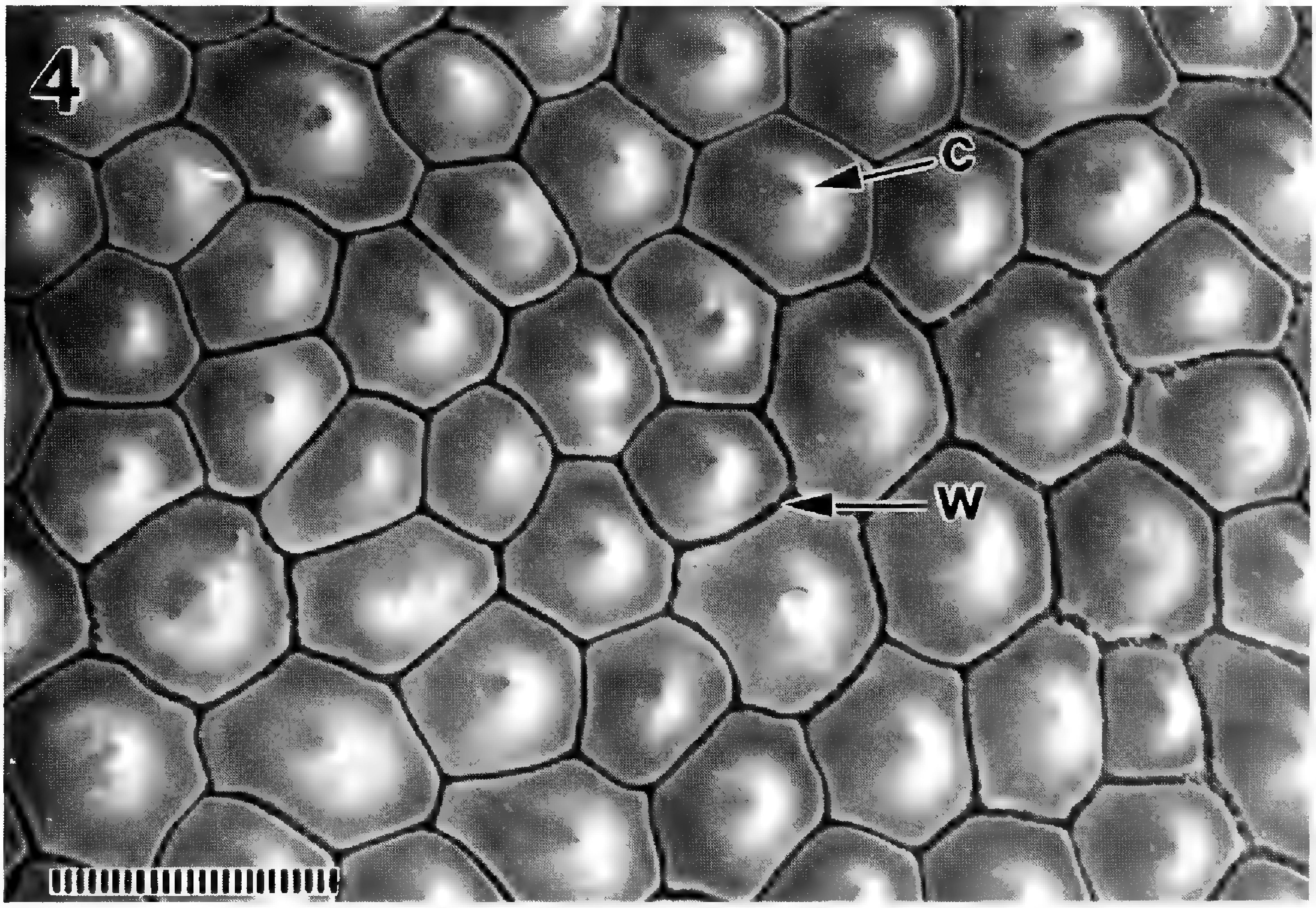

FIG. 4. *Carex perdentata*, epidermal cells, SEM micrograph (*S.&G. Jones 8349*, isotype: TAES). C. Central body. W. Anticlinal wall. Bar equals 50m.

1951, *Shinners 13027* (BRIT/SMU). **Hood Co.**: 10 mi NE of Granbury, limestone slope above stream, under trees, in leaf mold and silt, 1 May 1949, *Shinners 11036* (BRIT/SMU). **Kendall Co.**: 2.4 mi S on FR 289 (Welfore-Waring Rd.) from its jct. with the "T" in Waring, NW of Boerne, open mesic disturbed roadside with calcareous soil and limestone rocks, 27 Apr 1991, *S. & G. Jones 7380* (BRIT/SMU, ctb, MICH, MO, SAT, TAES, TEX, US, VDB, WARM). **Kerr Co.**: 10.8 mi SW from Hunt on TX 39 from its jct. with FR 1340, mesic riverine habitat along W side of the South Fork of the Guadalupe River, 11 May 1991, *Jones 6670 and Kral* (BRIT/SMU, ctb, MICH, MO, SAT, TAES, TEX, US, VDB, WARM). **Kimble Co.**: ca. 20 mi SW of Junction, valley of Paint Creek near its jct. with South Fork of Llano River, forest of large oaks, walnuts, and pecans, 11 May 1947, *McVaugh 8278* (CAS, NA, TEX). **Lampasas Co.**: 4.1 mi E on FM 580 from its jct. with FM 581, infrequent, 20 Apr 1988, *S. & G. Jones 1268* (TAES). **Llano Co.**: ca. 9 mi W of Buchanan Dam, on the road between Burnet and Llano, 29 Apr 1946, *Lundell 14563* (TEX). **McClennan Co.**: vicinity of China Spring, limestone hills, 15 Apr 1970, *Mauldin s.n.* (BRIT/SMU). **Mills Co.**: 8 mi SW of Goldthwaite, creek bank, in shade, sand and limestone gravel, 30 Apr 1960, *Shinners 28312* (BRIT/SMU). **Palo Pinto Co.**: 2.3 mi S on FR 4 from its jct. with FR 3137, S of Palo Pinto, mesic live oak W-facing hillside slope with reddish sandy loam soil and sandstone, 23 Apr 1992, *S. & G. Jones 8349* (Type series: BRIT/SMU, ctb, MICH, MO, SAT, TAES, TEX, US, VDB, WARM). **Parker Co.**: 9.5 mi E of Weatherford, clayey limestone soil near pond, in shade, 24 Apr 1949, *Shinners 10963* (BRIT/SMU). **San Saba Co.**: on Ellison Ranch, at Chapel, low, wet, shaded area by pool below natural waterfall, at edge of water, growing in black soil, 24 Apr 1977, *Barnette 256* (BRIT/SMU). **Somervell Co.**: 1 mi NE of Glen Rose on Hwy 67, sandy stream bank, in thicket, 2 Apr 1950, *Shinners 12157* (BRIT/SMU). **Sutton Co.**: Sonora, experiment station, 21 Apr 1931, *Jones*

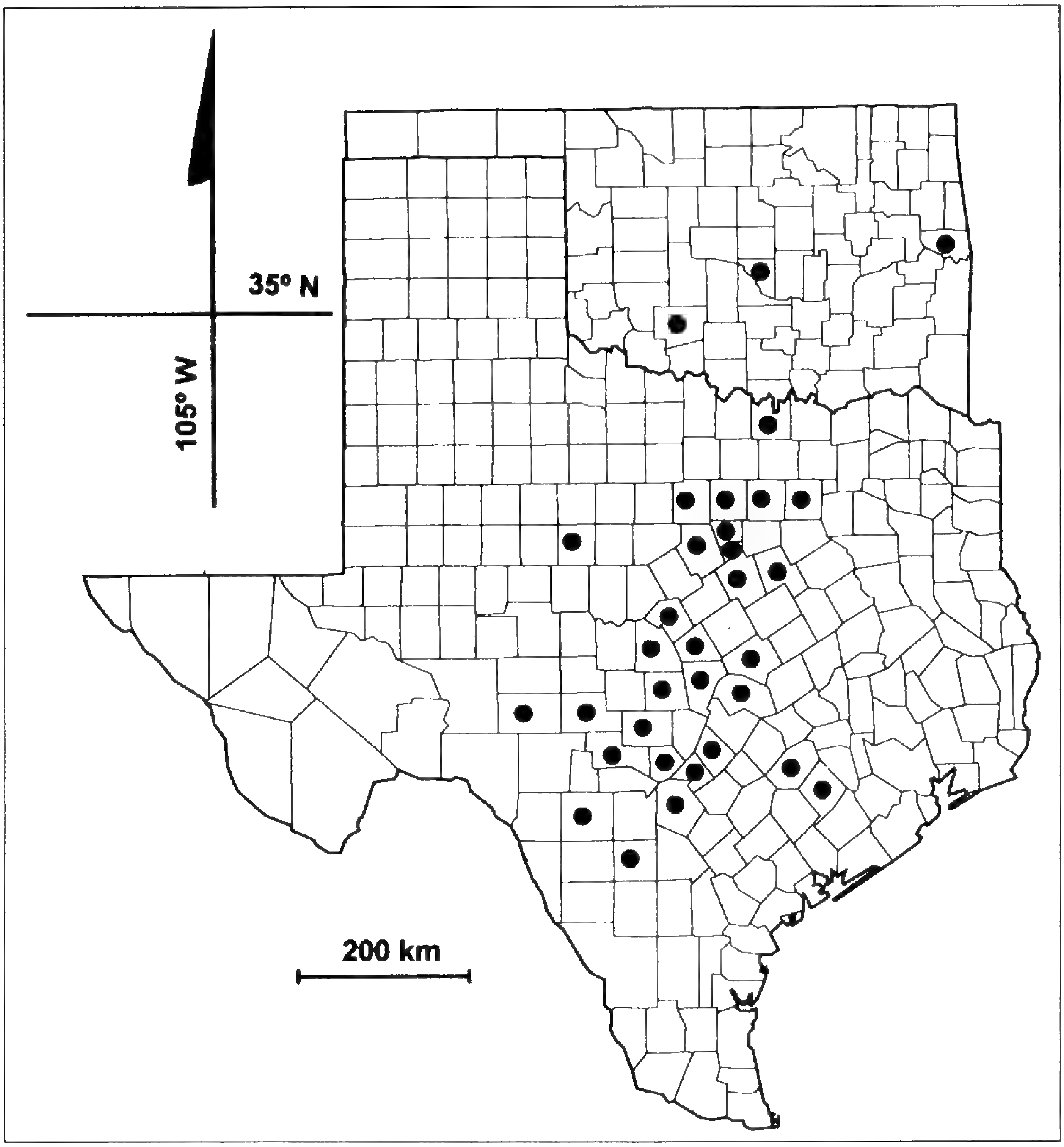

FIG. 5. *Carex perdentata*, distribution by county based on annotated herbarium specimens.

28383 (UC). **Tarrant Co.**: Sycamore Park, NW of East Rosedale St. and South Beech in Fort Worth, mesic creek meander through open woods with loamy clay soil, 23 Apr 1992, *S. & G. Jones 8339* (BRIT/SMU, ctb, MICH, MO, SAT, TAES, TEX, US, VDB, WARM). **Taylor Co.**: Abilene State Park, in deciduous woods along Elm Creek, 28 May 1943, *Tolstead 7330* (OMA, UC). **Travis Co.**: 0.2 mi SW on the Andrandok Trail with its jct. with Loop 390 in Bull Creek Park, Austin, S side of Bull Creek on N-facing slope of a juniper-oak woodland, 7 Apr 1990, *S. & G. Jones 4225* (BRIT/SMU, ctb, MICH, MO, SAT, TAES, TEX, US, VDB, WARM). **Uvalde Co.**: near Uvalde, woods along Leona River, 30 Apr 1928, *Palmer 33641* (UC). **Williamson Co.**: Georgetown near dam on San Gabriel River, alluvial soil, partial shade, 14 Apr 1947, *Whitehouse 18073* (BRIT/SMU).

The following dichotomous key is for the taxa of section *Phaestoglochin* occurring in Arkansas, Louisiana, Oklahoma, and Texas. Incomplete veins refer to veins that do not extend from the base of the perigynium to the apex. Septate-nodules refer to cross-veins. Dorsal and ventral are used synonymously with abaxial and adaxial respectively.

KEY TO THE SPECIES OF SECTION *PHAESTOGLOCHIN* IN ARKANSAS, LOUISIANA, OKLAHOMA, AND TEXAS

1. Leaf sheaths baggy around the culm (loose) 2

2. Apex of ventral leaf sheath straight or slightly concave, not callused or only slightly thickened, friable; dorsal leaf sheath white or pale green with darker green veins with darker green septate-nodules, but not green,mottled with white, frequently with scattered red dots ventrally; perigynia turning stramineous to brown at maturity; perigynia (3.4–)3.5–5.6 mm long ..... C. *gravida*

2. Apex of ventral leaf sheath concave, callused or not, friable or not; some dorsal leaf sheaths white or pale green with darker green veins and darker green septate-nodules with some dorsal sheaths green, mottled white, without scattered red dots ventrally; perigynia remaining green at maturity; perigynia 3.3–4.6 mm long 3

3. Spikes of inflorescence aggregated, apex of ventral leaf sheath concave, slightly to strongly callused, not friable; awns of most pistillate scales reaching or exceeding the base of the perigynium beak; beaks 1.0–1.8(–2.0) mm long; widest leaves (3.0–)3.5–5.0(–6.0) mm wide; perigynia (3.4)3.6 4.5 mm long ..... C. *aggregata*

3. Spikes of inflorescence separated, internodes between spikes frequently much greater than the length of the spikes; apex of ventral leaf sheath concave but not callused, friable; awns of most pistillate scales shorter than the base of the perigynium beak; beaks 0.8–1.0(–1.2) mm long; widest leaves (4–)5–10 mm wide; perigynia 3.3–4.0(–4.3) mm long ..... C. *sparganioides*

1. Leaf sheaths tight around the culm (not baggy) 4

4. Lowest inflorescence bract 5.5–25 cm long, greatly exceeding the inflorescence, two to many times as long 5

5. Culms smooth below inflorescence; plants of open bottlomlands or floodplain habitats ..... C. *arkansana*

5. Culms antrorsely scaberulous below inflorescence; plants of open mesic to submesic woodlands ..... C. *perdentata*

4. Lowest inflorescence bract less than 5.5 cm long, not exceeding the inflorescence, or less than two times as long 6

6. Pistillate scales brown with a contrasting green mid-stripe ..... C. *occidentalis*

6. Pistillate scales hyaline, hyaline tinged with yellow or green, or pale yellow to stramineous with a green or greenish mid-stripe, but not brown with a contrasting green mid-stripe 7

7. Beaks of perigynia smooth, not serrated; perigynia spongy at base at maturity 8

8. Perigynia ovate-deltoid; veinless ventrally, perigynia spongy at base but without a swollen spongy area at base on ventral surface ..... C. *leavenworthii*

8. Perigynia ovate-lanceoid; veins present on ventral surface, at least proximally over an enlarged spongy area at base of perigynia 9

9. Perigynia 1.3–1.8 mm wide; widest leaf blade 1.5– 3.0 mm wide ..... C. retroflexa

9. Perigynia 1.0–1.3 mm wide; widest leaf blade 1.0–1.5 mm wide .... C. texensis

7. Beaks of perigynia serrated, not smooth; perigynia spongy or not at base at maturity 10
    - 10. Perigynia spongy at base with or without a ventral swollen area basely 11
        - 11. Perigynia (1.4–)1.5–2.7(–2.8) mm wide, ovate-deltoid or conspicuously ovate; perigynia without a swollen spongy area at base on ventral surface 12
            - 12. Perigynia 2.2–3.2(–3.3) mm long; veinless ventrally; 0(–3) veins dorsally .... *C. leavenworthii*
            - 12. Perigynia (3.3–)3.4–5.2(–5.6) mm long; 0–5(–8) narrow veins (ca. 0.1–0.2 mm wide) ventrally; 0–10(–11) narrow veins dorsally .... *C. perdentata*
        - 11. Perigynia 0.9–1.8 mm wide, ovate-lanceoid or slightly ovate oblong; perigynia with a swollen spongy area at base of ventral surface 13
            - 13. Perigynia (3–)4–5 times as long as wide; with rhizomes ± elongate .... *C. socialis*
            - 13. Perigynia 3 or less times as long as wide; without elongate rhizomes 14
                - 14. Widest leaf width 1.3–1.9 mm wide; stigmas straight or only slightly coiled .... *C. radiata*
                - 14. Widest leaf width 1.8–2.6 mm wide; stigmas once to twice coiled .... *C. rosea*
    - 10. Perigynia not spongy at base 15
        - 15. Abaxial and adaxial leaf surface smooth, not minutely papillose (sandpaper-like), except sometimes sparingly along major veins 16
            - 16. Perigynia (3.4–)3.5–4.7 mm long, (2.0–)2.1–2.7(–3.1) mm wide 17
                - 17. Apex of the ventral leaf sheath straight or slightly concave not callused or only slightly thickened, friable; frequently with scattered reddish dots; dorsal leaf sheath white or pale green with darker green veins with darker green septate-nodules, but not green, mottled with white; perigynia turning stramineous to brown at maturity; widest leaves (3–)4–8 mm wide; most culms forming greater than 70° angle with the ground .... *C. gravida*
                - 17. Apex of ventral leaf sheath concave, callused, not friable; without scattered reddish dots; all dorsal leaf sheaths green, or if white or pale green with darker green septate-nodules, then some sheaths green mottled with white; perigynia turning stramineous to brown at maturity or remaining green; widest leaves 2.5–6.0 mm wide; culms either forming less than a 50° angle or greater than a 70° angle with the ground 18
                    - 18. Dorsal leaf sheaths green; perigynia frequently turning stramineous to brown at maturity; widest leaves 2.5–4.5 mm wide; most culms forming less

than a 50° angle with the ground, usually much less; many bract and/or pistillate scale awns greatly exceeding the perigynia beaks .... *C. austrina*

18. Some dorsal leaf sheaths white or pale green with darker green veins and darker green septate-nodules, but some sheaths green mottled with white; perigynia remaining green at maturity; widest leaves (3.0–)3.5–5.0(6.0) mm wide; most culms forming an angle greater than 70° with the ground; most bract and/or pistillate scale awns not exceeding the apex of the perigynia beaks, occasionally a few bract awns surpass the beaks .... *C. aggregata*

16. Perigynia 2.0–3.5 mm long, 1.3–2.3(–2.4) mm wide 19

19. Perigynia bodies ovate-deltoid; perigynia beaks 0.3–0.7(–0.8) mm long with a single row of serrations, abruptly arising from the apex of the perigynium; widest leaf blade 1.1–3.0(–4.0) mm wide; leaves per fertile culm 2–6(–7); culm width, ca. 2 cm above rootstock, 1.0–2.4(–3.5) mm wide; pistillate scale (1.3–)1.5 2.2 (–2.5) mm long; pistilate scale awn 0–0.8(–1.0) mm long; dorsal leaf sheath frequently green mottled with white dots .... *C. leavenworthii*

19. Perigynia bodies ovate or suborbicular; perigynia beaks 0.8–1.1 mm long with a double row of serrations, gradually tapering from the shoulder of the perigynium; widest leaf blade (1.9)2.5–4.4 mm wide; leaves per fertile culm (4–)5–8; culm width, ca. 2 cm above rootstock, 1.7–3.2(–3.3) mm wide; pistillate scale 1.1–1.7(–1.9) mm long; pistillate scale awn 0–3.2 mm long; dorsal leaf sheath mostly green, infrequently green mottled with white dots .... *C. cephalophora*

15. Abaxial, adaxial, or both leaf surfaces minutely papillose (sand paper-like), at least near distal end 20

20. Inflorescence capitate, 12–19 mm long, 9–14 mm wide; leaves conspicuously shorter than culm, (6.5–)8.4–21.0 (–23.0) mm long; ventral surface of perigynia veinless, dorsal surface veinless or rarely with 1–4 incomplete narrow veins (ca. 0.1–0.2 mm wide) .... *C. mesochorea*

20. Inflorescence short-oblong, oblong, or linear, (12.0–)13.5–47 mm long, 6.0–18.0(–28.0) mm wide, the central axis visible, at least between some spikes, usually the lowest two; leaves short or long, 11.3–46.4(–55.5) mm long; ventral surface of perigynia 0–15-veined, dorsal surface 0–12-veined 21

21. Ventral surface of perigynia with (5–)6–15 conspicuous broad veins (ca. 0.5 mm wide); dorsal surface with (0–)1–12 broad veins .... *C. muehlenbergii* var. *muehlenbergii*

21. Ventral surface of perigynia with 0–6(–8) narrow veins (ca. 0.1–0.2 mm wide); dorsal surface with 0–11(–14) narrow veins 22

22. Pistillate scales 3.0–4.2(–4.3) mm long, (1.0–)1.6–2.6(–3.0) mm wide; mid-stripe 3-veined, rarely 1-veined; culms usually forming an angle of 50° or less with the ground .... *C. austrina*
22. Pistillate scales (1.5–)1.8–3.1 mm long, (1.0–)1.2–1.8(–2.2) mm wide; mid-stripe 1-veined, occasion ally 3-veined; culms usually forming an angle of 70° or more with the ground 23
    23. Beaks of perigynia 0.2–0.6(–1.0) mm long, abruptly arising from apex of perigynium; perigynia broadly ovate, (1.5–)2.5–3.8 mm long; dorsal leaf sheaths frequently green with mottledwhite dots; plants wide spread, from Texas east to Georgia and north to Canada .... *C. muehlenbergii* var. *enervis*
    23. Beaks of perigynia (1.0–)1.4–1.7(–1.8) mm long, tapering from shoulders or occasionally abruptly arising from apex of perigynia; perigynia ovate or ovate-deltoid, 3.2–5.2(–5.6) mm long; most dorsal leaf sheaths infrequently mottled with white dots; plants restricted to central Texas north to Oklahoma .... *C. perdentata*

This treatment does not recognize varieties of *Carex gravida*. However, further research may prove that infraspecific taxa are warranted [i.e., *C. gravida* var. *lunelliana* (Mackenzie) F.J. Hermann], but until that time, I have opted for a more conservative approach. In floras where *C. gravida*, *C. aggregata*, and *C. sparganioides* occur together, they have classically been separated from other members of section *Phaestoglochin* by having baggy sheaths. However, I have encountered specimens of *C. gravida* and *C. aggregata*, both in the field and on herbarium sheets, that have tight leaf sheaths. It is possible that a single recessive gene is responsibile for tight leaf sheaths, or developmental through ontogeny. Another plausible explanation provided by A.A. Reznicek [(MICH) pers. comm.] is that the individuals with tighter leaf sheaths are growing in less than optimum habitat. Regardless, *C. gravida* and *C. aggregata* usually have baggy leaf sheaths but can have tight leaf sheaths so they key out under baggy and tight leaf sheaths.

The classical spelling of *C. muhlenbergii* should be corrected to *C. muehlenbergii*. This was pointed out by Peter Ball [(TRTE) pers. comm.]. Willdenow's original spelling was *C. mühlenbergii* with a diacritical sign (an umlaut over the "u"). Greuter et al. (1988), Article 73.6 state that diacritical signs are not used in Latin plant names. In names which are drawn from words in which such signs appear, the signs are to be suppressed with the necessary transcription of the letters so modified (i.e., ü becomes ue).

Carex perdentata's closest putative relative is *C. mesochorea*. *Carex perdentata* differs in having longer perigynia with their bases slightly spongy, slightly narrower and conspicuously longer leaves, usually longer inflorescences, more spikes per inflorescence but with fewer perigynia per spike, and for the most part, longer anthers. The teeth of the beaks of *C. perdentata* are noticeably longer and spreading at maturity in contrast to the short and usually straight teeth of *C. mesochorea* which rarely reach 1 mm long. The species epithet "perdentata" refers to the conspicuous teeth on the beaks of the perigynia.

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NOTES ON *CAREX* (CYPERACEAE), WITH *C. GODFREYI* NEW TO ALABAMA AND *C. COMMUNIS* AND *C. SCOPARIA* NEW TO MISSISSIPPI

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ABSTRACT

Field explorations have yielded *Carex godfreyi* new to Alabama and *C. communis* and *C. scoparia* new to Mississippi, U.S.A. Additional range extensions are presented for *C. bicknellii* var. *opaca* and *C. oklahomensis* in Mississippi. Locality and habitat data are presented for all species reported.

RESUMEN

Las exploraciones de campo han dado como resultado *Carex godfreyi* nuevo para Alabama, y *C. communis* y *C. scoparia* nuevos para Mississippi, U.S.A. Se presentan extensiones de areal para *C. bicknellii* var. *opaca* y *C. oklahomenis* en Mississippi. Se indican la localidad y el hábitat de todas las especies citadas.

INTRODUCTION

In preparing a synoptic treatment of *Carex* as a contribution to the Flora of Mississippi Project, the senior author has continued to examine herbarium specimens and conduct field surveys for species with potential to occur within Mississippi and other southeastern states in the U.S.A. The authors have also continued assessment of population size, distribution, and habitat requirements of recently reported species *C. bicknellii* Britton var. *opaca* F.J. Herm. and *C. oklahomensis* Mack., especially because these may have potential to become weedy. This mauscript adds to the knowledge of *Carex* that has been reported in recent years (Bryson 1984a; Bryson & Jones 1990; Bryson et al. 1991; Bryson et al.

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1992; Bryson & Carter 1994; Carter et al. 1990; Morris & Bryson 1986; Naczi & Bryson 1990). As previously discussed, the flora of Mississippi is still poorly known in comparison with several adjacent states (Bryson & Carter 1994). Lowe's *Plants of Mississippi* (1921), although outdated, must continue to serve as a baseline for the general floristic work in the state.

The terminology of physiographic regions or resource areas in Mississippi follows Lowe (1921) as adapted by Morris (1989). Herbarium abbreviations follow Holmgren et al. (1990), except ctb, MMNS, and USMH (pers. herb. of Charles T. Bryson; Mississippi Museum of Natural Science, Jackson; and University of Southern Mississippi, Hattiesburg, respectively).

NEW STATE RECORDS

Carex communis Bailey var. **communis** belongs to the section *Acrocystis* (Rettig 1988) and is known from dry to mesic rich woods in mountains, steep ravines, rocky ledges, and calcareous soils from Quebec to Ontario and Minnesota, south to Georgia, Tennessee, Alabama, and Arkansas (Mackenzie 1931; Naczi 1993; Radford et al. 1964; Rettig 1988; Steyermark 1963). The following are the first collections of *C. communis* from Mississippi.

Voucher specimens: U.S.A. MISSISSIPPI. **Monroe Co.**: ca. 1 mi N Lake Monroe, T13S R7E S10 SW/4, 12 May 1992, *MacDonald 4561* (ctb, IBE, MICH, others to be distributed); 28 Apr 1993, *MacDonald 5928 & Warren* (ctb, IBE, MICH, SWSL, others to be distributed); 19 May 1994, *Bryson 13651 & MacDonald* (ctb, SWSL, others to be distributed).

At this site in the Tennessee Hills Region, *C. communis* var. *communis* was found at an elevation of about 75 to 90 m in a mesic beech-maple-oak forest near the crest of a N- to NE-facing slope on Ruston and Cuthbert soils. It was associated with *Acer barbatum* Michx., *Actaea pachypoda* Elliott, *Adiantum pedatum* L., *Asimina triloba* (L.) Dunal, *Arabis canadensis* L., *Carex abscondita* Mack., *C. cephalophora* Willd., *C. corrugata* Fernald, *C. blanda* Dewey, *C. gracilescens* Steudel, *C. rosea* Willd., *C. laxiflora* Lamarck var. *serrulata* F.J. Herm., *C. willdenowii* Willd., *Cynoglossum virginianum* L., *Decumaria barbara* L., *Fagus grandifolia* Ehrhart, *Geranium maculatum* L., *Hepatica americana* (DC.) Ker, *Lindera benzoin* (L.) Blume, *Morus rubra* L., *Obolaria virginica* L., *Osmorhiza longistylis* (Torrey) DC., *Panax quinquefolium* L., *Quercus alba* L., *Rhamnus caroliniana* Walter, *Thelypteris hexagonoptera* (Michx.) Weath.

Carex godfreyi Naczi occurs in wet hammocks, swamps, and floodplains in the coastal plain from southern North Carolina southward to the central peninsula of Florida and west and to southwestern Georgia and nearby portions of the Florida panhandle. It inhabits shaded, mesic to wet areas in calcareous muck or sandy loam soils (Naczi 1993). *Carex godfreyi* belongs to a complex of species that include *C. amphibola* Steudel, *C. corrugata* Fernald, and *C. grisea* Wahlenb.

Carex godfreyi is distinguished from the preceding species by its more loosely cespitose habit, its leaf sheaths and cataphylls with more extensive purple-red pigmentation, and its narrower leaf bases. The following citations are the first report of *C. godfreyi* from Alabama.

Voucher specimens: U.S.A. ALABAMA. **Houston Co.:** ca. 9 mi S of Dothan, vicinity of Big Creek; on road to Madrid at 0.2 mi SE of Hwy US 231, 18 May 1992, *MacDonald 4594a* (ctb, IBE, KNK, others to be distributed); Chattahoochee State Park, area where Irwin Mill Creek meets Hwy AL 95, 5 May 1993, *MacDonald 5975* (ctb, IBE, KNK, SWLS, others to be distributed).

At the site about nine miles south of Dothan, *C. godfreyi* grew in a *Fagus grandifolia-Magnolia grandiflora* L.-*Magnolia virginiana* L.-*Pinus glabra* Walter-*Quercus laurifolia* Michx.-*Quercus michauxii* Nutt. forest above Big Creek. Additional associates included *Carex abscondita*, *C. complanata* Torr. & Hook., *C. debilis* Michx., *C. leptalea* Wahlenb., *C. styloflexa* Buckley, *Gordonia lasianthus* (L.) Elliott, *Uvularia floridana* Chapm. At the Chattahoochee State Park site, *C. godfreyi* grew in an *Acer barbatum-Magnolia grandiflora-Magnolia virginiana-Persea palustris* (Raf.) Sarg.-*Quercus hemisphaerica* Bartram forest above Irwin Mill Creek on a clay soil. Associates present at this site also included *Aristolochia serpentaria* L., *Bumelia lanuginosa* (Michx.) Persoon, *Conopholis americana* (L.) Wahl., *Cornus stricta* L., *Dryopteris ludoviciana* (Kunze) Small, *Ilex cassine* L., *I. montana* Torr. & Gray, *Lyonia lucida* (Lamarck) K. Koch, *Osmanthus americana* (L.) Benth. & Hook., *Pedicularis canadensis* L., *Ponthieva racemosa* (Walter) C. Mohr, *Rhododendron canescens* (Michx.) Sweet, *Sanicula canadensis* L., *S. marilandica* L., *Thelypteris palustris* Schott, and *Viburnum obovatum* Walter. *Carex atlantica* Bailey subsp. *capillacea* (Bailey) Reznicek, *C. leptalea*, *Cicuta mexicana* Coult. & Rose, *Decodon verticillatus* (L.) Elliott, *Nasturtium microphyllum* (Boenn.) Rchb., *Rosa palustris* Marshall, and *Zizaniopsis miliacea* (Michx.) Doell & Asch. grew in wetter areas nearby. Both collections are from the Doughtery Plain District of the East Gulf Coastal Plain of Alabama (Sapp & Emplaincourt 1975).

Carex scoparia Willd. var. **scoparia** is known from open areas in swampy or wet river bottoms, valleys, prairie swales, upland prairies, margins of sink-hole ponds, and roadside ditches from Newfoundland to British Columbia, south to South Carolina, Tennessee, Arkansas, Oklahoma, New Mexico, and Oregon (Kolstad 1986; Mackenzie 1931; Radford et al. 1964; Steyermark 1963). This collection is first of *C. scoparia* from Mississippi.

Voucher specimens: U.S.A. MISSISSIPPI. **Lafayette Co.:** Presbyterian Camp Hopewell, ca. 6 mi NE Oxford, T8S R2W S9, 28 May 1994, *Bryson 13910* (ctb, IBE, MICH, SWSL, others to be distributed).

At this site in the Central Hills Region, *C. scoparia* var. *scoparia* grew in an open area on coarse sandy soil above a small spring-fed lake in association with

Carex albolutescens Schwein., *C. festucacea* Willd., *C. laevivaginata* (Kük.) Mack., *C. longii* Mack., *C. lurida* Wahlenb., *C. triangularis* Boeck., *C. vulpinoidea* Michx., *Fuirena squarrosa* Michx., *Rhynchospora glomerata* (L.) Vahl, *Xyris torta* J.E. Smith.

OTHER NOTEWORTHY COLLECTIONS

Carex bicknellii Britton var. **opaca** F.J. Herm. was described from three collections of Delzie Demaree from river terraces in Lonoke and Prairie counties, Arkansas (Hermann 1972). *Carex bicknellii* var. *opaca* was first found in Mississippi at a site in the Black Prairie Region of Mississippi where *C. oklahomensis* Mack. was first collected in the state (Bryson & Carter 1994). The following citation is the second report for Mississippi.

Voucher specimens: U.S.A. MISSISSIPPI. Itawamba Co.: N of Dorsey, SW of junction of Hwy US 78 and Dorsey-Fawn Grove Road Exit, T9S R7E S25, 25 May 1994, *Bryson 13802* (ctb, MICH).

Three plants of *C. bicknellii* var. *opaca* were observed at this site in close association with *C. oklahomensis* Mack. Each plant was depauperate compared to those from a Lee County site observed in 1993 (Bryson & Carter 1994), but plant size was also reduced at the Lee County site in 1994, possibly due to dry conditions. In Itawamba County, *C. bicknellii* var. *opaca* was also associated with *C. bushii* Mack., *C. cherokeensis* Schweinitz, *C. complanata* Torr. & Hook., *C. glaucodea* Tuck., *C. longii* Mack., *C. vulpinoidea* Michx., *Cyperus echinatus* (L.) Woods, *C. lancastriensis* Porter in Gray, *C. odoratus* L., *C. strigosus* L., *Festuca pratensis* Huds., *Eleocharis obtusa* (Willd.) Schult., *Fimbristylis autumnalis* (L.) Roem. & Schult., and *Rhynchospora capitellata* (Michx.) Vahl.

Carex oklahomensis Mack. is known in Mississippi only from Lee County, just east of Tupelo (Bryson et al. 1992). The following data are for an additional site in Lee County and for the first stations in Itawamba and Lowndes counties.

Voucher specimens: U.S.A. MISSISSIPPI. **Itawamba Co.:** N of Dorsey, SW of jct. of Hwy US 78 and Dorsey-Fawn Grove Road Exit, T9S R7E S25, 24 May 1994, *Bryson 13803* (ctb, MICH). **Lee Co.:** Tupelo, SW of jct. Hwy US 78 and Veterans Blvd. (=old Saltillo Road), T9S R6E S21, 24 May 1994, Bryson 13806 (ctb, MICH). **Lowndes Co.:** ca. 5 mi N of Columbus, Columbus Air Force Base, T16S R18W S30 SE/4 of E/2, 7 Jun 1993, *Warren 2469* (ctb, IBE, MICH, MISS, MMNS, SWSL, USMH, VDB, VSC, additional specimens to be distributed); 19 May 1994, *Warren 2595, MacDonald & Bryson* (IBE, MICH, additional specimens to be distributed); *MacDonald 7197, Warren & Bryson* (ctb, IBE, MICH, additional specimens to be distributed); *Bryson 13680, Warren & MacDonald* (BRIT/SMU, ctb, DSC, IBE, MICH, MISS, MMNS, USMH, VDB, VSC, additional specimens to be distributed).

The additional collection from Lee County and the one from Itawamba County are both along highway US 78. As previously speculated (Bryson et al. 1992), it is likely *C. oklahomensis* was introduced with blown hay for erosion control along the construction corridor of Highway US 78 in Itawamba and Lee counties. Associates at both sites are the same as those previously discussed for *C. bicknellii* var. *opaca*. It is likely that *C. oklahomensis* was introduced at the Lowndes County site in much the same manner as the Itawamba and Lee county sites or as a contaminate of grass seeds planted for erosion control. At the Lowndes County site, *C. oklahomensis* grew west of Independence Boulevard along and south of a small drainage ditch through a pine-hardwood forest. In 1993, *C. oklahomensis* plants were 1.4 to 1.7 m tall. At the time the specimens were collected in June, plants were drooping from the weight of the infructescences. Plants were only 1.0 to 1.2 m tall in 1994; the reduced plant height may have been caused by increased competition from grasses and drier than normal conditions. Associates at the Lowndes County site are *Carex frankii* Kunth, *C. longii* Mack., *C. triangularis* Boeck., *Eleocharis obtusa* (Willd.) Schult., *Festuca pratensis*, and *Glyceria septentrionalis* Hitch. In Mississippi, *C. oklahomensis* inhabits open sites with mucky clay soil, which are transitional between the Black Prairie and Tennessee Hills regions.

ACKNOWLEDGMENTS

Thanks are expressed to A.A. Reznicek (MICH) who confirmed the determination of *Carex bicknellii* var. *opaca*, *C. oklahomensis* and *C. scoparia*; R.F.C. Naczi (KNK) who confirmed the determinations of *Carex godfreyi*; and Richard Carter (VSC), S.D. Jones (TAES), R.F.C. Naczi, and A.A. Reznicek who reviewed the manuscript.

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FURTHER NOTES ON THE GENUS *ARDISIA* (MYRSINACEAE) IN MADAGASCAR

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ABSTRACT

Ardisia capuronii Pipoly is described and illustrated, and its phylogenetic relationships are discussed. Placement of *Ardisia capuronii* in subgenus *Akosmos* Mez is justified. A key to the species of *Ardisia* Sw. in Madagascar is presented.

RESUMEN

Ardisia capuronii es una nueva especie de Madagascar. La especie se describe, se ilustra y se discute su parentesco. Se justifica la ubicación de la especie dentro del subgénero *Akosomos*. Se presenta una clave para identificar las especies del género *Ardisia* procedentes del Madagascar.

During a recent visit to the Laboratoire de Phanérogamie (P), to begin to prepare treatments of the Myrsinaceae for several different floristic projects, some curious collections by Capuron were discovered among the materials from Madagascar, representing a new taxon that is here described.

Ardisia (subg. **Akosmos**) **capuronii** Pipoly, sp. nov. (Fig. 1)

Quoad ramulos crassos, suberosos glabrosque, folia petiolata marginataque, inflorescentiam pyramidali-paniculatam longipedunculatamque, anteras ad initium poris apicalibus denique rimis longitudinalbus dehiscentes, petalos membranaceos *A. procerae* Capuron valde arcte affinis, sed ab ea foliis obovatis (non lanceolatis) coriaceis (nec membranaceis) supra dense minuteque scrobiculatis (nec laevibus), petiolis 2-plo minoribus, pedunculo lignoso (non succulento) epunctato (nec dense manifeste atro punctato-lineato), necnon floribus in umbellas (non corimbos) dipositas atque lobulis calycinis rugosis (non laevibus) suborbicularibus (nec ovatis) praeclare distat.

Tree to 25 m tall; branchlets terete, 1.5–2 cm diam., glabrous, with exfoliating reddish outer bark. Leaves persistent; lamina thinly coriaceous, obovate, (10–)12–20 cm long, (5–)6–10 cm wide, the apex widely rounded to truncate, the base cuneate, decurrent on the petiole, the midrib slightly raised above, prominently raised below, the secondary veins 14–18 pairs, densely and prominently black punctate, glabrous, the margin revolute; petiole marginate, 1.5–2 cm long, glabrous. Inflorescences axillary, pendent, 21–35.8 cm long, 10–16 cm wide, essentially columnar; inflorescence bract unknown; rachis hollow, glabrous, densely and prominently black punctate; peduncle (7–)10–16 cm long,

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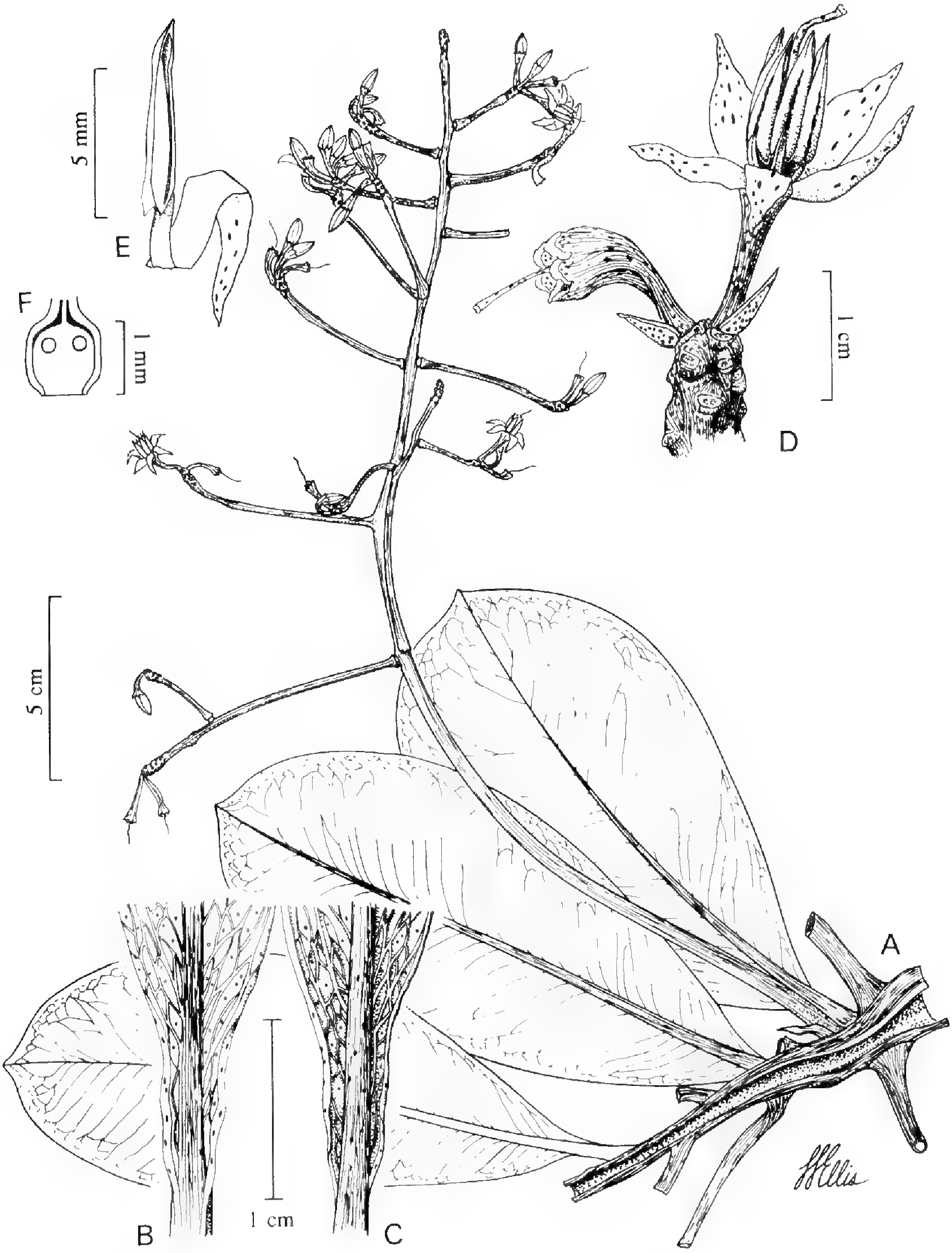

FIG. 1. *Ardisia capuronii* Pipoly. A. Habit. B. Adaxial leaf base, showing marginate petiole and punctations. C. Abaxial leaf base, showing petiole, raised midrib and raised secondary veins. D. Inflorescence branch apex, showing bracts, slightly asymmetric, long-acuminate petals, and punctate style. E. Stamen and petal base, showing terminal pore and longitudinal slit. F. Ovary longisection, showing uniseriate ovules. A–F, drawn from holotype.

broadened at base, glabrous; secondary branch bracts early caducous, unknown; floral bracts chartaceous, linear 2–3 mm long, 0.3–0.5 mm wide, the apex acuminate, densely and prominently red punctate, somewhat involute, the margin hyaline, entire, glabrous; pedicels cylindrical, recurved, 12–15 mm long, sparsely but prominently black and red punctate;. Flowers bisexual, pink, in terminal indeterminate 5–10-flowered umbels; buds ovoid, abruptly tapered apically; sepals 5, quincuncial, membranaceous, broadly ovate to suborbicular, 2.0–2.3 mm long, 1.8–2.0 mm wide, the apex broadly rounded, medially thickened or somewhat carinate, somewhat rugose and prominently black punctate basally, red punctate toward apex, the margin irregular, entire, hyaline, glabrous; petals 5, quincuncial, membranaceous, ovate, 9–11 mm long, 3.5–4 mm wide, united ca. 1–1.5 mm basally, the apex long acuminate, slightly asymmetrical, sparsely but prominently black punctate, glabrous, the margin entire, opaque, glabrous; stamens free, subequalling petals, 8–10.5 mm long, the filaments free, flat, membranaceous, lanceloid, 2–2.5 mm long, glabrous, epunctate, the anthers linear, 6–7 mm long, 1.8–2.5 mm wide, the apex acute, the base subsagittate, dehisceing first by apical pores, then by narrow longitudinal slits, the connective densely and prominently black punctate-lineate dorsally; ovary ovoid, 1–1.5 mm long and in diam., black-punctate, placenta globose, ovules 3–4, uniseriate; style tortuous, 7.5–8.5 mm long, densely black-punctate; stigma punctiform. Fruit unknown.

Type. MADAGASCAR. Ambinanifaho: W of Isahana-Ambodipont, between Antalaha and Sambava; 19 Apr 1966 (fl), *R. Capuron 24739-SF* (holotype: P; isotypes: P- 2 sheets, TAN).

Paratype. MADAGASCAR. Ambalabe: N of Ambohitralanana (Antalaha), 18 Mar 1967 (fl), *R. Capuron 27744-SF* (P, TAN).

Local names: "Barabahala."

Ecology and distribution: Ardisia capuronii is an element of the NE wet forest. It appears to be endemic to the region.

Etymology: It is a great pleasure to name this new species for the late R. Capuron, collector and ardent student of the Malagasy flora.

Ardisia capuronii is the fourth species of *Ardisia* subgenus *Akosmos* Mez to be discovered in Madagascar. It is closely related to *A. procera* Capuron, but is easily recognized by the obovate, coriaceous leaves minutely scrobiculate above, the shorter petioles, stout peduncles, umbellate flowers, rugose and suborbicular calyx lobes. The four species of *Ardisia* Sw. which occur in Madagascar all belong to subgenus *Akosmos* (Mez, 1902) defined by paniculate, long-pedunculate inflorescences subequal to the leaves, slightly curved style subequal to the petals, punctiform stigma and anthers with first poricidal, then longitudinal dehiscence. Miller and Pipoly (1993) placed *Ardisia* subgenus *Madardisia* Capuron (1963) in synonymy under subgenus *Akosmos*, and the latter concluded that Stone (1989, 1990) was correct in his conclusion that *Ardisia* subgenus *Akosmos* had its principal center of diversity in the Malesian region. The species of *Ardisia* occurring in Madagascar are separated in the following key:

KEY TO SPECIES OF *ARDISIA* IN MADAGASCAR

1. Inflorescence a panicle of umbels; panicle branches perpendicular to central rachis; placenta rounded.
    2. Branchlets 8–10 mm diam.; leaf blades oblong or lanceolate, 2–3.5 cm wide; sepals chartaceous, ovate, 1.8–2 mm, flat; petals chartaceous, oblong, 4.5–5 mm long, symmetric, epunctate .... *A. didymophora*
    2. Branchlets 15–20 mm diam.; leaf blades obovate, 5–10 cm wide; sepals membranaceous, broadly ovate to suborbicular, 2–2.3 mm long, somewhat carinate; petals membranaceous, ovate, 9–11 mm long, slightly asymmetric, sparsely but prominently punctate .... *A. capuronii*
1. Inflorescence a panicle of racemes or corymbs; panicle branches at 45° to central rachis; placenta apiculate.
    3. Inflorescence an erect, pyramidal panicle of racemes; petioles 3–5 cm long; pedicels 1–2 mm long; petals 4–5 mm long, apices acute .... *A. marojejyensis*
    3. Inflorescence a pendent, columnar panicle of corymbs; petioles obsolete; pedicels 10–20 mm long; petals 10–11 mm long, apices abruptly caudate-acuminate. .... *A. procera*

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FIRST RECORDS OF THE AQUATIC WEED *HYGROPHILA POLYSPERMA* (ACANTHACEAE) FROM TEXAS

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ABSTRACT

The first collections of *Hygrophila polysperma*, a species with the potential to become a noxious aquatic weed, are reported from the Comal and San Marcos rivers of central Texas, and a description and illustrations of the species are provided.

RESUMEN

Se citan las primeras recolecciones de *Hygrophila polysperma*, una especie que tiene el potencial de convertirse en una mala hierba acuática, de los ríos Comal y San Marcos de Tejas central, y se ofrecen una descripción e ilustraciones de la especie.

Key words: *Hygrophila*, Acanthaceae, aquatic weeds, Texas.

In the spring of 1994 we began to question the identification of several aquatic macrophyte collections from the upper San Marcos River in Hays County, Texas, on deposit at SWT. The specimens in question had been variously identified as either *Hygrophila lacustris* (Schlecht. & Cham.) Nees (Acanthaceae) or *Ludwigia repens* Forst. (Onagraceae) and represented vouchers from two separate studies of the river's macrophyte flora (Lemke 1989, Staton 1992). Contributing to the difficulty of making an accurate determination was the fact that most of the specimens comprised only sterile material, a common deficiency of aquatic plant collections. Ultimately, however, we were able to secure both flowering and fruiting material of these plants and to identify them as *Hygrophila polysperma* (Roxb.) T. Anderson, a previously unreported vascular hydrophyte from Texas that has the potential to become a troublesome aquatic weed.

Hygrophila R. Br. comprises approximately 80 species distributed primarily in the Old World tropics, particularly Indochina and Malaysia, with only a few African and American species (Long 1970). The only representative of the genus native to the U.S. is *H. lacustris*, which is distributed from Florida to eastern

Texas (Correll & Correll 1975, Godfrey & Wooten 1981). *Hygrophila polysperma* is a native of India and Malaysia that was introduced into the United States in the 1940s and quickly became a popular aquarium plant (Innes 1947). In the U.S., the species has been reported as naturalized in lakes and drainage canals in south Florida (Les & Wunderlin 1981). Our recent field observations and collections indicate that the species is also naturalized in and along the San Marcos and Comal rivers in, respectively, Hays and Comal counties, Texas. Furthermore, herbarium records indicate that *H. polysperma* has been well-established in the San Marcos River for at least 25 years (see specimen citations below).

We surmise that *H. polysperma* was introduced into Texas river systems either directly through cultivation by local aquatic plant nurseries, as documented by Hannan (1969) for the hydrophytic pteridophyte *Ceratopteris thalictroides* (L.) Brongn., or indirectly through careless dumping by aquarists. Profuse vegetative reproduction is well developed in *H. polysperma* (Spencer & Bowes 1985, Van Dijk et al. 1986) and even small fragments will produce roots and grow into new individuals. We therefore feel it is likely that isolated introductions of plants cultivated for sale may have resulted in the establishment of the species in both the Comal and San Marcos river systems.

The high growth potential of *H. polysperma* may pose a serious threat to the native flora and biotic integrity of the Comal and San Marcos river ecosystems. Several studies (Lemke 1989, Staton 1992, U.S. Fish and Wildlife Service 1994) have suggested that elements of the native biota of these two river systems are being displaced or otherwise adversely affected by exotic plant species. High growth potential, profuse vegetative reproduction, lack of seasonal variation in biomass, low light compensation and saturation points, a low CO_2 compensation point, and the capacity to rapidly change resource acquisition ability in response to environmental change are characteristics that make *H. polysperma* a competitive plant and potentially serious weed (Spencer & Bowes 1985, Botts et al. 1990, Kovach et al. 1992). The species is included on the federal list of noxious aquatic weeds (U.S. Department of Agriculture 1983) and is listed as a category II species by the Exotic Pest Plant Council of the State of Florida, indicating that its population is rapidly expanding and has the potential to invade and disrupt native vegetation in that state (Lantz 1993); however, the species is not currently recognized as a potentially harmful aquatic weed in Texas.

To facilitate the identification of future collections of this species, we provide the following key, description and illustration (Fig. 1):

KEY TO TEXAS SPECIES OF *HYGROPHILA*

Plants terrestrial or emergent; aerial leaves 5–12 cm long; flowers in axillary clusters along length of stem; capsule 8–12 mm long, glabrous .... *H. lacustris*

Plants submersed, emergent, or only rarely terrestrial; aerial leaves 0.7–2.5 cm long; flowers solitary in the axils of distal leaves; capsule 6–7 mm long, distally pilose .... *H. polysperma*

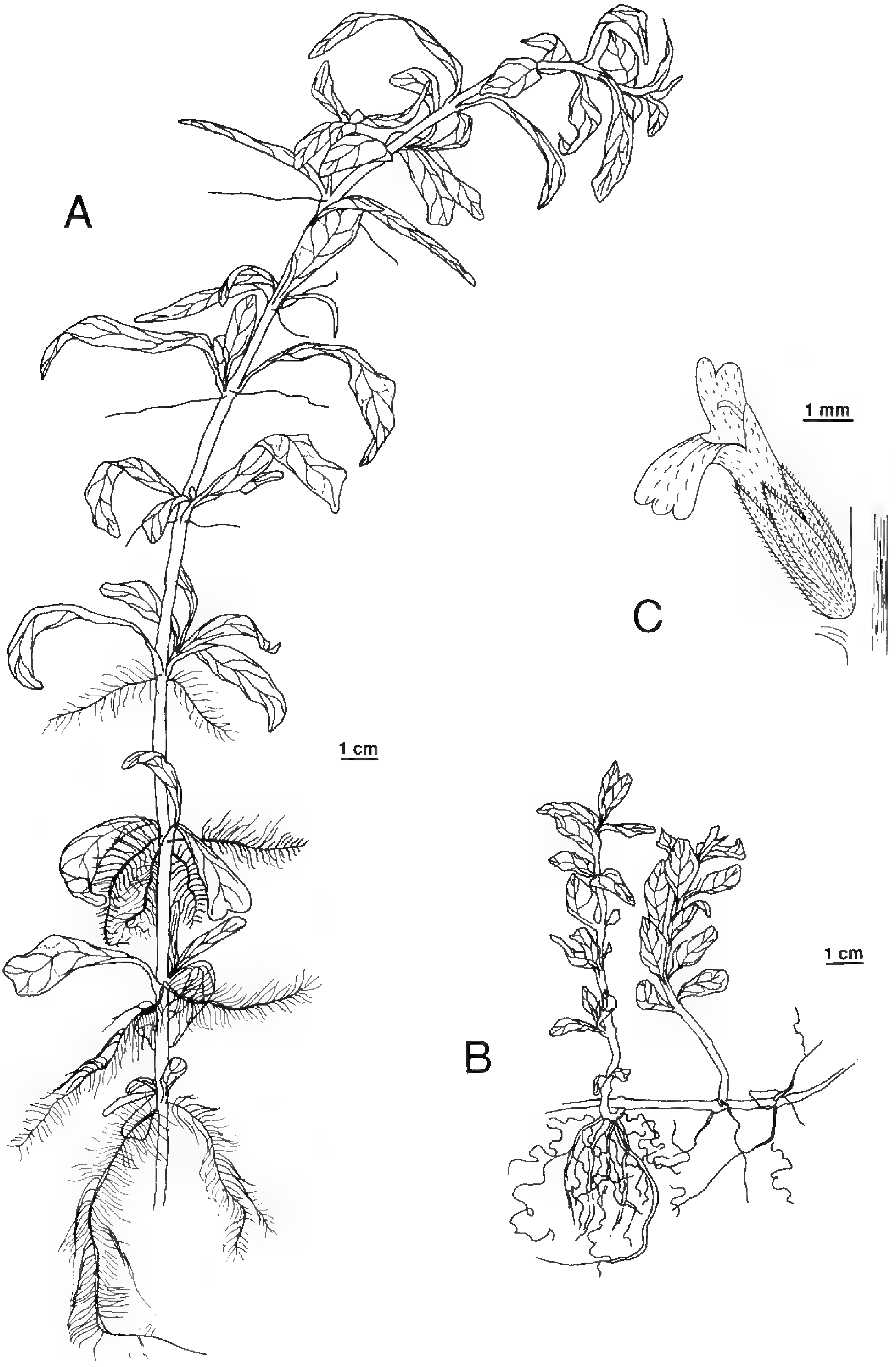

FIG. 1. *Hygrophila polysperma*, A. Distal portion of submersed shoot with abundant adventitious roots. B. Terrestrial form, drawn to same scale. C. Flower. A and B drawn by Amy L. Mahloch from live material; C redrawn after an illustration provided by the Center for Aquatic Plants, University of Florida, Gainesville.

Hygrophila polysperma (Roxb.) T. Anderson, J. Linn. Soc., Bot. 9:426. 1876.

Justicia polysperma Roxb., Fl. Ind. 1:120. 1820.
Hemidelphis polysperma (Roxb.) Nees in Wall., Pl. Asiat. Rar. 3:30. 1832.

Perennial rhizomatous terrestrial or aquatic herbs to 1.5 m tall. Stems ascendant or rarely erect, more or less 4-angled, puberulent to glabrate, with abundant elongate or rarely rounded cystoliths in the epidermis. Leaves opposite, broadly elliptic to oblanceolate, acute at apex, attenuate to a subpetiolar base, minutely denticulate to entire, 7–65 mm long, 2–10 mm wide, mostly glabrous but those subtending the flowers hispid, especially on the margins, the abaxial and adaxial surfaces with abundant elongate cystoliths. Flowers solitary in the axils of uppermost leaves, sessile. Bracts narrowly lanceolate, 4–5 mm long, herbaceous. Calyx equally 5-lobed, the lobes scarious-margined, 4–5 mm long, united basally, hispid. Corolla bluish-white (yellowish in dried specimens), 5–6 mm long, the upper lip 2-lobed, the lower lip 3-lobed, puberulent. Fertile stamens 2, included, filaments glabrous, anthers 2-celled, ca. 1 mm long. Ovary hispid distally, the style ca. 3 mm long, sparingly hispid, the stigma flattened, ca. 0.3 mm long. Capsule 6–7 mm long, mostly glabrous but with a few distal hairs. Seeds flattened, round, ca. 0.8 mm diameter. Blooming mostly Sep–Oct.

In the San Marcos and Comal rivers, *H. polysperma* is most often found growing completely submersed, although we have frequently encountered both emergent and terrestrial individuals along the upper San Marcos River. Submersed individuals have longer stems (0.3–1.5 m tall) with elongate internodes (20–54 mm long), relatively large oblanceolate leaf blades (17–65 mm long), and produce abundant adventitious roots at the upper nodes. Terrestrial individuals are of shorter stature (10–20 cm tall) with shorter internodes (2–16 mm long), smaller elliptic leaves (7–25 mm long), and bear roots almost exclusively on the rhizome. We have observed flowers and fruits primarily on terrestrial individuals and, occasionally, on emergent shoots of partially submersed plants; in both cases the distal leaves subtending the flowers are marginally hispid. These observations accord well with those of Sculthorpe (1967) who cited numerous examples of normally terrestrial plants (e.g., species of *Alisma* L., *Bacopa* Aublet, *Campanula* L., *Gratiola* L., *Nomaphila* Bl., *Ranunculus* L., and *Rotala* L.) that can grow entirely submerged even in deep water, leading to their common use as ornamental plants in aquaria; submersed individuals of such species were usually found to be characterized by elongation of the leaf blade, loss of pubescence, and sterility.

Two previous studies of the aquatic macrophytes of the San Marcos River failed to document the occurrence there of *H. polysperma*. Lemke (1989) incorrectly identified collections of this species as *H. lacustris,* while Staton (1992) misidentified her collections as *Ludwigia repens. Hygrophila lacustris,* a native of the southeastern U.S., occurs in only a few counties in southeast Texas (Brazoria, Chambers, Fort Bend, Hardin, Harris, Jackson, Montgomery, Orange, and Walker counties), where it grows as a terrestrial or emergent plant along muddy stream and pond margins (Wasshausen 1966, Correll & Correll 1975). The plants are typically erect herbs to 80 cm tall with leaves mostly 5–12 cm long and flowers borne in distinct axillary clusters along the length of the stem. *Hygrophila polysperma,* in contrast, is usually found submersed, the leaves of the aerial shoots are typically 7–25 mm long, and the flowers are solitary in the axils of the uppermost leaves.

When first introduced to the aquarium plant market, *H. polysperma* was though to be a species of *Ludwigia* L. and was given the common name "oriental ludwigia" (Innes 1947). Vegetatively, the terrestrial shoots of *H. polysperma* are very similar to those of *L. repens*, a native species also known from the San Marcos and Comal rivers; both species have small, opposite, elliptic leaves and short internodes. Even in the absence of reproductive structures, however, the two species are readily separable by nodal morphology. The petioles of *L. repens* are subtended by a pair of minute, glandular stipules less than 1 mm long, while the connate leaf bases of *H. polysperma* are exstipulate but bear a number of setiform hairs to 1.5 mm long (Fig. 2).

Hygrophila polysperma is the second adventive aquatic member of the Acanthaceae to be reported from Texas in recent years. Ramamoorthy and Turner (1992) documented the occurrence of *Nomaphila stricta* (Vahl) Nees, another Malaysian species, from San Felipe Springs in Val Verde County and surmised that this species was also introduced by aquarists.

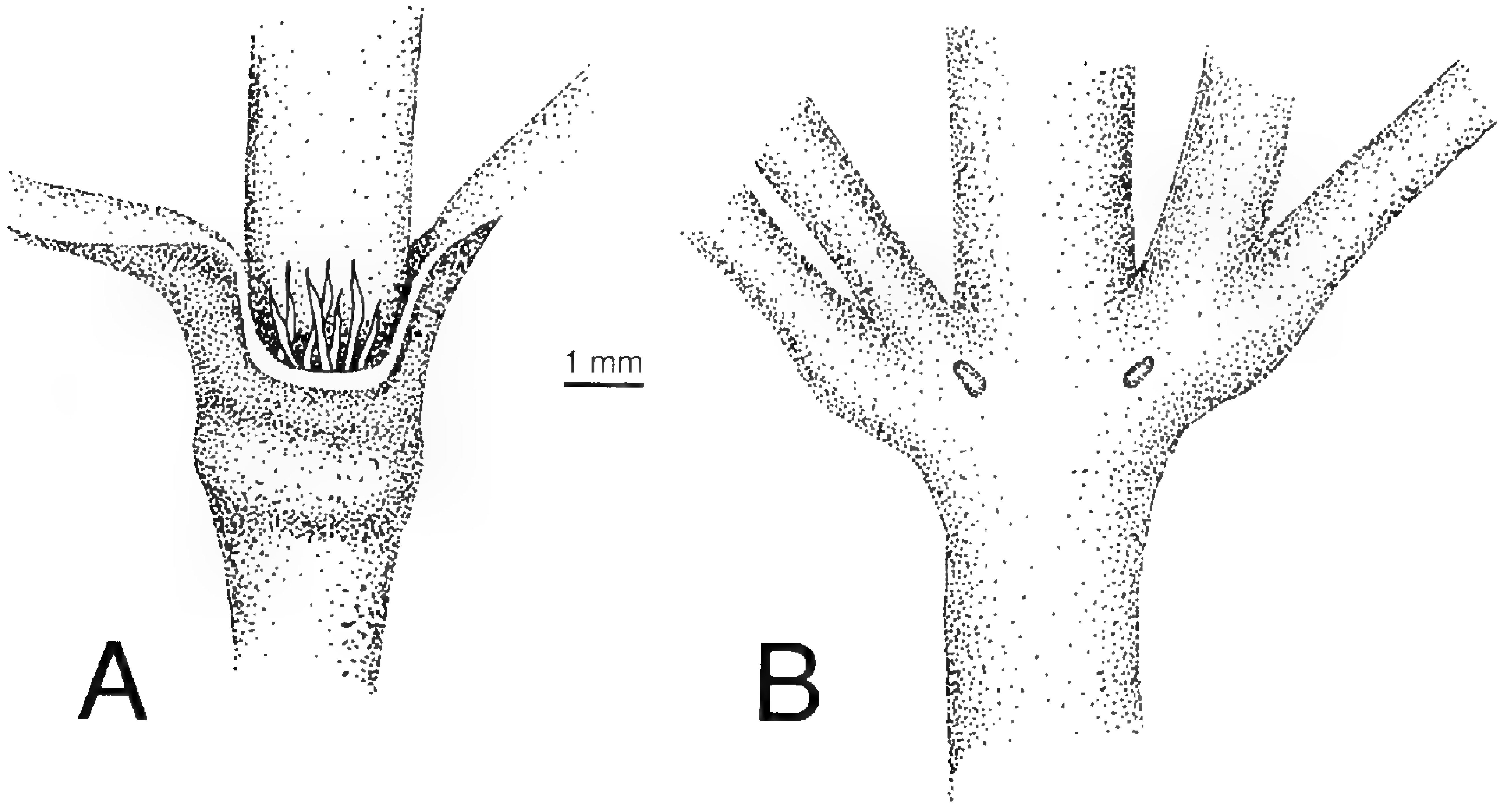

FIG. 2. Comparison of nodal morphology in *Hygrophila* and *Ludwigia*. A. *Hygrophila polysperma*. B. *Ludwigia repens*. Drawn by Amy L. Mahloch from live material.

Specimens examined. TEXAS. **Comal Co.:** Comal River, Landa Park, City of New Braunfels, ca. 100 m upstream of Pecan Island, mid-channel, in 1–2 ft of water, 21 Feb 1994, *Angerstein 94-1* (BRIT, SWT, TEX); Comal River, Landa Park, City of New Braunfels, in spring run underneath Landa Dr., 23 Feb 1994, *Angerstein 94-2* (SWT). **Hays Co.:** San Marcos River below Southwest Texas State University campus, 30 Nov 1969, *Tabler s.n.* (SWT); shoreline sandbar formed at mouth of Sessoms Creek, 22 Nov 1975, *Litchfield s.n.* (SWT); San Marcos River downstream from Clear Springs Apts. spillway, 5 Jul 1976, *Litchfield s.n.* (SWT); Southwest Texas State University raceway in gravel substrate, 28 Aug 1976, *Litchfield s.n.* (SWT); San Marcos River at Thompson's Island below county road bridge, 6 Mar 1991, *Staton s.n.* (SWT); San Marcos River upstream from Purgatory Island, 26 Apr 1991, *Staton s.n.* (SWT); San Marcos River at University Blvd., 26 Jun 1991, *Bierner 91-71* (TEX); Rio Vista Park, Purgatory Island, City of San Marcos, 30 Mar 1994, *Angerstein 94-5* (SWT, TAES); San Marcos River, Lions' Park area, San Marcos, 30 Mar 1994, *Angerstein 94-6* (SWT); San Marcos River, Sewall Park, San Marcos, along edge of concrete channel, 30 Mar 1994, *Angerstein 94-7* (SWT, TEX); Southwest Texas State University campus pond beside Freeman Bldg., 30 Mar 1994, *Angerstein 94-8* (SWT, TAES); Southwest Texas State University campus pond directly in front of J.C. Kellam Bldg., 30 Mar 1994, *Angerstein 94-9* (BRIT, SWT).

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THOMAS, TOWNSEND, OR TOWNSHEND— WHAT WAS T.S. BRANDEGEE'S NAME?

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T.S. Brandegee and his wife Katharine Brandegee were important California botanists (Setchell 1926) who contributed greatly to our knowledge of the flora of that floristically rich region during the early decades of the 20th century. The nature and extent of their contributions are amply dealt with elsewhere (see references) and need not detain us here. We became aware of the fact, however, that T.S. Brandegee's full name is referred to in the literature with several variants, which may be a source of confusion. We wished to ascertain which alternative is correct and to share our findings.

In his own publications Brandegee usually cited his name with initials only, as "T.S. Brandegee." Others often referred to him in this same way, but sometimes also as "Townsend Stith Brandegee" (Lanjouw & Stafleu 1954, Lindsay 1955, Thomas 1969, Stafleu & Cowan 1976), sometimes as "Townshend Stith Brandegee" (Setchell 1926, Jones 1929, Ewan 1950, Lindsay 1955, McVaugh 1956, Langman 1964, Thomas 1969, Hunt Institute 1972, Lenz 1986, pp. 26, 84, Bonta 1991, p. 87, Reveal & Pringle 1993), and sometimes as "Thomas Stith Brandegee." (Jones 1929, Rodgers 1968, Lenz 1986, p. 200). Indeed, four of the references cited above (Jones 1929, Lindsay 1955, Thomas 1969, Lenz 1986) are internally inconsistent in citing two different variants of Brandegee's name. We therefore conclude that no single reference can be considered authoritative in solving this problem, nor do we believe that this sort of question can be resolved by majority rule.

All references agree on his second name "Stith," taken from his mother's maiden name, so that is not a source of controversy. The first name (whether Thomas, Townsend, or Townshend), however, is clearly a source of uncertainty. But two references give an unequivocal answer and thus resolve the uncertainty, and we wish to share this information in the present note.

One paper published by Brandegee (Brandegee 1913) departs from his usual practice of using only initials in the byline, and clearly states "Townshend Stith Brandegee." The second and more persuasive bit of evidence is the portrait of Brandegee at the age of 80 published by Setchell (1926: plate 14), which includes the full signature of Brandegee, reading "Townshend Stith Brandegee." Thus, since it is attested in his own hand, there can be no doubt about the correct spelling of Brandegee's given name, which was not "Townsend" and certainly was not "Thomas."

Even more compelling but less readily accessible are documents in the Brandegee archives kept at the herbarium of the University of California (UC), including his "doctoral diploma from Yale, pension papers, and discharge from the U.S. Army," all of which specify his given name as "Townshend" (Barbara Ertter, pers. comm.).

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NOTES

NOTEWORTHY NEW RECORDS FOR NEOTROPICAL GENTIANACEAE—New distribution records, based on specimens I have recently identified, are reported here for six Mexican and South American species of Gentianaceae.

Gentiana mirandae Para

MEXICO. VERACRUZ: Mun. Huayacocotla, Viborillas, Huayacocotla, 2200 m, *Hernández M. & Trigos 1188* (F, GH).

This is the first record of this showy but rarely collected species for Veracruz, although the locality is near a previously reported locality in Hidalgo (Pringle 1977).

Gentianella achalensis (Hieron. ex Gilg) T.N. Ho & S.W. Liu

BOLIVIA. TARIJA. **Prov. Arce:** 12.5 km N of Emboroza-Sidras road, on road to Padcaya, 22° 12'S, 64° 37'W, 1150 m, *Solomon 10160* (MO). **Prov. Cercado:** 54.9 km E of Tarija-Padcaya road, on road to Entre Ríos, 21° 29'S, 64° 20'W, 2050 m, *Solomon 10324* (MO).

These records extend the known range of this species hitherto recorded only form Argentina, into southernmost Bolivia. Field work in Bolivia by J.C. Solomon was supported by the National Science Foundation.

Gentianella armerioides (Griseb. ex Gilg) J.S. Pringle

BOLIVIA. LA PAZ. **Prov. Loayza:** along the S fork of the Río Jiskha Choque Kkota which leads down from Cerro Huatia Kkota, ca. 4 km SE from Viloco, 16° 29'W, 4300–4650 m, *Lewis 871320* (MO).

This record extends the known range of this species, hitherto recorded only form Depto. Puno, Perú, into adjacent Bolivia.

Gentianella primuloides (Gilg) J.S. Pringle

BOLIVIA. LA PAZ. **Prov. B. Saavedra:** cerca de la carretera nueva de Cotacampa a Ulla-Ulla, Cerro Piñita, 4500 m, *Menhofer X-1782* (HAM, LPB).

The isotype at G, from Depto. Puno, Perú, which is of particularly good quality, is closely matched by this recent collection from just across the border in Bolivia, indication that this species is correctly attributed to the floras of both countries. The corollas were described by Manhofer (in sched.) as red ('rojas'), and show contrasting whitish bases, corresponding to Gilg's (1916) description.

Gentianella vargasii Fabris

BOLIVIA. LA PAZ. **Prov. Murillo:** La Paz-Calacoto 64 km hacia el nevado Illimani, sobre el pueblo de Pinaya, pie de Illimani, 4200 m, *Beck 9073* (HAM, LPB).

This record extends the known range ca. 570 km to the southeast and is the first for Bolivia, the species hitherto being known only form Depto. Cuzco, Perú (Fabris 1958). This indicates that the range of *G. vargasii* may be more extensive than that of most Andean *Gentianella* species, even though the species may be relatively uncommon. A parallel is approached, however, in the relatively extensive range of *G. punicea* (Wedd.) Holub, which extends from Depto. La Paz, Bolivia, along the mountain ranges northeast of Lake Titicaca, well into Perú. These ranges are essentially continuous from the international border to the southeastern part of Depto. Cuzco from which *G. vargasii* was previously reported.

Tapeinostemon zamoranum Steyerm.

PERU. AMAZONAS. **Luya Prov.:** Camporredondo-Tullanya, trocha hacia el Cerro Huicsocunga, 2350 m, *Díaz & Campos 3733* (HAM, MO). CAJAMARCA. **Cutervo Prov.:** San Andrés de Cutervo, Parque Nacional de Cutervo, entrando por "Chorro Blanco" sobre invernas del Sr. Nicolás Navarro, 2300–2400 m, *Díaz et al. 3951* (HAM, MO).

These records, which are the basis of my inclusion of this species in Brako & Zarucchi's (1993) *Catalogue of the Flowering Plants and Gymnosperms of Peru,* are the first for the genus and the species for Perú, *T. zamoranum* hitherto having been reported only from southern Ecuador (Steyermark 1951).

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This is Contribution No. 85 from the Royal Botanical Gardens, Hamilton, Ontario.

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SAGINA PROCUMBENS (CARYOPHYLLACEAE), NEW TO ILLINOIS—*Sagina procumbens* L., procumbent pearlwort, is a Eurasian native that has been found at various sites in North America, well established primarily along both the Atlantic and Pacific coasts (Crow 1978). Within the Great Lakes Region, it has been reported from scattered sites in Michigan, Minnesota, Ohio, and Wisconsin; all but four sites, three in the Lower Peninsula of Michigan (Crow 1978, Voss 1985) and one in central Ohio (Crow 1978), are along the shore of Lake Superior.

Sagina procumbens can now be reported from four counties in Illinois from the following collections:

ILLINOIS. **Cook Co.:** in patio blocks, 2601 Lake Ave., Wilmette, last week Jun 1976, *E. McArdle & R. H. Fargo s.n.* (MOR, SIU); sidewalk cracks, 5300 Block of N Spaulding Ave., Chicago, 27 Jun 1985, *Hattaway 5326* (MOR, [SIU]). **Kane Co.:** sidewalk cracks, 40 W 693 McDonald Rd., N of Wasco, 13 Jul 1991, *K. Johnson s.n.* (MOR). **Lake Co.:** between stones or brick, Farwell & Lydia Lee's residence, Lake Forest, 6[?] Jul 1965, *Rulison 49-X* (SIU). **Peoria Co.:** in brick sidewalk cracks, 200 block N Garfield St., Peoria, 15 Jun 1955, *Chase 14252* (ILL[2]).

The reports of *Sagina decumbens* (Elliott) Torrey & A. Gray from Cook and Lake counties by Mohlenbrock and Ladd (1978) and Swink and Wilhelm (1979) are based on specimens of *S. procumbens* cited here. *Sagina decumbens* is native to sandy areas in the southeastern United States and, except for a single collection from Peoria Co., is "occasional in the s. 1/2 of the state (Mohlenbrock 1986)." When the dots for Cook and Lake counties are removed, the map in Mohlenbrock and Ladd (1978) for the distribution of *S. decumbens* in Illinois is once again correct.

Hattaway 5326 is the basis of his report of *Arenaria groenlandica* (Retz.) Sprengel as new to Illinois and the Midwest (Hattaway, 1987); it was erroneously identified as that species.

Sagina procumbens can be distinguished from *S. decumbens* via the following key:

1. Plant perennial, stems procumbent, sepals diverging from the dehiscent capsule .... *S. procumbens*
1. Plant annual, stems filiform and mostly erect, sepals remaining appressed to the dehiscent capsule .... *S. decumbens*

Two other characters are commonly cited as separating these two species, features that *are* diagnostic in many, but not all cases. The flowers of *S. procumbens* are predominantly 4-merous with petals much shorter than the sepals or absent while those of *S. decumbens* are predominantly 5-merous with petals about equalling the sepals. Some populations of *S. decumbens* include plants that are smaller and more branched and that often have 4-merous apetalous flowers (specimens seen from Coles and Wabash cos., ILLS); Crow (1978) included these within the range of variation of *S. decumbens*.

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EMILIA FOSBERGII (ASTERACEAE: SENECIONEAE), A NEW INTRODUCTION TO TEXAS—*Emilia* is an Old World genus with approximately 45 species, three of which have become neotropical weeds (Nicolson 1975). Until recently *Emilia fosbergii* Nicolson has been reported in the United States only as a casual weed growing in southern Florida (Cronquist 1980; Barkley & Cronquist 1978).

In the fall of 1993, a population of approximately 40 individuals of *Emilia fosbergii* was found growing in and around a gravelly path in a south Austin nursery. Upon inquiry the manager informed me that the nursery has suppliers in Florida, which might explain the presence of this weed.

Voucher specimen: TEXAS. **Travis Co.:** City of Austin, A-1 Grass Nursery, two blocks S of Barton Skyway along S Lamar St., growing in gravel of parking lot and planting area, 20 Nov 1993, *Williams s.n.* (TEX).

Emilia fosbergii is distinguished from other Texas genera in the Senecioneae by the red disk flowers and absent ray flowers. The receptacle is flat to slightly convex, the leaves are alternate.

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NEW COLLECTION RECORDS FOR THE AQUATIC MACROPHYTES *CERATOPTERIS THALICTROIDES* (PARKERIACEAE) AND *LIMNOPHILA SESSILIFLORA* (SCROPHULARIACEAE) IN TEXAS—The spring systems that arise along the Balcones fault zone of central Texas support a diversity of aquatic macrophytes, including a number of adventive species that have not been reported from elsewhere in the state (Lemke 1989, Ramamoorthy & Turner 1992, Angerstein & Lemke 1994). The upper San Marcos River in Hays County, Texas, supports a macrophyte community comprising thirty-one species (Lemke 1989), two of which, *Ceratopteris thalictroides* (L.) Brongn. and *Limnophila sessiliflora* Bl., have not previously been reported elsewhere in Texas (Correll & Johnston 1970). Recent collections of aquatic macrophytes from Landa Lake, a small reservoir formed by the damming of the headwaters of the Comal River in New Braunfels, Comal County, Texas, have documented the presence of these two species in this river system as well.

Ceratopteris thalictroides is a tropical, free-floating, homosporous aquatic fern that has been introduced into Florida, Louisiana, Texas, and California (Lloyd 1993). The species was first reported from Texas by Morton (1967) and its introduction into the San Marcos River by a local aquarium plant supply company was documented by Hannan (1969). The following collection represents only the second county record for the species in Texas:

Voucher specimen: TEXAS. Comal Co.: free-floating along north shore of Landa Lake, Landa Park, City of New Braunfels, 16 Apr 1994, *Lemke 4163* (SWT).

Limnophila sessiliflora is a submersed or emergent macrophyte indigenous to India and Southeast Asia. It resembles the native species *Cabomba caroliniana* A. Gray in gross morphology, but can be easily distinguished in the vegetative state by its bright green coloration, more compact growth habit, and verticillate leaves. *Limnophila sessiliflora* is reported to be sporadically naturalized in Florida and Georgia; the following collection represents only the second county record for the species in Texas:

Voucher specimen: Texas. Comal Co.: submerged along north shore of Landa Lake, Landa Park, City of New Braunfels, 25 May 1994, *Lemke 4171* (SWT).

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It seems likely that these species were introduced into Landa Lake either intentionally, as has been documented for *C. thalictroides* in Texas by Hannan (1969) and for *L. sessiliflora* in Florida by Mahler (1980), or unintentionally through careless dumping by aquarists, as has been surmised for the aquatic weeds *Nomaphila stricta* (Vahl) Nees (Acanthaceae) by Ramamoorthy & Turner (1992) and *Hygrophila polysperma* (Roxb.) T. Anders. (Acanthaceae) by Angerstein & Lemke (1994).

Although *C. thalictroides* has not been reported to occur so abundantly as to cause problems in aquatic ecosystems, *L. sessiliflora* is of concern as a potential aquatic weed. Several species of *Limnophila,* including *L. sessiliflora,* are responsible for major weed infestations throughout much of Southeast Asia and virtually all herbicides registered for use in aquatic systems have proven ineffective in controlling these species (Misra & Tripathy 1975, Takematsu et al. 1976, Mahler 1980). Spencer & Bowes (1985) reported that *L. sessiliflora* has several characteristics that could provide it with a competitive advantage over native aquatic plants in Florida, such as a substantial reproductive capacity, the potential for a low photorespiration rate, and the ability to photosynthesize effectively under low light regimes.

Limnophila sessiliflora was reported to be uncommon in the San Marcos River by Lemke (1989) but has been found to be abundant in parts of Landa Lake, where several individuals were observed to be flowering in the summer of 1994. Although the species has a limited capacity for asexual reproduction, this may be offset by its profuse sexual reproduction. Spencer & Bowes (1985) reported that each flower of *L. sessiliflora* may set between 200 and 300 seeds with a germination rate as high as 96 percent. Presently there is no evidence that *L. sessiliflora* is having a deleterious effect on the growth of native aquatic plant species in either the San Marcos or Comal rivers; however, the spread of this species in the spring systems of central Texas should be closely monitored.

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QUERCUS LACEYI (FAGACEAE) NEW TO THE LLANO UPLIFT AREA OF CENTRAL TEXAS—The Lacey oak, *Quercus laceyi* Small, is a small to moderate-sized tree that is commonly found on mesic north-facing slopes and in canyons on the Edwards Plateau of central Texas. The range of the species in Texas extends from Bexar and Medina counties in the east to Terrell and Brewster counties in the west; it is also found on the eastern slopes of the Sierra Madre Oriental in Coahuila and Nuevo Leon, Mexico (Muller 1951, Nixon & Muller 1992). These plants were included in *Q. glaucoides* Mart. & Gal. by Trelease (1924) and Correll & Johnston (1970), but have recently been shown to represent a distinct allopatric species, with true *Q. glaucoides* being confined to central and southern Mexico (Nixon & Muller 1992).

Quercus laceyi was described by Small (1901) from material collected "on limestone hills" in Kerr County, Texas, and subsequent descriptions of the habitat of the species (e.g., Muller 1951, Correll & Johnston 1970, Nixon & Muller 1992) have always emphasized the calcareous substrate. In October, 1993, I discovered a stand of several dozen individuals of *Q. laceyi* in a mesic canyon at Enchanted Rock State Natural Area in Gillespie and Llano counties, Texas. The individuals were mostly mature trees 20–30 cm in diameter growing in association with *Celtis reticulata* Torr. and *Diospyros texana* Scheele. The following collection citation is the first documentation of the occurrence of *Q. laceyi* on the igneous-derived sandy soils of the Llano Uplift rather than the limestone-derived soils of the surrounding Edwards Plateau:

Voucher specimen: TEXAS. Llano Co.: Enchanted Rock State Natural Area, in canyon between Enchanted Rock and Little Rock, 13 Oct 1993, *Lemke 4138* (SWT, TEX).

Given that several vegetation studies have been conducted in the area now included within Enchanted Rock State Natural Area (Whitehouse 1933, Butterwick 1979, Walters 1980) and that the collection site is situated along a frequently used hiking trail, it is surprising that the occurrence of *Q. laceyi* has not been previously noted. This may be due to superficial similarities between Lacey oak and post oak (*Q. stellata* Wang.), which is common throughout the park. I myself have walked past this stand of trees numerous times over the last 18 years and never noticed them until last fall. Upon close examination, however, the characteristic bluish-green upper leaf surface and waxy deposits on the pulvinus readily distinguish *Q. laceyi* from *Q. stellata*.—*David E. Lemke, Department of Biology, Southwest Texas State University, San Marcos, TX 78666, U.S.A.*

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SOLANUM VIARUM (SOLANACEAE), NEW TO MISSISSIPPI—*Solanum viarum* Dunal, TROPICAL SODA APPLE, is a perennial shrub that belongs to section *Acanthophora* of subgenus *Leptostemonum* (Nee 1991). It is native to Brazil and Argentina but has become a weed in other areas of South America and in Africa, India, Nepal, West Indies, Honduras, and Mexico (Nee 1991) and Florida, U.S.A. (Coile 1993, Mullahey et al. 1993a, 1993b, 1993c).

Mature plants of *S. viarum* are 1 to 2 m tall and are armed on the leaves, stems, pedicles, petioles, and calyxes with broad based white to yellowish prickles up to 12 mm long (Nee 1991, Mullahey et al. 1993c). Leaves and stems are pubescent; corollas are white with five recurved petals and white to cream colored stamens that surround the single pistil (Coile 1993). Immature fruits are mottled whitish to light green and dark green (i.e., like a watermelon) (Mullahey et al. 1993c). The mature fruits are smooth, globular, yellow, and 2 to 3.2 cm in diameter with a leathery skin surrounding a thin-layered, pale-green, mucilaginous, scented pulp and moderately flattened, reddish-brown seeds (Coile 1993; Mullahey et al. 1993a). Each *S. viarum* plant has the capability to produce over 50,000 seeds (Mullahey et al. 1993c).

The first known U.S.A. collection of *S. viarum* was from Glades County, Florida

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in 1988, but it may have been present in Florida as early as 1981 or 1982 (Coile 1993). Since its introduction into Florida, *S. viarum* has spread rapidly. By 1993 it was reported to infest over 61,000 ha of improved pastures, citrus groves, sugar cane fields, ditches, natural areas (oak hammocks and cypress heads), etc. (Mullahey et al. 1993b). Drs. Robert Eplee and Randy Westbrooks (pers. comm., U.S. Dept. Agric., APHIS, PPQ, Whiteville, NC) estimated that by early 1994 *S. viarum* infested as many as 285,000 ha in Florida. Because of its rapid population explosion in Florida, *S. viarum* was placed on the Florida noxious weed list on February 28, 1994.

The primary means of dispersal of *S. viarum* seems to be livestock and wildlife, such as raccoons, deer, feral hogs, and birds feeding on the fruits (Coile 1993, Mullahey et al. 1993a). Mullahey et al. (1993a) reported that *S. viarum* foliage is unpalatable to livestock although cattle will eat the mature fruit. Scarification of seeds by digestive systems of livestock and wildlife seems to promote seed germination. Intra- and inter- county and state movement of livestock that have recently fed on *S. viarum* fruit may be the primary vectors for its spread. However, contaminated hay may also serve as a means of dispersal (Wunderlin et al. 1993). Once *S. viarum* is established, livestock and wildlife continue to disperse seeds resulting in population levels that may increase exponentially.

Collection data for *S. viarum* in Mississippi follow with herbarium abbreviations after Holmgren et al. (1990), except MMNS and USMH (Mississippi Museum of Natural Science, Jackson and University of Southern Mississippi, Hattiesburg, respectively).

Voucher specimens: U.S.A. MISSISSIPPI. **Forrest Co.**: NW of Hattiesburg, 5 mi NE jct. of Hwys I-59 & US 98, S of US 98, Southeast Mississippi Livestock Auction, 27 Jul 1994, *Bryson 13995* (BRIT/SMU, IBE, MISS, MMNS, NLU, PIHG, SWSL, USMH, VSC, VDB, additional specimens to be distributed); 15 Aug 1994, *Bryson 14188 & Rosso* (SWSL, additional specimens to be distributed). **Lamar Co.**: S of Oloh, 2.8 mi S of Hwy US 98 and to E of Purvis-Oloh Rd, 27 Sep 1994, *Bryson 14454, Byrd, & Rouse* (SWSL, additional specimens to be distributed); *Bryson 14456, Byrd, & Rouse* (IBE, NY, SWSL, additional specimens to be distributed); Oak Grove Community, SE of jct. Oak Grove Road (= old Hwy US 11) & Griffith Rd, 27 Sep 1994, *Bryson 14457, Byrd, & Rouse* (SWSL, additional specimens to be distributed). **Pearl River Co.**: SE of Poplarville, 4.3 mi SE jct. of Hwys I-59 and MS 53, E of MS 53, 14 Jul 1994, *Byrd s.n.* (IBE, SWSL); 27 Jul 1994, *Bryson 13996* (BRIT/SMU, DSC, IBE, MISS, MMNS, NLU, PIHG, SWSL, USMH, VSC, VDB, additional specimens to be distributed); 16 Aug 1994, *Bryson 14266 & Lockley* (SWSL, additional specimens to be distributed); 8 Sep 1994, *Bryson 14367* (NLU, SWSL); SE of Poplarville, 2.1 mi SE jct. Hwys I-59 & MS 53, N of Restertown Rd, 17 Aug 1994, *Bryson 14274 & Byrd* (SWSL); SE of Poplarville, 2.1 mi SE of jct. Hwys I-59 & MS 53, E on Restertown, W of Bert Gentry Road, 17 Aug 1994, *Bryson 14276 & Byrd* (SWSL). **Stone Co.**: ca. 11 mi WSW of Perkinston, 1.5 mi S of jct. Ridge Rd & Red Gap Rd on Red Gap Rd, 17 Aug 1994, *Bryson 14279 & Byrd* (SWSL, additional specimens to be distributed).

The senior author first observed several plants of *S. viarum* growing in the

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median of Hwy I-10 between mile markers 17 and 18 in Hancock County, Mississippi on 17 October 1993 but did not realize the significance of the observation until the annual meeting of the Weed Science Society of America in February 1994. Subsequent trips to this site and surrounding areas in May, June, and early July 1994 were unproductive in relocating *S. viarum* because the median had been mowed. An additional sighting was reported from Hinds County, Mississippi in late 1993.

At the Forrest County location six *S. viarum* plants were found along a livestock holding-pen fence. Plants were about 1 m tall and were possibly established the previous year, each bearing up to 50 mature fruits per plant. About 200 *S. viarum* plants in a 2 to 4 ha area were present at the inital Pearl River County location, ranging in size from seedlings to 1.5 m tall with mature fruit. Additional seedling plants were observed with each successive visit to this location. At this site, plants were observed growing in the shade of pecan and oak trees but most were growing in full sun. Dead plants with mature fruit from the previous season were observed along a fence row that had been treated with a herbicide. The land owner stated that the plants had been at this Pearl River County location since 1991 and he pointed out several plants that had produced fruit in 1993. Evidently *S. viarum* is at least a short-lived perennial in southern Mississippi. At the Stone County location, *S. viarum* infests several 100 ha of pastures and holding-pens around a farm headquarters barn at the end of Red Gap Road. In Lamar County, *S. viarum* infests a total of about 50 ha at two locations. At each of the locations in Lamar, Pearl River, and Stone counties, *Solanum viarum* was found in pastures where livestock had been introduced from Florida within the past few years and population size seems to be directly proportional to the total number of livestock imported from infested areas in Florida.

At each location in Mississippi, plants were growing in a sandy loam soil. Mature plants were dug up at each location. In mature plants, *S. viarum* root systems were up to 3 dm deep with lateral roots up to 1 m long and 1.5 to 2.5 cm in diameter.

In laboratory and greenhouse experiments at Stoneville, MS, it was discovered that *S. viarum* fruit will ripen in sunlight if the green fruit were greater than 2 cm in diameter. Seed germination from these fruit was greater than 70% in greenhouse conditions. In addition to dispersal by livestock and wildlife, it was discovered that *S. viarum* fruit may be dispersed by water. *Solanum viarum* fruit from less than 1 cm in diameter to mature yellow or dry fruit are extremely buoyant. Thus, control of *S. viarum* requires elimination of immature and mature fruit as well as the whole plant including the root system.

In order to prevent further dispersal of this pernicious weed, the U.S. Dept. Agric., APHIS, PPQ and the Mississippi Cooperative Extension Service are initiating an education and notification campaign on the potential weed problem of *S. viarum*. Additional surveys and an eradication program in Mississippi may be required to prevent *S. viarum* spread not only within Mississippi but into other states. Botanists, livestock producers, weed scientists, and regulatory officials should be alerted that *S. viarum* may already be in their region. Early detection is paramount to eliminate this weed, which has the potential to infest millions of ha of pasture lands, row crops, truck crops, sod farms, lawns, forests, and natural areas, especially in tropical and subtropical regions of the U.S.A. and other countries. Additional research is needed to determine *S. viarum* fitness to more northern areas of the U.S.A.

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We thank Michael Nee (NY) for verification of the initial collections of *S. viarum* and Richard Carter (VSC), Nancy Coile (PIHG), Jeff Mullahey (SW Florida Research and Education Center, Immokalee, FL), and Robert Eplee and Randy Westbrooks (U.S. Dept. Agric., APHIS, PPQ, Whiteville, NC) for providing information on the biology and spread of *S. viarum* in Florida.

—Charles T. Bryson, USDA, ARS, Southern Weed Science Laboratory (SWSL), Stoneville, MS 38776, U.S.A. and John D. Byrd, Department of Plant and Soil Sciences, Mississippi State Univ., Mississippi State, MS 39762, U.S.A.

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BOOK REVIEW

Bremer, K. (with assistance of A. A. Anderberg, P. O. Karis, B. Nordenstam, J. Lundberg, and O. Ryding) 1994. **Asteraceae: Cladistics and Classification.** (ISBN 0-88192-275-7, hbk). Timber Press, Portland, Oregon. $79.95 (hbk). 752 pp., 89 figures, 24 tables, 6" x 9".

Often viewed as a nontraditionalist for his early espousal of cladistic methodology, Kåre Bremer has produced a monograph of the Asteraceae in the finest Benthamian tradition. This is no easy task in today's world of multiple sources of comparative data and conflicting taxonomic opinions among the disproportionately populous community of synantherologists. However, Bremer, who heads a Swedish research team in studying the systematics of the Old World composite tribes, has become a recognized authority on the Asteraceae as a whole. Bremer has created a handbook of genera and suprageneric taxa set in the context of insights from recent phylogenetic research and of unresolved problems. However, unlike recent symposium volumes which provide a forum for disparate views and often uneven treatments, this volume is the expression of relationships and classification seen from a single perspective.

The book is composed of four introductory chapters and 19 systematic chapters that treat the three subfamilies and 17 tribes in detail. The introductory chapters cover 1) a brief overview of cladistic methods, 2) the history of classification of the Asteraceae, 3) morphological criteria, and 4) the origin of the family and major unresolved problems relevant to the family as a whole. Each of the systematic chapters provides 1) an overview of the variation in and past treatments of the subfamily or tribe, 2) a new or recently published cladistic analysis, 3) discussion of the taxon's evolution, and 4) formal descriptions of the subtribes and genera. The treatments of the Inuleae, Plucheeae, Gnaphalieae, Calenduleae, Helenieae, Heliantheae, and Eupatorieae were contributed in whole or part by Bremer's associates.

Bremer's goal is "...not to provide a final classification of the Asteraceae, but rather to review the strengths and weaknesses of current classification to facilitate further revisions by future taxonomists" and "to provide a fairly even and consistent treatment of the tribes". In my opinion, he has succeeded in both. Even though the treatments of the Old World tribes are given somewhat more attention because the Stockholm group is most familiar with them, the disparity does not create a noticeable unevenness, and the added insights are a plus for the North American synantherologist who has not ventured beyond the Isthmus of Tehuantepec.

In a sense, the value of the book depends on the audience. I believe that it will be of greatest use to students, to herbarium curators, and to amateur and general taxonomists. These people can use it as a reference to the genera of composites, as well as to understand the evolution of the family as whole. However, professional synantherologists, who already have references with generic descriptions, will find the value to be in the cladistic analyses and discussions. Bremer could have maintained the force in his views, as well as greatly reduced the size and price, by forgoing the generic descriptions. In fact, the information present is summarized in coded form in the data matrices provided.

Along this same line, one could criticize the cladistic analyses because the monophylesis of the generic OTUs is not explicitly substantiated in the text or tables. One must wonder whether variable characters of certain large genera are coded for the most plesiomorphic state of a synapomorphic transition or whether the most plesiomorphic of a symplesiomorphic transition (relative to segregates) was used. This may not be a problem for the suprageneric classification if the segregate and the large potentially paraphyletic genus are treated in the same subtribe.

However, the suprageneric classification is problematic in cases such as *Dendroseris*, which is treated in its own subtribe. Sanders et al. (1987) reviewed the suggestions for the origin of this oceanic island endemic. Included are *Hieracium* (probably sect. *Stenotheca)*, *Sonchus*, *Stephanomeria*, and a few other small genera. Bremer cites a paper that suggests the transfer of sect. *Stenotheca* to *Crepis*. Each of these four possible ancestors is in a separate subtribe. In Bremer's cladogram, *Dendroseris* is several branches and 10 steps away from *Stephanomeria*, 6 steps away from *Crepis*, and one step away each from *Hieracium* and *Sonchus*. Undoubtedly, sect. *Stenotheca* should have been treated as a separate OTU and/or the large genera should have been represented by potentially monophyletic subgroups to more accurately assess the subtribal alignment of *Dendroseris* and circumscription of the pertinent subtribes.

Bremer and his associates have thoroughly referenced the pertinent literature. However, I did find at least one minor error. T. F. Stuessy is omitted as a co-author of Sanders et al. (1987). This is especially unfortunate because Prof. Stuessy designed the study, obtained funding, led the field work, and kept a reign on me while I carried out analyses and drafted the initial text.

Overall, I recommend this book based on its scholarly production and provocative content. Depending on one's needs, this may be a "must have" reference. However, many specialists may wince at having to buy another large, expensive review of the Asteraceae.

Literature Cited:

SANDERS, R. W., T. F. STUESSY, C. MARTICORENA, and M. SILVA O. 1987. Phytogeography and evolution of *Dendroseris* and *Robinsonia*, tree-Compositae of the Juan Fernandez Islands. *Opera Bot.* 92: 195-215.—*Roger W. Sanders.*

Notes

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A NEW SPECIES OF *ZIGADENUS* (LILIACEAE) FROM NEW MEXICO, WITH ADDITIONAL COMMENTS ON THE SECTION *ANTICLEA*

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ABSTRACT

A new species, *Zigadenus mogollonensis*, is described and illustrated. Its large flowers are campanulate, cernuous, and have a distinct purplish tinge. It is endemic, but quite locally common, to the Mogollon Mountains of southwestern New Mexico. A discussion on related species characteristics and variation within the section *Anticlea* of the genus *Zigadenus* is also presented.

RESUMEN

Se describe e ilustra una nueva especie, *Zigadenus mogollonensis.* Sus flores grandes son campanuladas, colgantes y tienen un tinte púrpura manifiesto. Es endémica, aunque muy común localmente, de las montañas Mogollon del Suroeste de Nuevo México. Se ofrece también una discusión de las características y variación en las especies emparentadas dentro de la sección *Anticlea* del género *Zigadenus.*

In 1968, Hess collected a *Zigadenus* from the interior of the Mogollon Mountains in southwestern New Mexico and identified it as *Zigadenus virescens* (Kunth) J.F. Macbr. In the summer of 1993, he returned to the same general area and recollected this plant. Upon becoming familiar with the true *Z. virescens*, it was evident that the original collection was misidentified and that this *Zigadenus* was undescribed. Through inquiry, Hess discovered that Sivinski was also studying this same plant in the Mogollon Mountains, and had independently arrived at the same conclusion that it was a new and undescribed species of *Zigadenus*.

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Zigadenus mogollonensis Hess & Sivinski, sp. nov. (Fig. 1)

Perennius robustus, (4.5–)5.5–8.5(–9.5) dm altus. Bulbi tenues ovoidei, 2–3 × 1.3–2 cm, tegmento papyraceo tenue vel tegmento crasso fibrarum e basibus foliorum veterum ad 1 dm infra terram. Folia basalia ad 35 cm longa, 10–18 mm lata, margines leviter scabri; folia caulina 1–3(–5) sursum deminuta. Inflorescentiae racemosae (8–)10–21(–28) nodis, 10–25(–35) × 3.5 -8 cm, interdum paniculati ramis ex infernis 2–3 nodis. Pedicelli crassi, 1.3–2 cm longi, recurvati sub anthesi, fructificantes erecti; bracteae infimae 2–4 × 0.5–1.2 cm, acutae vel acuminatae, pallide virides, saepe tinctae purpurae per longitudinem marginum, longiores pedicellis, interdum extensi trans flores. Flores campanulati et cernui; tepala elliptica, margines saepe recurvi, 12–16 × 7–9.5 mm, rutilantia vel margines rutilantes, virescentes (pallide flavovirentes vel virides) prope venam mediam abaxialem, adaxialem vulgo pallidiores; apices rotundati, aliquando leviter emarginati; gradatim angustati ad basem vel late unguiculati; venae viridulae, arcuatae versus apicem; glandes 5–6.5 × 3.2–5(–6) mm, leviter expansae ad extremitates, apices emarginati vel undulati, aliquantum bilobati, flavovirentes; stamina cum filamentis 7–8 mm longa, dilata basi, 1.5–2 mm lata, decrescentia ad 0.5 mm lata articulo antherarum, antherae 2.4–2.6 × 1.7–2 mm, hippocrepiformia, dehiscentia per totam longitudinem, pollen striatum, monosulcatum 30–42µ × 18–24µ; pistilla tricarpellata, ovaria partim inferiora, trilocularia, 3 styli et stigmata; ovula numerosa, plana, breviter lanceolata. Capsulae trilobatae, 12–15 mm longae, lobi tepalae orientes 4–5 mm super pedicellos; nulla semina observata.

Robust perennials, (4.5–)5.5–8.5(–9.5) dm tall. Bulbs slender, ovoid, 2–3 × 1.3–2 cm, with thin, papery covering to thick, fibrous covering from old leaf bases, to 1 dm below ground. Basal leaves to 35 cm long, 10–18 mm wide, margins slightly scabrous; cauline leaves 1–3(–5), reduced upwards. Inflorescences racemose, with (8–)10–21(–28) nodes, 10–25(–35) × 3.5–8 cm, occasionally paniculate with branches from lower 2 or 3 nodes. Pedicels stout, 1.3–2 cm long, recurved at anthesis, erect in fruit; lowest bracts 2–4 × 0.5–1.2 cm, acute to acuminate, pale green, often purple-tinged along the margins, longer than pedicels, occasionally extending beyond the flowers. Flowers campanulate and cernuous; tepals elliptic to broadly elliptic, the margins often arching inward, 12–16 × 7–9.5 mm, purplish-red or margins purplish-red blending to pale yellow-green or green near midvein abaxial side, mostly lighter colored adaxial side; apices rounded, occasionally slightly emarginate; gradually tapering to base or broadly clawed; veins greenish, arching towards apex; glands 5–6.5 × 3.2–5(–6) mm, slightly expanded terminally, apices emarginate or undulate, somewhat bilobed, greenish-yellow; stamens with filaments 7–8 mm long, dilated at base, 1.5–2 mm wide, tapering to 0.5 mm wide at anther connection, anthers 2.4–2.6 × 1.7–2 mm, horseshoe-shaped, dehiscing entire length, pollen striate, monosulcate, 30–42µ × 18–24µ; pistil tricarpellate, ovary partially inferior, trilocular, 3 styles and stigmata; ovules many, flat, short lanceolate. Capsules 3-lobed, 12–15 mm long, tepal lobes originating 4–5 mm above pedicels; no seeds seen. Flowering late August to early September. Fruiting September.

Fig. 1. *Zigadenus mogollonensis.* A. Habit. B. Flower with outline of glands on tepals. C. Flower and bract. D. Pendulous flowers

TYPE: U.S.A. NEW MEXICO. Catron Co.: Mogollon Mts., of the Gila Wilderness, Gila National Forest, vicinity of Mogollon Baldy, Whitewater Baldy, Black and Sacaton Mts., on Little Dry Creek Trail from Apache Springs, elev. 2860 m, 20 Aug 1968, *W. Hess 2212* (HOLOTYPE: MOR; ISOTYPES: ARIZ; NCU; NMC; NY; OKLA; SMU; US).

Additional collections examined: U.S.A. NEW MEXICO. Catron Co.: Mogollon Mts., S of Whitewater Baldy, center of sect. 30, T11S R18W, elev. 3140 m, understory of dense, mature forest, 9 Sep 1980, *R. Fletcher 4856* (UNM); 15 mi NE of Mogollon, 1 Aug 1938, *C.L. Hitchcock, R.V. Rethke, R. van Raadshooven 4463* (WTU); along Bursum Road E of Mogollon, T11S R18W sect. 3, elev. 2770 m, 19 Jul 1994, *C.A. Huff 1660* (UNM); between Apache Cabin & Sacaton, Baldy, Mogollon Mts., 9000 ft, 20 Jul 1959, *A.R. Kruckeberg 4671* (WTU; UC); Gila Forest Trail 182, ca. 2.5 km S of NM 78, T11S R18W sections 2 and 11, elev. 3050 m, 2 Aug 1987, *G.A. Levin 1909* (NMC); Gila Wilderness, Whitewater Baldy, spruce-fir forest with *Vaccinium myrtillus* and *Rubus parviflorus*, infrequent, elev. 3020 m, 2 Aug 1974, *W.H. Moir 315* (NMC; RM); Mogollon Mts., Forest Trail No. 182, Sandy Point, first 2 mi, ponderosa pine-aspen forest, 15 Aug 1974, *D. Pinkava, E. Lehto & T. Reeves P12558* (ARIZ; WTU); Gila National Wilderness, Mogollon Mts., ca 10 air mi ESE of Mogollon and 1 mi from Hwy 78 on Trail 206 to Redstone Park, on W-slope, soil rocky clay with humus, *Populus tremuloides, Pteridium, and Rubus*, elev. 2680 m, 5 Sep 1976, *J. Reitzel, D. Hill & R. Spellenberg 33* (NMC); Mogollon Mts., Forest Service Road 159 between Silver Creek Divide and Sandy Point, T11S R18W sect. 3 SW 1/4, on rhyolitic soil, N-facing slope in understory of mixed conifer forest of *Pseudotsuga menziesii, Abies concolor, Acer glabrum, Geranium richardsonii, Viola canadensis*, elev. 2800 m, 12 Aug 1993, *R. Sivinski & K. Lightfoot 2517* (MOR, UNM); on NM Hwy 78 between Mogollon and Beaverhead, T11S R18W sect. 2 SW 1/4, with spruce, fir, limberpine, aspen, thimbleberry, *Geranium, Cornus, Oxalis, Senecio cardamine*, elev. 2770 m, 16 Aug 1985, *R. Spellenberg & N. Zucker 8237* (NMC); Mogollon Mts., Mogollon Road, 8 Aug 1900, *E.O. Wooton s.n.* (US).

Zigadenus mogollonensis is apparently endemic to the mixed conifer and spruce-fir forests of the Mogollon Mountains between 2650 and 3200 meters in elevation. It is a common understory component of these high elevation forests and usually occurs on highly organic soils with a thick humus layer. Variation within this species is represented by its completely racemose or branched lower inflorescence, its range of tepal lengths between 12 and 16 mm, and corolla pigmentation of pale yellowish-green with pale purple margins to green with dark brownish-purple margins. The exceptional specimen of *Reitzel et al. 33* (NMC) has green tepals with only little anthocyanic pigmentation, and is here placed within *Z. mogollonensis* because of its long (13 mm) tepals and campanulate corolla. Previous collectors have usually identified this species as *Z. virescens*, but also as *Z. elegans* Pursh and *Z. porrifolius* Greene.

The nearest related species to *Zigadenus mogollonensis* are *Z. elegans* and *Z. virescens*. Both are widespread species, with *Z. elegans* ranging from Alaska to northern Mexico and *Z. virescens* occurring in the Sierra Madres of Mexico north to the southern mountains of Arizona and New Mexico. *Zigadenus mogollonensis* and *Z. elegans* have a similar inflorescence, which is usually racemose, but can have one or few lower panicled inflorescence branches.

Rotate to rotate-campanulate corollas, erect pedicels at anthesis, and shorter (5–10 mm) tepals are characteristics of *Z. elegans*, whereas *Z. mogollonensis* is distinguished by its campanulate corollas, cernuous flowers at anthesis, and longer (12–16 mm) tepals. *Zigadenus virescens* is a more delicate plant with thinner pedicels and panicle branches, shorter bracts (usually less than the length of the pedicel), small (4–7 mm) tepals, campanulate corollas, and recurved pedicels at anthesis. *Zigadenus mogollonensis* has more robust pedicels and branches, larger bracts (as long or longer than the pedicels) and much larger tepals. The anterior margins of its tepals are also suffused with anthocyanic red over yellowish-green, which gives the flower a brownish-purple appearance. Both *Z. elegans* and *Z. virescens* frequently have anthocyanic bracts; however, this pigmentation infrequently extends to the flowers, and then is confined to the base of the tepals on the abaxial surface. Their open flowers are white, ochroleucous, or pale green. The references to purplish-flowered *Z. elegans* in western American floras (Correll & Johnston 1970; Harrington 1964) are overstated and apparently derived from the description of purplish tepals for *Z. coloradensis* Rydberg (1900), which is a synonym of *Z. elegans*. The type specimen of *Z. coloradensis* is white-flowered, with small amounts of anthocyanic pigment on the abaxial surface of the tepals. The purplish pigmentation of *Z. mogollonensis* is much more intense and colors the anterior margins of the tepals.

Zigadenus elegans is very rare in the Mogollon Mountains of New Mexico and is known from that range by a single 1881 collection (*Rusby 406* US, only the flowering plant on sheet). However, *Z. elegans* is more common in the adjacent White Mountains of eastern Arizona and northern mountain ranges of Arizona and New Mexico. *Zigadenus virescens* is common in the Mogollon Mountains and occurs with *Z. mogollonensis* on the same forested slopes near Silver Creek Divide. No evidence of hybridization was observed at this point of sympatry. Pollen samples from four *Z. mogollonensis* and two adjacent *Z. virescens* were tested with Alexander's stain and found to be 99-100% viable. Late summer flowering times here are somewhat overlapped, but most *Z. virescens* flowered a little earlier and produced fruit at the time *Z. mogollonensis* was in full flower. A few unusual specimens of *Z. virescens* from the northern Mogollon Mountains (*Daniel & Nelson 3598* ASU; *Hubbard s.n.* UNM) have large, leafy bracts that could possibly indicate a past crossing event with *Z. mogollonensis*.

Zigadenus mogollonensis appears most similar to the large-flowered forms of *Z. volcanicus* Benth. in the Sierra de los Cuchumatanes in the Huehuetenango district of western Guatemala. These two populations have long tepals, large bracts, cernuous/campanulate flowers and thick pedicels. They are differentiated by the somewhat larger, purple tepals of *Z. mogollonensis* compared to the white to ochroleucous tepals of the plants in Guatemala.

ADDITIONAL COMMENTS ON SECTION *ANTICLEA*

The above species belong to the section *Anticlea* of the genus *Zigadenus,* which is characterized by a single bilobate or obcordate gland at the base of each tepal and a partially inferior ovary. Preece (1956) recognized five American taxa (*Z. elegans* var. *elegans, Z. elegans* var. *glaucus* (Nutt.) Preece, *Z. virescens*, *Z. vaginatus* (Rydb.) J.F. Macbr., *Z. volcanicus*) in this section with one, or possibly two, additional species in Asia. Turner (1992) recently added another Mexican species (*Z. hintoniorum* B.L. Turner) to the section *Anticlea*. The species of this section are usually distinct, but among the taxa intergradations and inconsistent variations are common. Species diagnosis must often rely on a combination of descriptive, qualitative features rather than definitive, measurable characteristics. Species descriptions that do not account for the range of variation have made this genus misunderstood, and is evidenced by a long list of synonymy and the questionable rank of a few taxa. After studying the types and several hundred specimen sheets, the following discussion attempts to clarify some of the morphological tendencies of the American taxa in the section *Anticlea* of *Zigadenus*.

The two most important characteristics in separating taxa in the section *Anticlea* are the position of the flower (erect or nodding) and flower shape (rotate or campanulate). The flowers at anthesis are either on erect pedicels with perianth widely spreading or rotate-campanulate, or cernuous pedicels with perianth consistently campanulate. Unfortunately, these characteristics are often difficult to assess on pressed and dried specimens, and collectors are well advised to note the floral aspects of fresh plants. It is also important to assess these characteristics on flowers in anthesis, since taxa with erect flowers can have cernuous buds, while those with nodding flowers will usually become erect in fruit.

Plants with erect/rotate flowers are best represented by the *Zigadenus elegans* complex. This is the common North American species that extends from Alaska and eastern Canada to the southern Rocky Mountains and is sporadic in northern Mexico. It is very polymorphic, but retains some consistency by its erect pedicels and rotate corollas. Its flowers can often be attached to the erect pedicels at an angle that turns the faces of the flowers toward the outside of the inflorescence and perpendicular to its axis. This may give the false appearance of nodding flowers in some pressed specimens. Such minor and inconsistent variation is especially common in the mountains of central New Mexico, but occasionally occurs on specimens from Colorado, Utah, northern Arizona, and Chihuahua. This variant often, but not always, occurs in combination with very large bracts.

The eastern variety, *Zigadenus elegans* var. *glaucus*, and a low elevation species from the canyonlands of western Utah, Z. *vaginatus*, are the only other erect pedicel-rotate corolla taxa presently recognized. The inflorescence of Z. *vaginatus* is similar to Z. *elegans*, particularly with those variants from central New Mexico that have a perpendicular flower attachment below the calyx. Most flowers of Z. *vaginatus* are often smaller, but within the range of typical Z. *elegans*. Cronquist *et al.* (1977) considered Z. *vaginatus* a synonym of Z. *elegans*. Preece (1956) and Welsh (1989) maintained these taxa as distinct species because the former occurs at lower elevations in hanging garden seeps on canyon walls and has a later flowering period of July through September. *Zigadenus elegans* in Utah and Colorado grows at higher elevations and flowers earlier during June and July. Preece (1956) and Welsh (1989) stated that Z. *vaginatus* is closely related to Z. *volcanicus* in Guatemala. However, we believe it is more closely related to Z. *elegans* because of its erect pedicels and rotate corollas rather than to Z. *volcanicus*, which has cernuous/campanulate flowers. *Zigadenus elegans* also occupies similar habitats and tends to flower later south to the Guadalupe Mountains on the New Mexico/Texas border. A feature unique to Z. *vaginatus* is its numerous hard, persistent leaf bases, which allows it to be separated from Z. *elegans*.

Zigadenus elegans is rare in northern Mexico, with a few known locations in Chihuahua and Coahuila. The Mexican populations differ from typical Z. *elegans* and have been treated variously. For instance, there is a large-flowered (tepals 10 × 5 mm long), large-bracted variant with rotate corollas and perpendicular flower attachment on erect pedicels called Z. *mohinorensis* Greenm. Greenman (1903) does not mention flower angle, but it is evident on the type specimen (*Nelson 4875* US). Preece (1956) placed Z. *mohinorensis*, known only from a few collections from Mt. Mohinora in Chihuahua, into synonymy with Z. *elegans*, but with some reservation.

Zigadenus gracilentus Greene (1901) was described, based on plants collected in the Sierra Madre of Chihuahua (*Pringle 1383* F, NY, US) and originally identified as Z. *elegans*. They had campanulate corollas, tepals 6–7 mm long, short stamens, and widely spreading pedicels. Greene described this new species as strictly dioecious and with different tepal characteristics for the staminate and pistillate plants. There is some variation in tepal morphology; however, the types studied for this discussion had obvious stamens and maturing ovaries. Preece (1956) placed Z. *gracilentus* into synonymy with Z. *elegans*. In addition to the campanulate corollas and long, spreading pedicels, the flowers might have been cernuous at anthesis. The inflorescence bracts are narrow, acuminate, and 2/3 the length of the pedicels, and are identical to the long, linear-bracted form of Z. *virescens* that is common in the northern Sierra Madres of Chihuahua and Sonora, and the Huachuca Mountains of southern Arizona. *Zigadenus gracilentus* is intermediate between *Z. virescens* and *Z. elegans* and cannot be comfortably placed into synonymy with either species. The precise type locality of *Z. gracilentus* is unknown, but if it were to be relocated and the population had plants with consistently erect pedicels and campanulate corollas, it might be worthy of taxonomic recognition.

South of the Rocky Mountains to Guatemala, the dominant form of *Zigadenus* has cernuous/campanulate corollas and is best illustrated by the variable *Z. virescens*. This species occurs predominantly in Mexico and usually characterized by small tepals (4–7 × 1.5–3.5 mm), exserted stamens, short bracts, and slender, recurved pedicels. *Zigadenus volcanicus*, compared to *Z. virescens*, ranges further south into Guatemala and has slightly to greatly larger flowers (tepals 6–15 mm long), included stamens, and broader tepals (3–6 mm). *Zigadenus mogollonensis* is a New Mexico endemic with large purple flowers.

There are many examples of herbarium specimens with inconsistent character combinations for particular species. For instance, intermediate forms between *Z. elegans* and *Z. virescens*, within a fairly broad area of sympatry in eastern Arizona, southwestern New Mexico and northern Mexico, frequently have the tepal measurements, thicker pedicels and somewhat longer bracts of *Z. elegans*, and cernuous/campanulate corollas of *Z. virescens*. They are the dominant form in some localized areas (i.e., Mt. Baldy in the White Mountains of eastern Arizona). They also are in mixed populations since they share the same herbarium sheet with typical *Z. virescens* (i.e., White Mts., AZ, *Peebles 12522* ARIZ) or with typical *Z. elegans* (i.e., Mogollon Mts., NM, *Rusby 406* US).

Several attempts have been made to recognize taxonomically these scattered, larger-flowered forms of *Zigadenus virescens*. The southwestern New Mexico plants were named *Z. porrifolius* Greene (1881), a name later applied to several collections from eastern Arizona and an aberrant form from southern Coahuila (Hemsley 1885). In 1940, O. S. Walsh annotated many of these specimens as *Z. virescens* var. *porrifolius,* a combination that was never published. Kearney and Peebles (1951) placed *Z. porrifolius* into synonymy with *Z. virescens*, but stated that it might be worthy of varietal status. Preece (1956) placed *Z. porrifolius* in synonymy with *Z. virescens* and attributed its larger flower size to the influence of *Z. elegans*. *Zigadenus porrifolius* is probably not worthy of taxonomic distinction because of its sporadic distribution and mixed populations. However, it is frequent enough to cause difficulties in species determination.

In eastern and southern Mexico, *Z. virescens* may also intergrade with *Z. volcanicus* and possibly *Z. elegans*. There are several collections with long bracts, thick pedicels, and broader tepals of *Z. volcanicus* and *Z. elegans*, but with the distinctly decurved pedicels, campanulate corollas, and longer stamens of *Z. virescens*. A few larger-flowered collections from the border area between Coahuila and Nuevo Leon strongly resemble *Z. volcanicus*, and the collection (*McDonald 1522* TEX) from Coahuila could easily be placed within that species. This, and most of the tall forms of *Z. virescens* in eastern Mexico, have recently been named *Z. hintoniorum* (Turner 1992). The holotype of *Z. hintoniorum* is somewhat aberrant, but it and the paratypes are clearly the highly variable species *Z. virescens*. In fact, the broad limits given to *Z. hintoniorum* would include *Z. porrifolius* and almost all of *Z. volcanicus*. Some *Zigadenus* from the Sierra Madre Orientale display odd character combinations that may be taxonomically divisible on a smaller scale; however, *Z. hintoniorum* is not correctly circumscribed and represents another attempt to segregate several intergrading and variable populations that cannot be comfortably assigned to *Z. virescens*, *Z. elegans*, or *Z. volcanicus*.

Zigadenus volcanicus is a poorly understood species that has been incorrectly represented by Preece (1956) and Turner (1992). Preece (1956) described *Z. volcanicus* as a short plant (2–3.5 dm) with erect or spreading pedicels and a corolla diameter of 1–1.4 cm, which could only be accurate if the corolla were rotate. However, among the specimens Preece annotated as *Z. volcanicus*, was one 7.5 dm tall (*Seler 2323* US), and the type specimen (*Hartweg 626* NY) was cut into several sections to fit on the sheet! These, and all other specimens of *Z. volcanicus* seen in this study, were greater than 3 dm tall and had cernuous/campanulate flowers. Turner (1992) inadequately characterized this species in his key to the section *Anticlea* and distinguished *Z. volcanicus* on the basis of tepals 14-15 mm long at anthesis. His description was obtained from a single Guatemalan specimen (*Beaman 3097* TEX), which represented either an extreme variation or undescribed species with very large flowers that are not at all typical of *Z. volcanicus*. Duplicates of this unusual collection (*Beaman 3097* US and MSC) have somewhat smaller tepals (12–13 mm long), less paniculate inflorescences, and a strong resemblance to *Z. mogollonensis*. However, *Z. mogollonensis* is readily distinguished from it by its purple flowers and occurs 3,000 km north of the Guatemalan plant.

The type specimen and original description of *Zigadenus volcanicus* (Bentham 1842) represented a species with tepals 6–8 mm long. Standley and Steyermark (1952), from an independent collection (*Steyermark 50153* US) for their *Flora of Guatemala*, agreed with Bentham (1842). Baker (1879) recognized *Z. volcanicus* as a cernuous-flowered species and distinguished it from *Anticlea mexicana* Kunth (= *Z. virescens*) by its somewhat broader tepals. Many of the specimens of *Z. volcanicus* that we studied could be further distinguished from *Z. virescens* by their longer bracts (often as long or longer than the pedicels) and stamens that are shorter than the tepals. The combined features of broader tepals and longer bracts also describe *Z. porrifolius* and *Z. hintoniorum* (both = *Z. virescens*). Like *Z. elegans*, bract length was not consistent in *Z. volcanicus* and varied from one-half to two times the length of the pedicel. Bract length in *Z. virescens* is also variable, but is usually less than the length of the pedicel. Other distinguishing, but inconsistent, features of *Z. volcanicus* were noted in this study. Several specimens displayed a wavy, and often twisted, central axis of the inflorescence. The flowers were often clustered at the ends of long panicle branches. The significance of these characteristics must wait for the collection and study of additional specimens.

The variation in *Zigadenus volcanicus* suggests that it may be further divisible, at least at an infraspecific level, and it is tempting to name the large-flowered form on the Sierra de los Cuchumatanes in northern Guatemala. However, in several collections from that location, the tepals range in length from an extreme 15 mm to the 7 mm of the more typical form. One collection (*Steyermark 50317* F) from Sierra de los Cuchumatanes is a mixed sheet containing a plant with tepals 10 mm long and another 7 mm long. Further collections and field studies are necessary before a large-flowered taxon can be separated from *Z. volcanicus*.

The following key to the taxa in *Zigadenus* section *Anticlea* accepts a broad concept of species variability and, therefore, somewhat artificial limits of taxon circumscription. The most ambiguous separation occurs between *Z. virescens* and *Z. volcanicus*. *Zigadenus hintoniorum* will mostly key out to *Z. virescens*, but because there is no consistent and distinguishing criterion for *Z. hintoniorum*, it may also key to *Z. volcanicus*. We prefer to extend the limits of variation for *Z. virescens* and the geographic distribution of *Z. volcanicus* rather than continue the use of a new and variable taxon that cannot be separated from existing species. Also, *Z. porrifolius* (= *Z. virescens*) in southeastern Arizona will occasionally key to *Z. volcanicus*. We suspect it is the result of intergradation with *Z. elegans*, and not because of a relationship to *Z. volcanicus*.

KEY TO THE AMERICAN TAXA IN *ZIGADENUS* SECTION *ANTICLEA*

1. Pedicels erect at anthesis; corolla rotate to rotate-campanulate; plants of United States and Canada with sporadic populations in northern Mexico.
    2. Lower stem sheathed with numerous hard, persistent leaf bases; tepals 4–8 mm long; plants of hanging gardens on cliffs in southeastern Utah .... *Z. vaginatus* (Rydb.) J.F. Macbr.
    2. Old leaf bases not persistent; tepals 5–10 mm long; plants widespread.
        3. Inflorescence usually racemose, occasionally with one or a few erect panicle branches in the lower inflorescence; plants of western N. America .... *Z. elegans* Pursh var. *elegans*
        3. Inflorescence usually paniculate with a few to several lax branches, rarely racemose, plants of eastern N. America .... *Z. elegans* var. *glaucus* (Nutt.) Preece

1. Pedicels decurved or widely spreading, attached to cernuous flowers at anthesis; corolla campanulate; plants of Arizona, New Mexico, Mexico, and Guatemala.
   4. Tepals 4–10 mm long at anthesis.
      5. Stamens usually as long or longer than the tepals; tepals 1.5–3.5(4) mm wide and < 8 mm long; floral bracts usually shorter than the subtended pedicels .... *Z. virescens* (Kunth) J.F. Macbr.
      5. Stamens shorter than the tepals; tepals 3 -6 mm wide and > 6 mm long; floral bracts $^1/_2$ to longer than the length of the subtended pedicels .... *Z. volcanicus* Benth.
   4. Tepals 12–16 mm long at anthesis.
      6. Tepals greenish with pale to dark purple margins; plants of conifer forests in the Mogollon Mts. of SW New Mexico .... *Z. mogollonensis*
      6. Tepals white to ochroleucous; plants of high alpine meadows on the Sierra de los Cuchumatanes of N. Guatemala .... cf. *Z. volcanicus*

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BOOK NOTICE

DE WAAL, LOUISE C., LOIS E. CHILD, P. MAX WADE, and JOHN H. BROCK (Eds.). 1994. **Ecology and Management of Invasive Riverside Plants.** (ISBN 0-471-94257-X, hbk.) John Wiley and Sons Ltd., Chichester, West Sussex, P019 1UD, England. $95.00. 217 pp.

This book, one in the "Landscape Ecology" series, seeks to bring together researchers and practitioners to solve plant invasion problems. Considering the fact that many different habitats are invaded by non-indigenous plants, I was somewhat intrigued why the riverside habitat was chosen. The preface provides scant information on this problem; the only clue offered is that the river environment is "especially prone to invasion." Among the 20 chapters, all concerned with plants that grow in or near rivers, 11 deal with control methods; 6, with basic biology of weeds; and 3, with rates of spread. Data from the Czech Republic, Denmark, England, Ireland, Scotland, Sweden, western United States, and Wales are presented. The book provides much information for the practitioner wanting to eliminate weeds. However, it not much use for those wanting to understand how and why riparian environments are invaded. Furthermore, there is scant information about the potential ecological functions of non-indigenous plants in riverside habitats.—*James O. Luken.*

UNA NUEVA ESPECIE DEL GENERO *PTEROPEPON* (CUCURBITACEAE) DE COLOMBIA

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RESUMEN

Se describe y se ilustra *Pteropepon oleiferum* y se discute su parentesco. Es una especie única dentro del género y de la familia debido al hecho de que tiene solamente un estambre con una antera bilocular insertada en un filamento cónico, y que es dioica. Sin embargo, está mejor colocada en *Pteropepon* que en cualquier otro género conocido hasta la fecha. Esta especie es la tercera especie nueva descrita de la región de Río Claro (Antioquia) en los últimos tres años, como resultado de las investigaciones de los autores. La zona donde crece tiene suelos calcáreos con un alto porcentaje de la flora aparentemente endémica, presentando también muchos elementos disyuntos y otros aspectos biogeográficos interesantes.

ABSTRACT

Pteropepon oleiferum is described, illustrated, and its phylogenetic relationships discussed. It is a unique species within the genus and family, based on its one stamen and one bilocular anther on a conic filament, concomitant with its dioecious habit. Nevertheless, we feel that the new entity is best placed in *Pteropepon* than in any other cucurbitaceous genus known, because of its laterally compressed, fibrous and winged fruit, and staminate flowers in panicles. As a result of the authors' collaborative research, this is the third new species to be described from the Río Claro area of Antioquia since 1991. The area is calcareous, apparently with a large percentage of the flora endemic, disjunct, or otherwise biogeographically interesting.

INTRODUCTION

El género *Pteropepon* (Cogniaux) Cogniaux (1916) fue descrito para incluir las especies de *Sicydium* Schlechtendal que son monoicas, con flores estaminadas en panículas, las pistiladas en pares, anteras uniloculares y sésiles o subsésiles; frutos lateralmente comprimidos, fibrosos y alados. Las otras especies que quedaron en *Sicydium* son dioicas, con flores estaminadas y pistiladas en panículas, el androceo de 2 anteras con 2 tecas y una con una teca, filamentos pequeños, y bayas globosas. En *Das Pflanzenreich*, Cogniaux reconoció dos especies, ambas del sureste de Brasil. Veinte años después,

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Macbride (1937) describió una variedad de *Pteropepon deltoideus* var. *peruvianus*, según las determinaciones de Harms, para entonces llegar a un total de 3 taxa en el género. Desde entonces, Jeffrey (1978) y Kearns (1993) no han reconocido var. *peruvianus* como entidad meritoria, aunque no han explicado el porqué. Adicionalmente, Crovetto (1950, 1952) describió *Pteropepon parodii* and *P. argentiniense*, respectivamente, y creó la sección *Micropteropepon*, para incluir las especies que tienen frutos pequeños y membranáceos, incrementando el total de los taxa hasta cinco. Como resultado de las investigaciones en la región de Río Claro en el Valle del Río Magdalena en Colombia, encontramos una especie que se ubique mejor en este género que en cualquier otro. La especie es otro ejemplo del alto nivel de endemismo en esa zona, como fue el caso con otras especies pertenicientes a los géneros *Erythroxylum* (Cogollo & Pipoly 1993) y *Cybianthus* (Pipoly 1991). La nueva especie aquí descrita se separa de las especies previamente conocidas por la siguiente clave.

CLAVE A LAS ESPECIES DEL GENERO *PTEROPEPON*

1. Plantas dióicas; frutos pequeños, membranáceos, bases y ápices emarginados .... sect. *Micropteropepon* Crovetto
    2. Inflorescencias estaminadas 8–12 cm de largo, mayores que las hojas; flores pistiladas brevemente racimosas; láminas tenuemente membranáceas .... *P. parodii* Crovetto
    2. Inflorescencias estaminadas 1.5–5 cm de largo, menores o subiguales a las hojas; flores pistiladas solitarias; láminas subcoriáceas o coriáceas .... *P. argentiniense* Crovetto
1. Plantas monóicas; frutos grandes, fibrosos, bases estipitados, ápices apiculados .... sect. *Pteropepon*
    3. Lámina membranácea, triangular o subdeltoidea, ápice acuminado, base truncada; estambres 3, anteras uniloculares.
        4. Sépalos lanceolado-triangulares; pétalos lanceolado-lineares, papilosos; frutos costados .... *P. monospermus* (Velloso) Cogniaux
        4. Sépalos subulados; pétalos anchamente ovados, glabros; frutos no costados .... *P. deltoideus* (Cogniaux) Cogniaux
    3. Lámina coriácea, ovada o oblongo-elíptica, ápice agudo, base redondeada; estambre 1;anteras biloculares .... *P. oleiferum* Cogollo and Pipoly

Pteropepon oleiferum Cogollo and Pipoly, sp. nov. (Fig. 1)

Quoad flores staminatos paniculatos denique fructum complanatum certe generi Pteropepon pertinet, sed a specibus caeteris foliis coriaceis (non membranaceis) ovatis vel oblongo-ellipticis (nec triangularibus vel subdeltoideis) ad apicem acutis (nec acuminatis) ad basim rotundatis (nec truncatis), stamini 1 (non 3) necnon antheris bilocularibus (nec unilocularibius) praeclare distinguitur.

Trepadora dioica; tallos gráciles, surcados, glabrescentes, ramificados. Pecíolos gráciles, 2.5–4.2 cm de largo, glabrescentes; láminas rígidas,

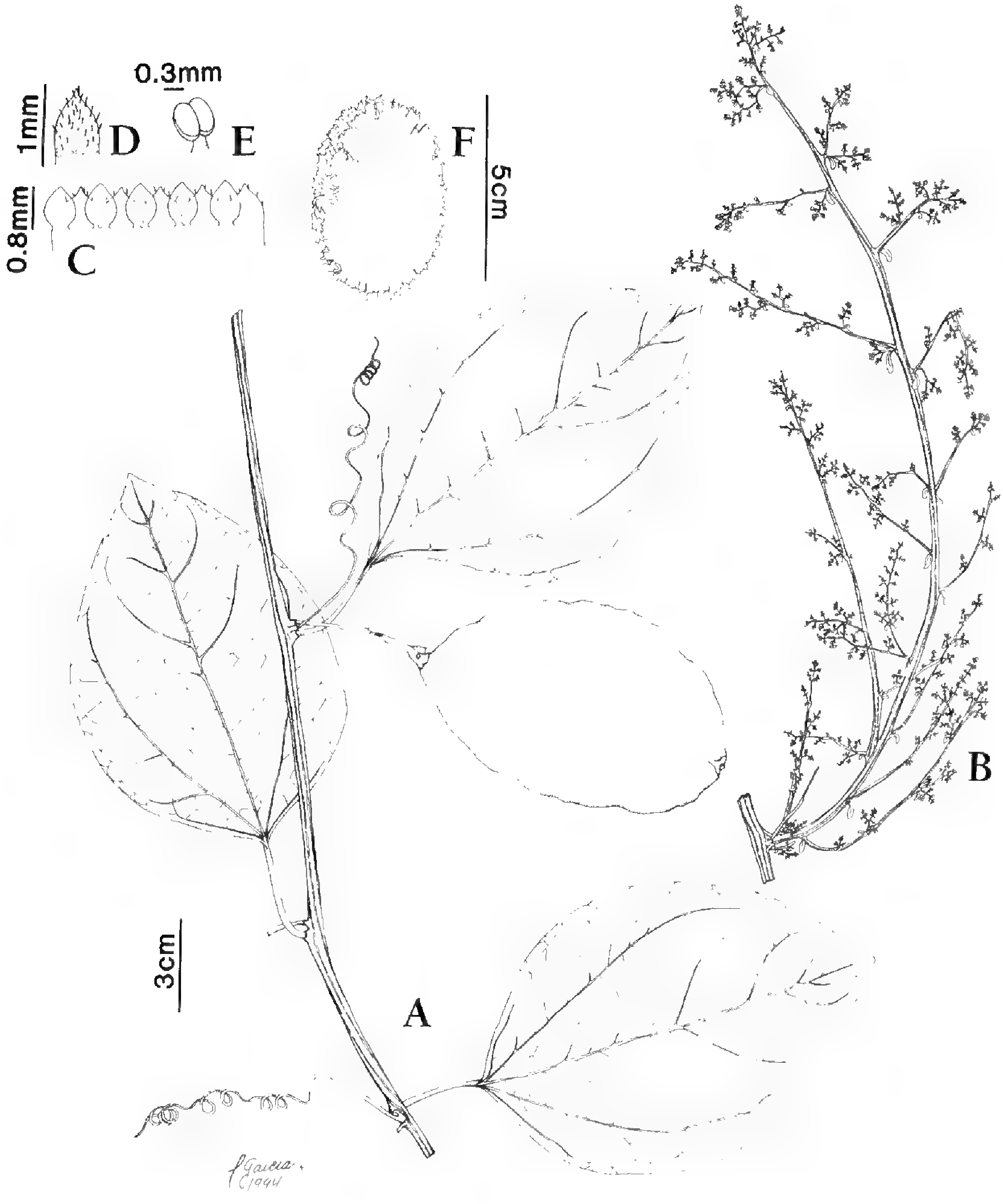

FIG. 1. *Pteropepon oleiferum* Cogollo and Pipoly A. Hábito, mostrando el fruto lateralmente comprimido, y caracteres foliares. B. Inflorescencia estaminada. C. Sépalos y pétalos estaminados. D. Detalle sepalar, mostrando las papilas. E. Estambre, mostrando los dos lóculos de la antera. F. Semilla. A y F: de *A. Cogollo & R. Borja* 764; B-E: del holótipo.

coriáceas, ovadas a oblongo-elípticas, (6.5–)7.5–16.0(–17.0) cm de largo, (4.5–)8.5–10.0(–13.2) cm de ancho, el ápice agudo, la base redondeada, glabras por ambas caras, las nervaduras laterales 3 a cada lado, impresas a ligeramente prominentes en la cara superior, prominentes en la cara inferior, el margen entero; zarcillos gráciles, redondos a ligeramente surcados, bífidos en el ápice. Inflorescencias estaminadas paniculadas; pedúnculo principal plurifloro, grácil, surcado, glabro a ligeramente papiloso, 3.5–30.0 cm de largo, las ramas divergentes, las basales de 2.5–12.0 cm de largo, más cortas hacia el ápice, subtendidas por unas brácteas de 2.0–7.0 mm de largo. Flores estaminadas pequeñas, verdosas, 2.0–2.5 mm de diámetro; receptáculo glabro, rotado; sépalos 5, oblongos, atenuados en el ápice, uninervios, abaxialmente papilosos, adaxialmente glabros; corola dividida hasta el receptáculo; pétalos 5, ovados, glabros, alternándose con los sépalos, un poco más grandes que los sépalos; estambre 1, pequeño, el filamento cónico, de 0.3–0.5 mm de largo, la antera 1, amarilla, bilocular, lóculos ca. 0.5 mm de largo, 0.3 mm de diámetro. Flores pistiladas desconocidas. Fruto fibroso, coriáceo, elíptico a obovado, glabro, 9.0–10.5 cm de largo, 6.0–8.0 cm de ancho y 2.0–2.5 cm de espesor, alado, con 2 costillas prominentes longitudinales. Semilla 1, elíptica, de 5.0–6.0 cm de largo, 4.0–5.0 cm de ancho, verrugosa, con testa leñosa.

Tipo. COLOMBIA. Antioquia: Municipio de Puerto Triunfo, autopista Medellín-Santafé de Bogotá, sector Río Claro-Río Magdalena, camino de la autopista hacia la gruta de "El Condor," ca. 400 m de la autopista; 05° 56'N, 74° 50'W, 350–400 m, 27 Feb 1994 (fl. estam.), *A. Cogollo & G. Jaramillo 8020* (HOLÓTIPO: JAUM; ISÓTIPOS: BRIT, COL, HUA, HUC, JBGP, MEDEL, MO).

Paratipos. COLOMBIA. Antioquia: Municipio de San Luís, Cañón de Río Claro, margen derecha, sector sur, 05° 53'N, 74° 39'W, 325–410 m, 3 Oct 1983 (fr), *A. Cogollo & R. Borja 764* (COL, JAUM, MO), 3 Dic 1983 (fl. estam.), *A. Cogollo 1040* (COL, JAUM, MO); corregimiento "El Prodigio," vereda "Las Confusas," 06° 03'N, 74° 47'W, 350–500m, 6 Mar 1990 (fl. estam.), *D. Cárdenas & J. Ramírez 2545* (COL, JAUM, MO); corregimiento "El Prodigio," Caño El Tigre, 06° 06'N, 74° 48'W, 350–700 m, 21 Nov 1990 (fr), *D. Cárdenas & J. Ramírez 3034* (COL, JAUM, MO); municipio de Puerto Triunfo, autopista Medellín-Bogotá, sector Río Claro- Río Magdalena, camino de la autopista hacia la gruta de "El Condor," ca. 400 m de la autopista, 05° 56'N, 74° 50'W, 350–400 m, 27 Feb 1994 (fl), *A. Cogollo & G. Jaramillo 8021* (BRIT, COL, HUA, HUC, JAUM, JBGP, MEDEL, MO).

Distribución.—Pteropepon oleiferum es conocida hasta ahora unicamente de la región de río Claro, en las faldas orientales de la Cordillera Central de los Andes, hacia el valle medio del Río Magdalena, en los municipios de San Luís y Puerto Triunfo, Departamento de Antioquia, Colombia, entre 300 y 700 m de altitúd.

Etimología.—El epíteto específico "oleiferum" es del latín, "oleum" (aceite) con el sufijo adjectival "-fer" (de portar, o contener); así que se refiere al hecho de que la semilla contiene aceite.

Ecología.—*P. oleiferum* crece en orillas de quebradas, en bordes de bosques y en rastrojos; principalmente en suelos calcáreos; sus frutos se dispersan por agua.

Usos y Condiciónes Actuales en Cuanto a Conservación: Las semillas de

P. oleiferum contienen una gran cantidad de aceite, el cual es extraído en forma rudimentaria por algunos habitantes de la región, y es usado para lubricación de herramientas. La gente local aprecia el valor de la especie y por lo tanto, en algunos lugares hay planes de domesticarla.

Pteropepon oleiferum es una especie única dentro del género, por su flor estaminada con un solo estambre, antera bilocular, insertado en un filamento cónico, y por su condición dióica. Sin embargo, debido a sus frutos lateralmente comprimidos, fibrosos y alados; flores estaminadas y paniculadas, *P. oleiferum* no podría ser acomodada en otro género conocido.

El bosque de la zona del Río Claro sobre rocas calcáreas contiene no solamente las tres nuevas especies susodichas, sino otra medio docena de entitades no identificables hasta la fecha y posiblemente nuevas también. Estudios actualmente progresando indica que la zona tiene una mezcla rara de elementos chocoanos, andinos, amazónicos y centroamericanos, verificando su importancia como fuente de biodiversidad única en el departamento de Antioquia.

AGRADECIMIENTOS

La colaboracón de nuestros compañeros del herbario respectivos se ha facilitado el trabajo para ambos autores, y les agradecemos. En particular, el trabajo de Dáyron Cárdenas (COA), Luz Marina Vélez, y Juan Guillermo Ramírez nos facilitó mucho en compilar los datos sobre la especie. Lindsay Woodruff revisó el manuscrito y hizo comentarios valiosos. Apreciamos el apoyo financiero para el primer autor del Fondo Colombiano de Investigaciones Científicas y Proyectos Especiales, "Francisco José de Caldas"-COLCIENCIAS lo que ha permitido realizar exploractions en la región de Río Claro; también el apoyo de la National Geographic Society, cuya subvención para estudios en el Parque Nacional Natural "Las Orquídeas" nos ha permitido reunirnos bianualmente tanto para estudios de la flora del parque como estudios sobre regiones adyacentes, como el presente. También, comentarios sobre el manuscrito, hechos por Michael Nee (NY), Charles Jeffrey (K), y Dennis Kearns (MO) enriquecieron y mejoraron la presentación. Apreciamos el trabajo de la dibujante Consuelo García (HUA) por la ilustración aquí presentada.

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BOOK NOTICE

LEAKE, DOROTHY VANDYKE, JOHN BENJAMIN LEAKE, and MARCELOTTE LEAKE ROEDER. 1993. **Desert and Mountain Plants of the Southwest.** (ISBN 0-8061-2489-x, pbk). University of Oklahoma Press, P.O. B. 787, Norman, OK 73070-0787. $18.95. 239 pp.

A problem with plant identification guides such as this one lies not in what is *in*cluded but what is *ex*cluded. By implication, the book includes desert and mountain plants from western Texas to southern California and north through the southern half of Nevada, Utah, and western Colorado (map on page 2), a large order. The "over 250 species" represented in the book are thus but a fraction of the total desert/mountain flora of this region. True, the geographical coverage shrinks markedly on page vii, where it is said to be especially "the part of the Sonoran Desert located in Arizona." The book's title is obviously misleading. The illustrations are line drawings, some of which show well the features of the plants pictured. Placement of the illustrations is erratic—some on pages facing the text, some on pages before or after the text (text page-numbers are not given at the illustrations). A "Guide to plant families," which attempts to lead the user to the appropriate "group" including the plant in hand, is not highly successful. Following an appendix—"Plant characteristics illustrated," which novices should find useful—are a glossary, bibliography, and index. The book could have used the services of a botanically astute and critical editor.—*John W. Thieret.*

A NEW *TACHIGALI* (FABACEAE: CAESALIPINIOIDEAE) FROM WESTERN AMAZONIA

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RESUMEN

Se describe una nueva especie del género *Tachigali*, *T. vasquezii*, procedente de la cuenca amazónica colombiana y peruana. Se ilustra la especie y se discuten sus relaciones filogenéticas. Además, otras especies anteriormente clasificadas en el género *Sclerolobium*, que se encuentran en varias flórulas amazónicas actualmente en proceso de redacción, o con las que tienen parentesco, se transfieren al género *Tachigali*, resultando las nuevas combinaciones *Tachigali rugosa* (Martius) Zarucchi & Pipoly, *T. micropetala* (Ducke) Zarucchi & Pipoly, *Tachigali bracteosa* (Harms) Zarucchi & Pipoly. *Tachigali micropetala* y *T. bracteosa* son nuevas citas para Perú.

ABSTRACT

A new species of *Tachigali*, *T. vasquezii*, is described from the Amazon Basin of Peru and Colombia. The new species is illustrated and its phylogenetic relations are discussed. In addition, other species previously classified in the genus *Sclerolobium* now being treated in amazonian florulas in final preparation, or closely related to them, are transferred to *Tachigali*, resulting in the new combinations: *Tachigali rugosa* (Martius) Zarucchi and Pipoly, *T. micropetala* (Ducke) Zarucchi and Pipoly, and *T. bracteosa* (Harms) Zarucchi and Pipoly. The occurrence of *T. micropetala*, and *T. bracteosa* are new reports for Peru.

INTRODUCTION

Tachigali Aublet is a neotropical genus now considered to contain approximately 60 species, including the 35 species formerly included in *Sclerolobium* Vogel (Zarucchi & Herendeen 1993). Historically, the genera were distinguished by position of the pistil stipe with reference to the receptacle cup (*Sclerolobium*, centrally; *Tachigali*, eccentric) more than any other character (Dwyer 1954, 1957). However, Zarucchi and Herendeen indicate that there is a continuum in the stipe character and no other either morphologcial or anatomical character may successfully be used to separate the two groups. Both are frequently myrmecophilous, a trait otherwise rare in the Caesalpinioideae.

While carrying out a series of florulas in the western Amazon Basin of Peru and Colombia, a new taxon was discovered which is assigned to *Tachigali* and described herewith.

SIDA 16(3): 407 – 411. 1995

Tachigali vasquezii Pipoly, sp. nov. (Fig. 1)

Ob ramulos angulosos, laminas coriaceas ad apices acuminatos ad bases truncatos, stipulas bifoliolatas ovatas coriaceasque ad *T. rugosa* valde arcte affinis sed ab ea ramulis foliolisque subter chocolati (non aureo-) tomentosis, foliolis oblongis (non lanceolatis) desuper planis (nec bullatis), denique petiolulis teretibus (non subteretibus), 7–13 (nec 3–5) mm longis praeclare distat.

Emergent canopy tree to 30(–45) m tall, 57 cm DBH; branchlets subterete to 3–5-angled, bark brown and gray in alternating longitudinal bands, 0.8–1.2 cm diam., minutely chocolati-tomentellous, early glabrescent; pith large, soft; stipules foliaceous, bifoliolate, coriaceous, ovate, 1.8–3.5 cm long, 1.3–2.8 cm wide, apex acute, base asymmetric, truncate, midrib impressed above, prominently raised below, secondary veins 5–9 pairs, bullate and densely chocolati-tomentose and glandular along the midrib and secondary veins above, densely chocolati-tomentose below, the margin entire, revolute, glabrous. Leaves paripinnate, alternate, petiolate; petioles (5–)9–14(–27) cm long, 0.7–1.5 cm diam., pulvinate basally; rachis solid, subterete, with an adaxial furrow, without myrmecodomatia, densely and minutely chocolati-tomentellous, (14–)24–36(–47) cm long, apically mucronate, the mucron 1–2 mm long, caducous, eglandular; petiolules terete, (0.7–)0.9–1(–1.3) cm long, 2–3 mm diam., densely chocolati-tomentellous, the tomentum persistent; leaflets coriaceous, oblong, 12–18(–31) cm long, 5–7(–13) cm wide, apex abruptly acuminate, the acumen 0.5–1 cm long, base truncate, midrib impressed above, prominently raised below, densely tomentulose, secondary veins 14–20(–28) pairs, densely tomentellous and somewhat impressed above, prominently raised and tomentose below, submarginally loop-connected to the next distal secondary vein, tertiary veins somewhat impressed above, prominently raised below, nitid above, densely chocolati-tomentellous-velutinous below, the margin revolute, entire. Inflorescence an axillary panicle, 26–29 cm long, peduncle 6–9 cm long; pedicels 3–7 mm long. Flowers unknown. Fruit flat, oblong or rarely elliptic, 12.5–15 cm long, (3–)5–6.5 cm wide, apex rounded, base acute, testa reddish-coffeate, exfoliate at maturity, one-seeded.

TYPE. PERU. AMAZONAS: Valle del Río Santiago, 65 km N of Pinglo, Quebrada Caterpiza, 2–3 km behind Caterpiza, 200 m, 1 Feb 1980 (fr), *V. Huashikat 1910* (HOLOTYPE: MO; ISOTYPES: AMAZ, UC).

PARATYPES. COLOMBIA. AMAZONAS: Municpio Leticia, Parque Nacional Natural Amacayacu, Quebrada Agua Pudre, 1.5 km NE of Río Amacayacu mouth, MO Strategy Inventory site, tree No. 158, 03°47'S, 70°15'W, 200–220 m, 11 Nov 1991 (ster.), *J. Pipoly et al.* 15851 (BRIT, COL, FMB, MO). PERU. **Huánuco:** Prov. Pachitea; Codo de Pozuzo; alluvial floodplain of Río Pozuzo after it emerges from mountains, trail N of settlement to Río Mashoca, 75° 25'W, 9° 37'S, 500 m, 19 Oct 1982 (ster.), *R. Foster 9329* (F, USM). **Loreto:** Prov. Maynas, Distrito Iquitos, Allpahuayo, Estación Experimental del Instituto de Investigaciones de la Amazonía Peruana, 04°10'S, 73°30'W, 150–180 m, Dec

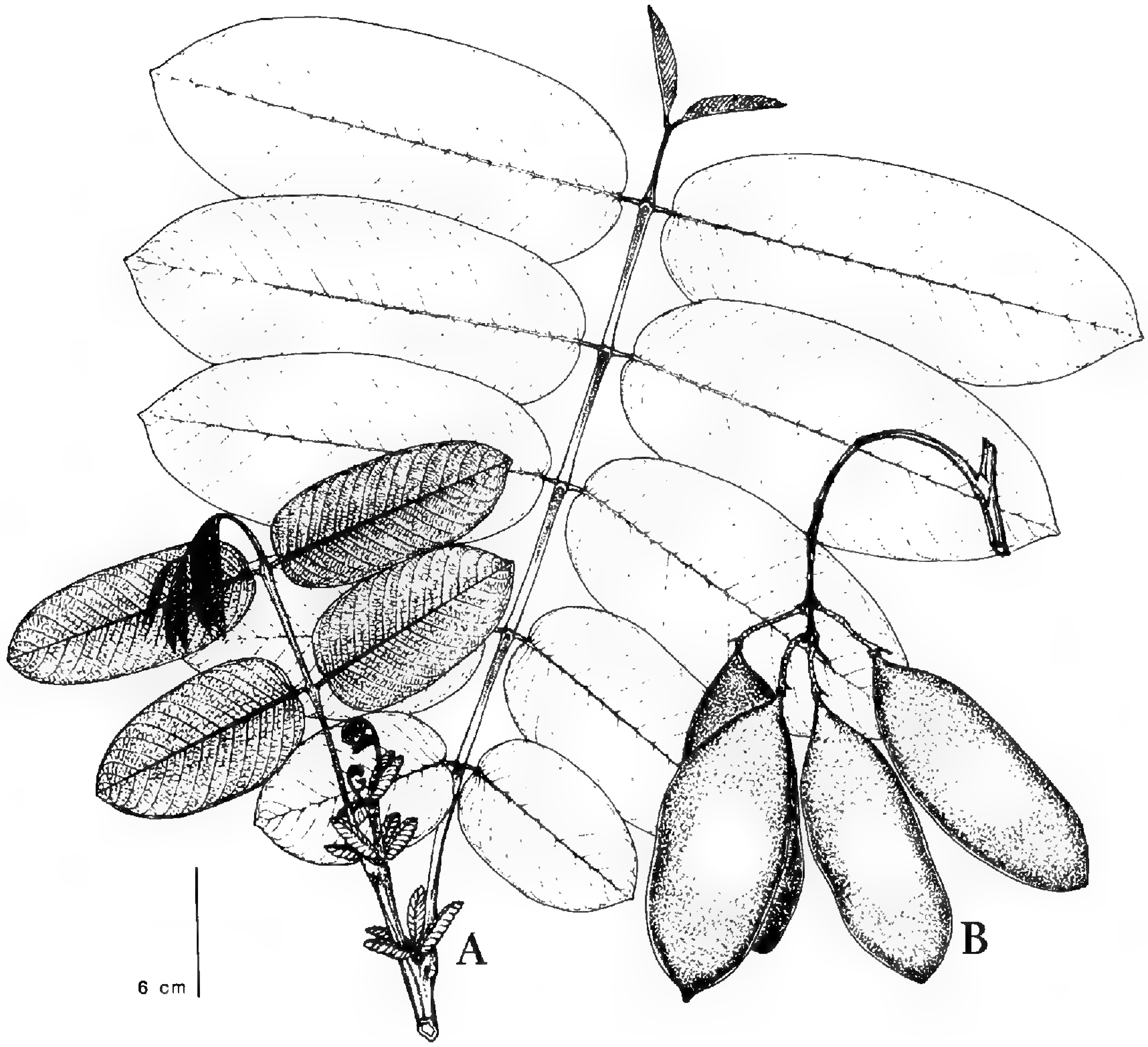

Fig. 1. *Tachigali vasquezii* Pipoly. A. Branchlet, showing the paired stipules and oblong leaflets with trunctae bases. B. Infructescence, showing fruits. Drawn from holotype.

1990 (ster.), *R. Vásquez & N. Jaramillo 15634* (AMAZ, MO, USM). Madre de Dios: Prov. Manu, Parque Nacional Manu, Río Manu, Cocha Cashu Station, 350 m, 23 Nov 1980 (ster.), *R. Foster 5830* (F, USM), Pakitza Station, Río Manu, North Trail, 350 m, 20 Nov 1980 (fr), *R. Foster 5780* (F, USM), Zone 1, one km N of camp, 11° 56'S, 71° 16'W, 350 m, 22 Dec 1988 (ster.), *R. Foster & S. Baldeón 12671* (F, USM). Prov. Tambopata, Tambopata, along Río Tambopata, 12°49'S, 89°18'W, 280 m, 19 Feb 1984 (ster.), *A. Gentry et al. 45635* (AMAZ, CUZ, MO, USM); Tambopata Tourist Camp, at jct. of Rios Tambopata and La Torre, 12°49'S, 69°43'W, 280 m, 22 July 1985 (ster.), *A. Gentry et al. 51088* (CUZ, MO, USM), 26 May 1987 (ster.) *A. Gentry et al. 57661*, 30 May 1987 (ster.), *A. Gentry et al. 57948;* Las Piedras, Cusco Amazónico, Permanent Inventory Plot, 12°29'S, 69°03'W, 200 m, 25 Nov 1991 (ster.), *M. Timaná & N. Jaramillo 3464* (CUZ, MO, MOL, USM), 31 Oct 1991 (ster.), *M. Timaná & N. Jaramillo 2934* (CUZ, MO, MOL, USM); 18 Jun 1989 (ster.), *O. Phillips et al. 412* (CUZ, MO), 21 Jun 1989 (ster.), *O. Phillips et al. 553* (CUZ, MO, USM). Pasco: Prov. Oxapampa, Valle del Palcazu, Iscozacín, camino a Villa America, 400 m, 8 Aug 1981 (ster.), *R. Foster 4688* (F, USM); PEPP Arboretum, 09° 50'-10°45'S, 68° 00'-68° 30'W, 300–600 m, (ster.), *G. Hartshorn, J. Quijano & E. Meza 2871* (CR, F, US, USM); Palcazu, Río Alto Iscozacín, Ozuz to Río Lobo, 10° 19'S, 75°16'W, 10 May 1985 (fr), *R. Foster & B. d'Achille 10070* (F, USM).

Common name.—"chaira pacae amarilla" (Peru).

Distribution: Throughout the western Amazon Basin, from near Leticia, Colombia, south and westward through the departments of Loreto, Amazonas and Pasco, to Madre de Dios, Peru, at 150–600 m elevation. In addition, reported to be common in the departments of Pando, Northern La Paz, and Beni, Bolivia (R. Foster- pers. comm.).

Ecology.—Common in the canopies of humid forests, on mostly old alluvial clays, especially sandy clays, or rarely, sands. *T. vasquezii* is frequently encountered on non-inundated terraces of old floodplains and low hilltops and slopes of the Upper Amazon and Andean foothills. Quantitative forest inventories containing permanent plots, established near Leticia, Iquitos and Cusco Amazónico have shown that 3–5 individuals of *T. vasquezii* may be found per hectare, sometimes clumped. Other data from those plots have revealed that *T. vasquezii* regularly grows in the same habitat as *T. ptychophysca* Spruce ex Bentham, but the two do not grow in close proximity. According to Robin Foster (pers. comm.), this species is monocarpic—individuals flowering once and then dying slowly as the seeds mature. The behavior is similar to that described for *T. versicolor* (Foster 1977), except there seems to be greater frequency of individuals in which only a part of the tree flowers and dies within a given year.

Etymology.—This species is dedicated to Rodolfo Vásquez Martínez, friend, colleague and director of the Peruvian exploration project for the Missouri Botanical Garden. He is principal author of the *Florula of the Biological Reserves of Iquitos,* containing nearly 3,000 species. He is also an authority on the systematics of the Hypericaceae, Ebenaceae and Myrsiticaceae of Peru, and the genus *Caraipa* (Clusiaceae) throughout its range.

The angulate branchlets, coriaceous leaves with acuminate apices and truncate bases, concomitant with the bifoliolate, ovate and coriaceous stipules, indicate that *Tachigali vasquezii* is most closely related to the vicariant *T. rugosa* (Martius) Pipoly and Zarucchi of the cerrado formations from eastern Brazil. However, *T. vasquezii* is easily recognized by the chocolate tomentum of the branchlets and abaxial leaflet surface, smooth oblong leaflets, and terete, longer petioles. Whether it is coincidence that the recently described *Affonsea* Pipoly and Vasquez, is also most closely related to an eastern Brazilian taxon remains uncertain pending further studies.

NEW COMBINATIONS IN *TACHIGALI*

As was previously mentioned in the introduction, *Tachigali* and *Sclerolobium* cannot be separated (Zarucchi & Herendeen 1993) on any character other than relative position of pistil stipe within the receptacle cup. The plasticity of this character, and lack of any other known character to separate the two groups necessitates the transfer of three species of

Sclerolobium related to, or occurring in florulas now in final preparation, to *Tachigali*.

Tachigali rugosa (Martius) Zarucchi and Pipoly, comb. nov. BASIONYM: *Sclerolobium rugosum* Martius ex Bentham in Hooker, J. Bot. 11: 237. 1850. TYPE. BRAZIL. MATO GROSSO: Cuiabá, *da Silva Manso s.n.*, Martius herbarium 1155, (HOLOTYPE: M (not seen); photo at F Neg. 6264).

Tachigali micropetala (Ducke) Zarucchi and Pipoly, comb. nov. BASIONYM: *Sclerolobium micropetalum* Ducke, Bol. Tech., Inst. Agron. Norte Belém. TYPE. BRAZIL. AMAZONAS: Manaus, without date, *Ducke 1219* (syntypes: K, MO, NY).

Tachigali bracteosa (Harms) Zarucchi and Pipoly, comb. nov. BASIONYM: *Sclerolobium bracteosum* Harms, Verhandl. Bot. Ver. Brandenb. 48:168. 1907. TYPE. BRAZIL. AMAZONAS: Rio Marmelos and Rio Madeiras, *Ule 6094* (F- fragment, HBG, photos at K, MO, US).

ACKNOWLEDGMENTS

This paper is the result of research on Amazonian plant diversity conducted during my tenure at the Missouri Botanical Garden, under the auspices of the John D. and Catherine T. MacArthur Foundation. Supplemental research on the Flora of Peru, which also contributed to fieldwork, was carried out through a grant from the Andrew W. Mellon Foundation. Rodolfo Vásquez, who provided the excellent illustration, is the director of the Peru program at the Missouri Botanical Garden, and is also supported by grants from the John D. and Catherine T. MacArthur Foundation for permanent inventory plot studies and the Andrew W. Mellon Foundation for the Peruvian exploration program. I thank Jim Zarucchi (MO), Alex Lasseigne and Robin Foster (F) for their reviews and helpful suggestions concerning the manuscript.

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BOOK NOTICES

POWELL, A. MICHAEL. 1994. **Grasses of the Trans-Pecos and Adjacent Areas.** (ISBN 0-292-76553-3, hbk; ISBN 0-292-76556-8, pbk). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819. $75.00 hbk; $29.95 pbk. 377 pp.

Texas west of the Pecos River is a wonderful land of deserts and mountains, with many peaks a mile or more high (up to 8751 ft on Guadalupe Peak). Powell's book accounts for 83 genera and 268 species of Trans-Pecos Poaceae (half of the grasses known from Texas). Endemic to that part of the state are 53 species. Most of the illustrations are the by-now-so-familiar ones from the Hitchcock *Manual* (1951). Artist Manning contributed a few original drawings; other illustrations are 22 black-and-white photos of Trans-Pecos scenery. Descriptions of species are given only in genera with but one species in the area; otherwise the genera alone are described, a disadvantage. Introductory chapters tell of the region, discuss grasses and grasslands, list the tribes and genera of Trans-Pecos Poaceae, and give a key to the 16 tribes included. Keys to genera and species are at appropriate places in the "descriptive grass flora" (75% of the book). The keys worked well for the 15 species of grasses I used to test them. Final chapters are a glossary, literature cited (ca. 150 entries), and an index. Frequently mentioned are taxonomic/nomenclatural aspects of various taxa. Nomenclature is up to date.—*John W. Thieret.*

JONES, DAVID L. 1993. **Cycads of the World. Ancient Plants in Today's Landscape.** (ISBN 1-56098-220-9, hbk). Smithsonian Institution Press, 470 L'Enfant Plaza, Washington, DC 20560. $45.00 (plus $2.25 postage). 312 pp.

This is a one-volume encyclopedia devoted to the 185 species of cycads. The illustrations—of plants, leaves, and cones—are the book's principal glory. Many (ca. 250) are fine color photos, some are original line drawings, and a few are reproductions of old engravings, color or black-and-white, from 19th century and later botanical works.

Part 1, about 30% of the volume, contain a most impressive wealth of information: discussions of the plants' history and prehistory, conservation, structure, economic importance, biology, cultivation, pests and diseases, and propagation. (Data on more recondite topics—e.g., gametophyte development, anatomy, chromosomes—must be sought elsewhere.) On the world map of distribution of cycads their occurrence in the United States—Florida and Georgia—was somehow overlooked; the error is corrected in the map of *Zamia.*

Part 2, the taxonomic section, presents a key to the 11 cycad genera and then an account of each genus and species. Generic accounts include a key to species (exception: no such key is given for *Cycas*, *Encephalartos*, and *Zamia*, because of the "confused state of the taxonomy" or the "size and complexity" of these genera). Then follow paragraphs on derivation of name, generic description, notable generic features, recent studies, habitat, cultivation, and propagation. Species accounts include description, notes on distribution and habitat, other notes, cultivation, and propagation. The bibliography has about 200 references; the index contains mostly scientific names. I recommend this excellently made book for cycadophiles and non-cycadophiles alike. Its relatively low price makes it one of the book bargains of the year.—*John W. Thieret.*

ANATOMICAL STUDY OF *ERIONEURON* AND *DASYOCHLOA* (POACEAE: CHLORIDOIDEAE: ERAGROSTIDEAE) IN NORTH AMERICA

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ABSTRACT

Leaf blades of *Erioneuron* and *Dasyochloa* species were analyzed for anatomical details. Analysis of transverse sections and epidermis show that both genera can be clearly delimited. Differences between *E. avenaceum* and *E. grandiflorum* were not found, supporting the interpretation that these are conspecific. Differences between *E. avenaceum*, *E. pilosum*, and *E. nealleyi* were found, suggesting that these be maintained as distinct entities. Differences between *Dasyochloa* and *Erioneuron* support the recognition of *Dasyochloa* as a monotypic North American genus.

RESUMEN

Fueron analizadas láminas de las especies de *Erioneuron* y *Dasyochloa*, para un estudio anatómico detallado. El análisis de la lámina en sección transversal y de la epidermis, muestra que los dos géneros pueden ser claramente definidos. No se encontraron diferencias entre *E. avenaceum* y *E. grandiflorum*, lo que apoya la interpretación de que no son especies distintas. Se encontraron algunas diferencias entre *E. avenaceum*, *E. pilosum* y *E. nealleyi*, que sugieren que éstas se pueden mantener como especies distintas. Las diferencias entre *Dasyochloa* y *Erioneuron*, apoyan el reconocimiento de *Dasyochloa* como un género monotípico para Norteamérica.

INTRODUCTION

Caceres (1950) studied the leaf blade anatomy of *Munroa mendocina* and *Blepharidachne benthamiana* Hitchc. and compared these species with species of *Eragrostis* and *Tridens pilosa* (Buckl.) Hitchc. var. *argentina* (O. Kuntze) L.R. Parodi {syn. *Erioneuron pilosum* (Buckl.) Nash var. *longiaristatum* (Kurtz) Anton}. Tateoka (1961) examined the leaf epidermis of *Tridens*, including

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Erioneuron and he concluded that the epidermal features were of the Chloridoid subtype as described by Prat (1936).

Sánchez (1979a) studied the leaf blade anatomy of three species of *Tridens* and two species, including their varieties, of *Erioneuron* from Argentina. Observations of the unique anatomical features of *Dasyochloa pulchella* (H.B.K.) Willd. ex Rydberg [syn. *Erioneuron pulchellum* (H.B.K.) Tateoka] were made. Sánchez (1979b, 1981) reported the development of the "Kranz" structure in the stems of *Munroa*, *Blepharidachne*, and *Erioneuron* from Argentina. Sánchez (1983) analyzed the anatomical differences between *Dasyochloa* and *Erioneuron* and proposed the segregation of *Dasyochloa* as an independent genus following, in part, criteria as outlined by Parodi (1934).

The grass genus *Erioneuron* was described by Nash in Small's (1903) *Flora of the Southeastern United States*, based on *Erioneuron pilosum*. Tateoka (1961), in a biosystematic study of the genus *Tridens*, presented cytological, morphological, and anatomical differences to support recognition of two distinct genera. One prominent difference was in the basic chromosome numbers, x = 8 for *Erioneuron* and x = 10 for *Tridens*. The results of the examination of the leaf anatomy show that all species of *Tridens* and *Erioneuron* have a Chloridoid subtype of the panicoid type of leaf epidermis, characterized by the presence of globose or club-shaped bicellular microhairs and saddle-shaped silica bodies. Particular kinds of bicellular microhairs were observed in *Tridens* and *Erioneuron*. *Tridens* had bullet-shaped hairs, and *Erioneuron* had ellipsoidal hairs. Differences in the leaf cross-section were found between genera in leaf margin, midrib of the leaf blade, and in the number of vascular bundles within the leaf. Based on these results Tateoka recognized the genus *Erioneuron* and suggested affinities with the genus *Munroa*, rather than with *Tridens*. Sánchez (1979b) studied the leaf anatomy of the species and varieties of *Tridens* and *Erioneuron* from Argentina. That study included a table of characters used to separate the genera, with keys to the species and varieties based on anatomical characters. This classification has been well accepted by agrostologists and used in several grass floras (Correll & Johnston 1970; Nicora 1973; Gould 1968, 1975, 1979; Anton 1977; and McVaugh 1983).

The generic name *Dasyochloa* Willd. first appeared in Steudel (1840) as a synonym of *Uralepis*. Two species of *Dasyochloa* were listed, *D. avenacea* Willd. and *D. pulchella* Willd., both as "nomina nuda." Although Rydberg (1906) validated *Dasyochloa* with an English description as part of a key, it has been regarded as a synonym of *Erioneuron*. Recently Caro (1981) transferred the species of the genus *Erioneuron* (excluding *E. pilosum*) to *Dasyochloa*, based on the lemma morphology. Sánchez (1983) reported that the anatomical features of *Dasyochloa* formed the most important difference within

Erioneuron s.l. She recognized *Dasyochloa* as a monotypic North American genus, consisting of *D. pulchella*.

Leaf blade anatomy of North American species of *Erioneuron* has not been fully studied. This study analyzes the leaf anatomy of *Erioneuron* and compares the results with the studies from Argentina. The results of this analysis will add to the anatomical characteristics of the leaf epidermis not reported by Sánchez (1983).

MATERIAL AND METHODS

Leaf blades were selected from population samples from across the geographic range of each species. Table 1 lists the specimens analyzed. At least three leaf blades were selected from each specimen so that leaf cross-sections and adaxial and abaxial epidermes could be observed and compared. Leaf blade sections one cm long were taken from the specimens. Leaf blades collected in the field were fixed in FAA for 24 hours and then transferred to 70% ethanol. Leaf blades from dried specimens were placed in a high molecular weight solution of 1:3, photo-flo 200 and water until thoroughly imbibed, and then transferred to 70% ethanol. Leaf blades for cross-section analysis were embedded in paraffin using the standard techniques (Berlyn & Miksche 1976). Fifteen sections per plant specimen were sectioned with a rotary microtome at 10–15 µm thickness, stained with safranin and fast green, and made permanent with Permount.

Adaxial and abaxial leaf epidermes were studied following rehydration in a high molecular weight solution. Leaf segments were then placed in a clorox solution for a few minutes to bleach the chlorophyll, placed flat on a microscope slide and scraped with a razor blade until the epidermis, mesophyll, and vascular bundles were removed. The remaining epidermis was stained with Azo-Black, washed with drops of 90% ethanol, and made permanent using Euparal and ethanol. In some instances only small fragments of the epidermis could be obtained because of the furrowed leaf blades and sclerenchyma on the margins. In such cases the remaining epidermis was not stained to avoid the possibility of losing the tissue in the destaining process. The silica cells, silica bodies, microhairs, macrohairs, and prickle hair variations were recorded for each taxon. The descriptions of leaf transections and epidermal structures follow the terminology used by Metcalfe (1960) and Ellis (1976, 1979). All drawings are original and were made with the aid of a drawing tube.

RESULTS AND DISCUSSION

Examination of the leaf blade of *Erioneuron* confirms that this genus has the Cloridoid leaf anatomy as described by Brown (1958), Metcalfe (1960),

TABLE 1. Specimens of *Erioneuron* and *Dasyochloa* used in analysis of leaf transverse sections and epidermal scrapes, listed by species identification, country, state, collector and collection number. Specimens are deposited at ANSM and TAES.

Erioneuron avenaceum (H.B.K.) Tateoka

MEXICO. SAN LUIS POTOSÍ: Guadalcazar, *Valdés-R. 1641*, *1636*, 20 mi N of San Luis Potosí, *Valdés-R.* 1644, Enrique Estrada, *Valdés-R. 1694*. COAHUILA: Saltillo, *Valdés-R. 1701*.

E. grandiflorum (Vasey) Tateoka

MEXICO. NUEVO LEÓN: El Salero, *Valdés-R. 1623*, *1627*.

E. nealleyi (Vasey) Tateoka

MEXICO: COAHUILA: Arteaga, *Hatch et al. 5033*, Saltillo, *Hatch et al. 6045*, *5050*, *Valdés-R. 1455*, Parras, *Valdés-R. 1576*. UNITED STATES. TEXAS. Presidio Co.: *Valdés-R. 1689*.

E. pilosum (Buckl.) Nash

MEXICO. COAHUILA: Saltillo, *Valdés-R. 1502*, *1537*. Nuevo León: Cerralvo, *Valdés-R. 1632*. UNITED STATES. NEW MEXICO. Grant Co.: *Valdés-R. 1681*. TEXAS. Travis Co.: *Valdés-R. 1653*.

Dasyochloa pulchella (H.B.K.) Willd. *ex* Rydb.

MEXICO. COAHUILA: Saltillo, *Valdés-R. 1532*, *Hatch et al. 5055a*. SAN LUIS POTOSÍ: Guadalcazar, *Valdés-R. 1642*, 20 mi N of San Luis Potosí, *Valdés-R. 1702*. UNITED STATES. NEW MEXICO. Grant Co.: *Valdés-R. 1683*, Otero Co.: *Morden 672*. TEXAS. Presidio Co.: *Valdés-R. 1686*, *1691*.

Tateoka (1961), Sanchez (1979a), and Renvoize (1983). Each bundle sheath, with its associated radial chlorenchyma, constitutes a discrete structural unit separated from similar adjacent units by large, clear bulliform cells. The radial chlorenchyma cells form one layer and are long, narrow, radially arranged, and contain few chloroplasts. This anatomical structure indicates that these grasses belong to the "C_4 plants" or "Kranz PS" as described by Brown (1977). The leaf epidermis of these grasses corresponds to Renvoize's (1983) general description of the Eragrostideae. Complete description of each species is given in Valdés-Reyna (1985).

ERIONEURON NASH

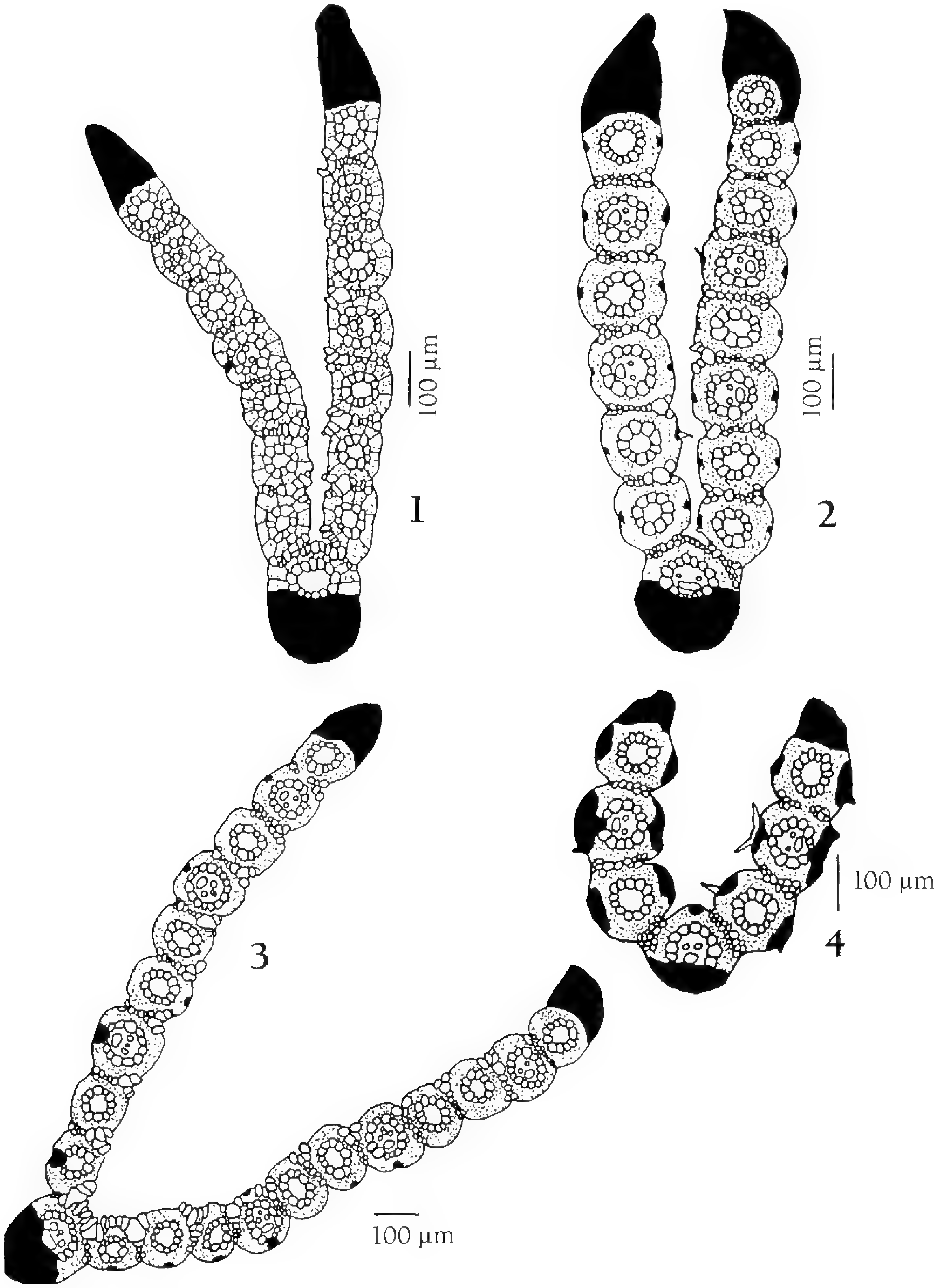
Laminas are V-shaped, i.e. conduplicate, narrow to standard, the adaxial side slightly sinuous with ribs and furrows present. The abaxial side of the lamina is sinuous with well-marked ribs and furrows present, containing a prominent central vein. Sclerenchyma are associated with the vascular bundles (VB's), and a small strand sometimes forms a girder between the bundle and the abaxial and adaxial epidermis. Bulliform cells are inflated and fan-shaped. The leaf epidermis contains intercostal long cells on both epidermes that are moderate to strongly sinuous. Stomata occur in 1–2 rows per intercostal zone with triangular subsidiary cells. Intercostal short cells occur as silico-suberose pairs between long cells. One papillae per cell occurs on the adaxial surface. Prickle hairs are distributed on intercostal and costal zones.

Microhairs have a spherical distal cell. The macrohairs are unicellular. The costal zone has a row of short cells, each alternating with silica cells. Silica cells are mostly dumbbell- to saddle-shaped.

Erioneuron pilosum (Buckl.) Nash

Transverse section (Figs. 1 & 5).—Lamina is V-shaped, with a narrow to standard angle, 2.4 mm wide, 0.12 mm thick, 13–15 vascular bundles wide. The adaxial side is slightly sinuous with furrows and the abaxial side with slight to shallow furrows, the ribs well-marked. The prominent midvein has a well-developed keel, and the colorless cells, bulliform cells, and sclerenchyma cells are associated with the median vein. The bulliform cells penetrate through the abaxial epidermis. Sclerenchyma are absent adaxially and very abundant abaxially. One primary VB comprises the keel. The position of the VB is at the same level for all bundles of different orders. These bundles are situated in between the center and the adaxial surface. Three primary, (including the midvein), two secondary, and 10 tertiary VB's are present, and round in outline. Mestome sheath cells are small, thick-walled, and surround the primary and secondary VB's, interrupting the tertiary VB's. Parenchyma sheath cells are large and thin-walled in the primary VB's and continuous or sometimes interrupted by sclerenchyma. The sclerenchyma that is associated with primary VB's forms a girder between the bundles and abaxial epidermis, and sometimes the adaxial epidermis. Secondary and tertiary VB's have adaxial sclerenchyma present as a minute strand consisting of a few subepidermal fibers. Sclerenchyma cell walls are very thick; with a well-developed sclerenchyma cap present on the margins of the leaf. This sclerenchyma cap is not in contact with the lateral bundle, and is wider than tertiary VB's. The chlorenchyma are radiate, one cell layer thick, in tabular arrangement, and interrupted by the sclerenchyma where associated with the bundle. The chlorenchyma of successive VB's are separated by bulliform cells and colorless cells. The colorless cells form a girder-like extension to the opposite epidermis and are associated with the bulliform cells. The colorless cells are smaller than bulliform cells, not inflated, and have one extension from each group. Across most of the blade, 3–6 bulliform cells occur in the furrows, and are extensive over midvein and in the adjacent furrow. The epidermal cell walls are thick and covered by a distinct cuticle that is continuous over the epidermal cells. Prickle hairs are present. Macrohairs are absent. Papillae are present on adaxial surface and restricted to the intercostal zone. There is one papilla per cell that is relatively broad, but not much more than half the width of the epidermal cells.

Abaxial epidermis (Fig. 9b).—The intercostal long cells have margins that are deeply undulating, strongly corrugated, 50–170 μm long, and about



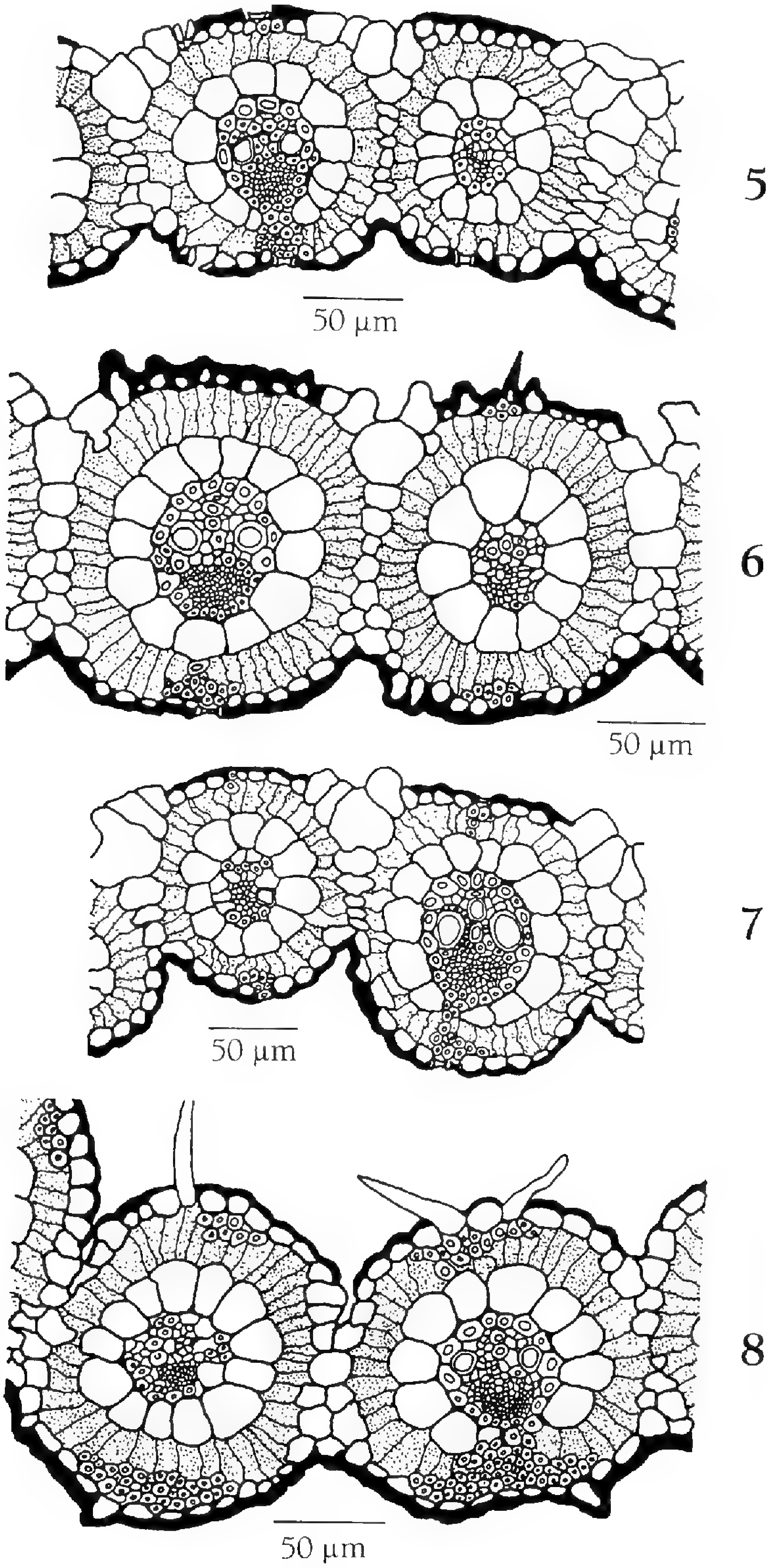
FIGS. 1-4. Whole leaf blade transverse sections of *Erioneuron* and *Dasyochloa*. Blackened areas indicate sclerenchyma tissue. Fig. 1. *E. pilosum*, *Valdés 1502*. Fig. 2. *E. avenaceum*, *Valdés 1644*. Fig. 3. *E. nealleyi*, *Hatch and Valdés 5050*. Fig. 4. *D. pulchella*, *Valdés 1686*.

10 µm wide. Stomata are in 1–2 rows per intercostal zone with triangular subsidiary cells. Intercostal short cells are solitary or paired between long cells; when paired the cells are silico-suberose, with tall and narrow smooth outlines. Papillae are absent. Bicellular microhairs occur as a single row attached to short cells, 20–25 µm long. The proximal cell is about 10 µm long, and the inflated and rounded distal cell is about 15 µm long. Prickle hairs are absent. Macrohairs are present on the intercostal zone. Costal zones have a row of paired short cells that are silico-suberosed and separated by normal costal short cells. These short cells have sinuous walls. Silica bodies, 8–10 µm long, are mostly dumbbell-and saddle-shaped, and relatively short.

Adaxial epidermis (Fig. 9a).—Epidermis is similar to the abaxial surface except for the following: intercostal zone long cells are slightly to moderately undulating; dome-shaped, inflated papillae are present, one per cell, with unthickened walls. Prickle hairs are infrequent on the intercostal zone.

Erioneuron avenaceum (H.B.K.) Tateoka

Transverse section (Figs. 2 & 6).—Lamina is V-shaped with a narrow to standard angle, 2.2 mm wide, 0.14 mm thick, 12–16 VB's wide. The adaxial side has ribs with slight to medium furrows, less than a quarter of the leaf thickness. The abaxial ribs are the same size to taller than the adaxial, appearing moniliform. The prominent midvein has a keel with one VB comprising the keel. The colorless cells, bulliform cells, and sclerenchyma cells are associated with the midvein. The bulliform cells in the adaxial epidermis are located above the median bundle. Sclerenchyma are absent adaxially and abundant abaxially. The position of the VB's is the same for all bundles of different orders. All bundles are positioned midway between the adaxial and abaxial surface. Five primary bundles (including the midvein) and 10 secondary bundles are present. Tertiary VB's were absent. Primary bundles are circular to elliptical in outline and vertically elongated; while secondary bundles are circular in outline. Mestome sheaths are composed of 10–12 small, thick-walled cells surrounding the primary and secondary VB's. The parenchyma sheath, of large thin-walled cells, is continuous or sometimes sclerenchyma interrupts the primary VB. Sclerenchyma are associated with the VB's on both the abaxial and adaxial surface and the strands consist of a few subepidermal fibers, sometimes forming a girder-like structure between the bundle and abaxial epidermis. The sclerenchyma cell walls are thick, with a sclerenchyma cap on the leaf margins. The chlorenchyma are radiate, in tabular arrangement, and separated from successive VB's by the bulliform cells and colorless cells. Colorless cells form a girder-like extension to the opposite epidermis, and are associated with bulliform cells but smaller. These cells are not inflated, and form one extension from each group. The furrows have 2–4 bulliform cells and are



FIGS. 5-8. Detail of primary and secondary vascular bundles of *Erioneuron* and *Dasyochloa*. Fig. 5. *E. pilosum*, *Valdés 1502*. Fig. 6. *E. avenaceum*, *Valdés 1644*. Fig. 7. *E. nealleyi Hatch and Valdés 5050*. Fig. 8. *D. pulchella*, *Valdés 1686*.

extensive over the midvein and in the adjacent furrows. The bulliform cells are inflated and fan-shaped. The cuticle is continuous over the epidermal cells. Prickle hairs are present on the adaxial surface. Macrohairs are absent. Papillae are present on the adaxial surface but restricted to the intercostal zone.

Abaxial and adaxial epidermis (Figs. 10a & 10b).—The anatomy of both surfaces is not different from that of *E. pilosum* epidermal surfaces; except that stomata, when seen, form one row per intercostal zone.

Erioneuron grandiflorum (Vasey) Tateoka

Significant differences were not observed between this species and *E. avenaceum*. Metcalfe (1960) reported the leaf anatomical features of *E. grandiflorum* [syn. *Tridens grandiflorus* (Vasey) Woot. & Standl.] and they correspond to our description of *E. avenaceum*.

Erioneuron nealleyi (Vasey) Tateoka

Transverse section (Figs. 3 & 7).—This species is similar to *E. avenaceum* and *E. pilosum* except that the lamina is 20–25 VB's wide. The adaxial surface is slightly sinuous, and the abaxial surface is moderately to shallowly ribbed and furrowed.

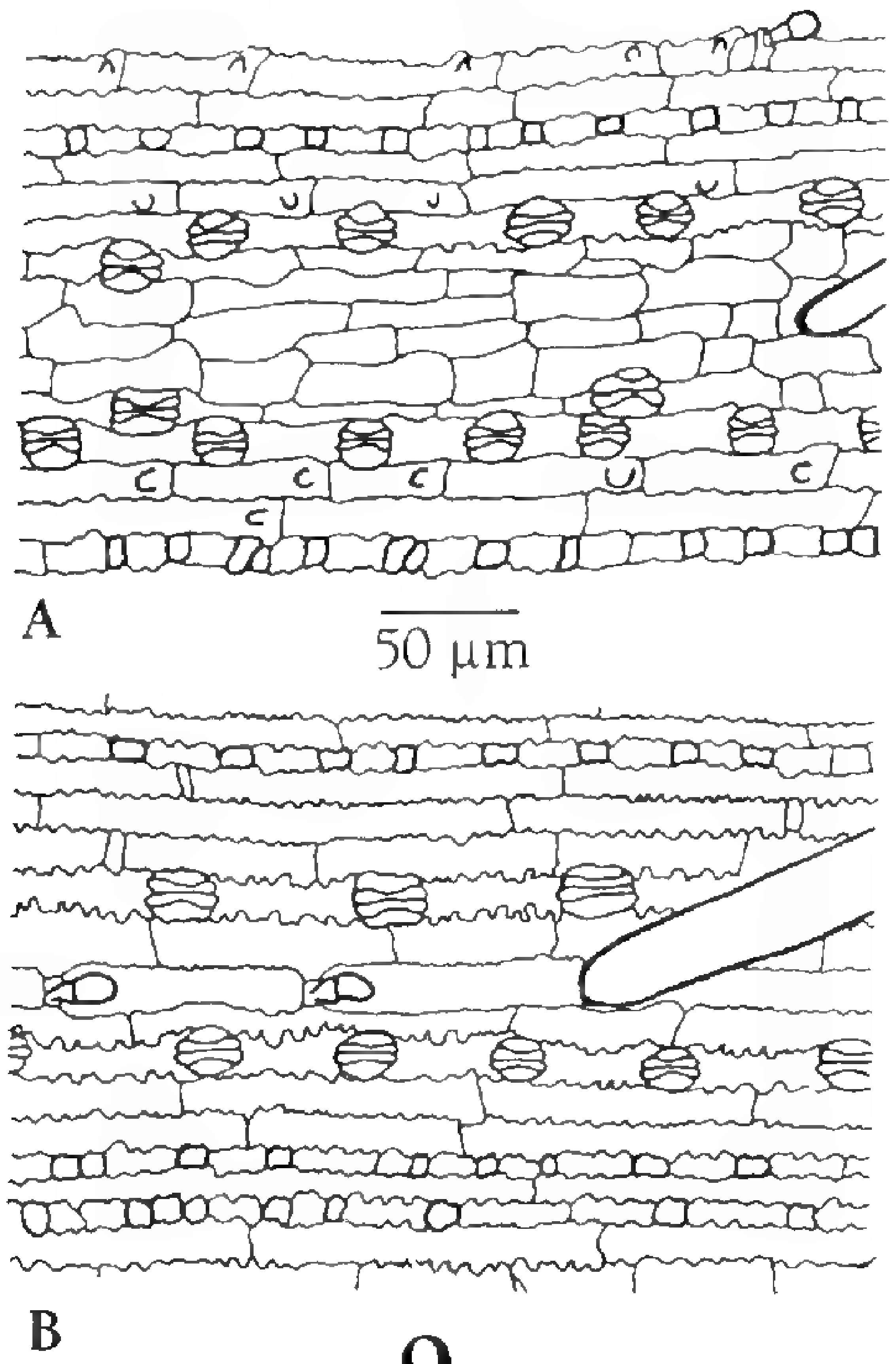
Abaxial epidermis (Fig. 11b).—Epidermis of *E. nealleyi* is similar to *E. avenaceum* and *E. pilosum* except that the intercostal long cell margins are moderately undulating.

Adaxial epidermis (Fig. 11a).—Similar to the species mentioned, except that the prickle hairs are more abundant.

DASYOCHLOA

Dasyochloa pulchella (H.B.K.) Willd. ex Rydb.

Transverse section (Figs. 4 & 8).—Lamina is U-shaped, without a definite angle formed with the midrib, 0.6–0.9 mm wide, 0.1 mm thick, 7 VB's wide. The abaxial and adaxial longitudinal ribs and furrows are moniliform. The bulliform cells are fan-shaped, the central one relatively small, and not much larger than bundle sheath parenchyma cells. Sclerenchyma are associated with the VB's on the adaxial epidermis with a well-developed strand that follows the shape of the adaxial rib. The well-developed sclerenchyma strand on the abaxial epidermis is wider than deep. The position of the VB's is at the same level for all orders. The three primary bundles and four secondary bundles are situated midway between the abaxial and adaxial surface. These types of bundles have a round outline. The thin-walled cells of the mestome sheath surround the VB's. The parenchyma sheath, of large thin-walled cells, is continuous or interrupted by scleren-



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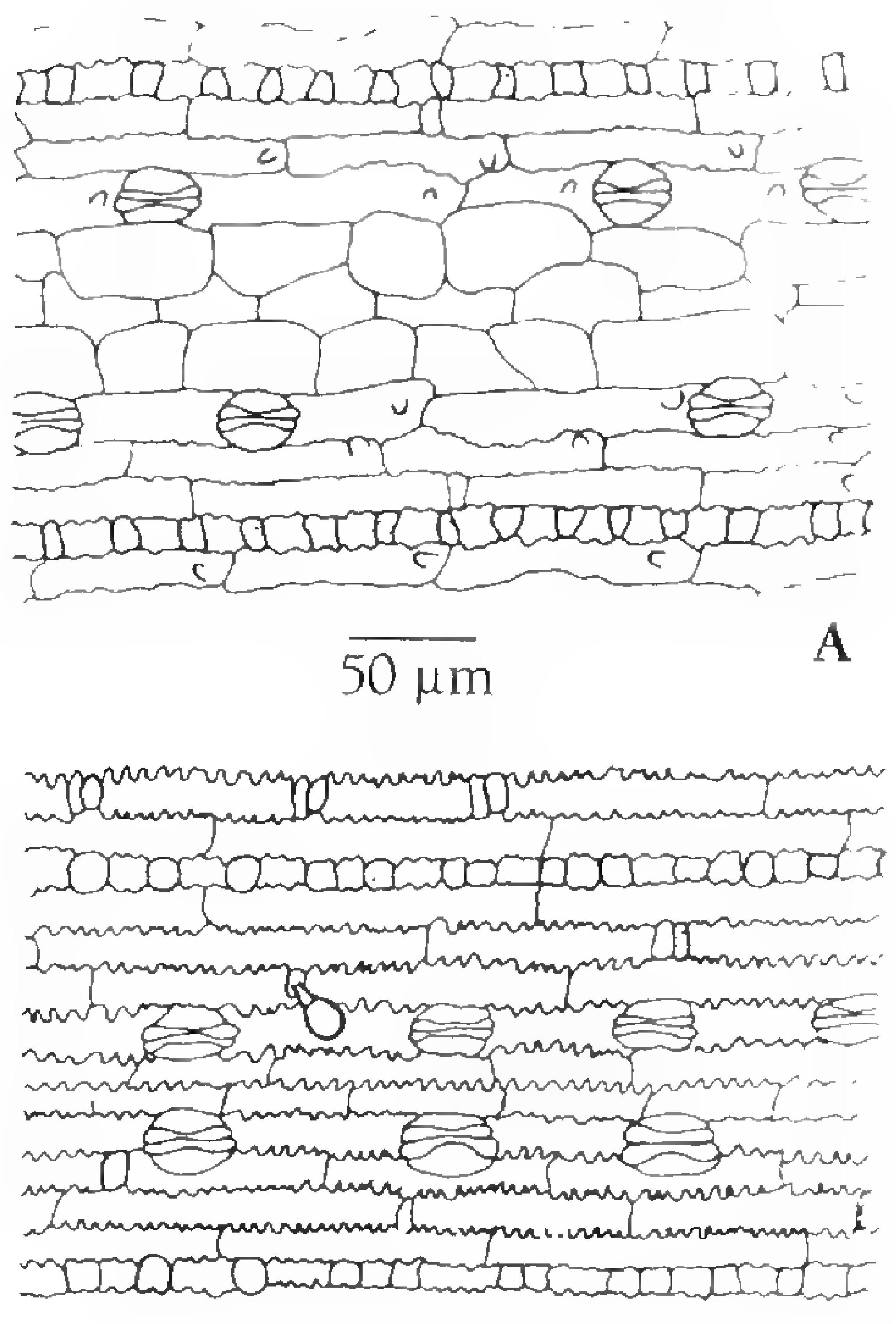

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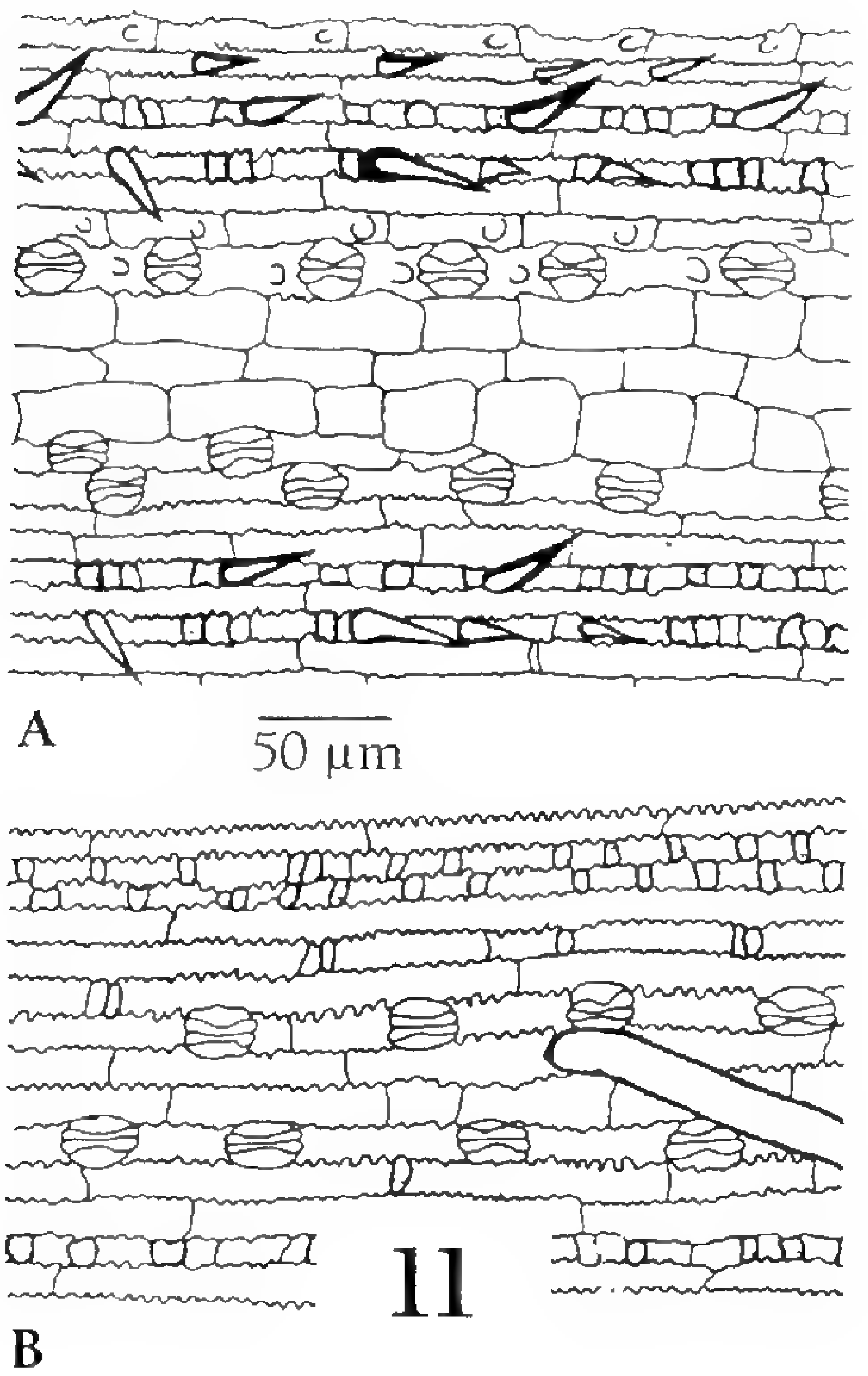

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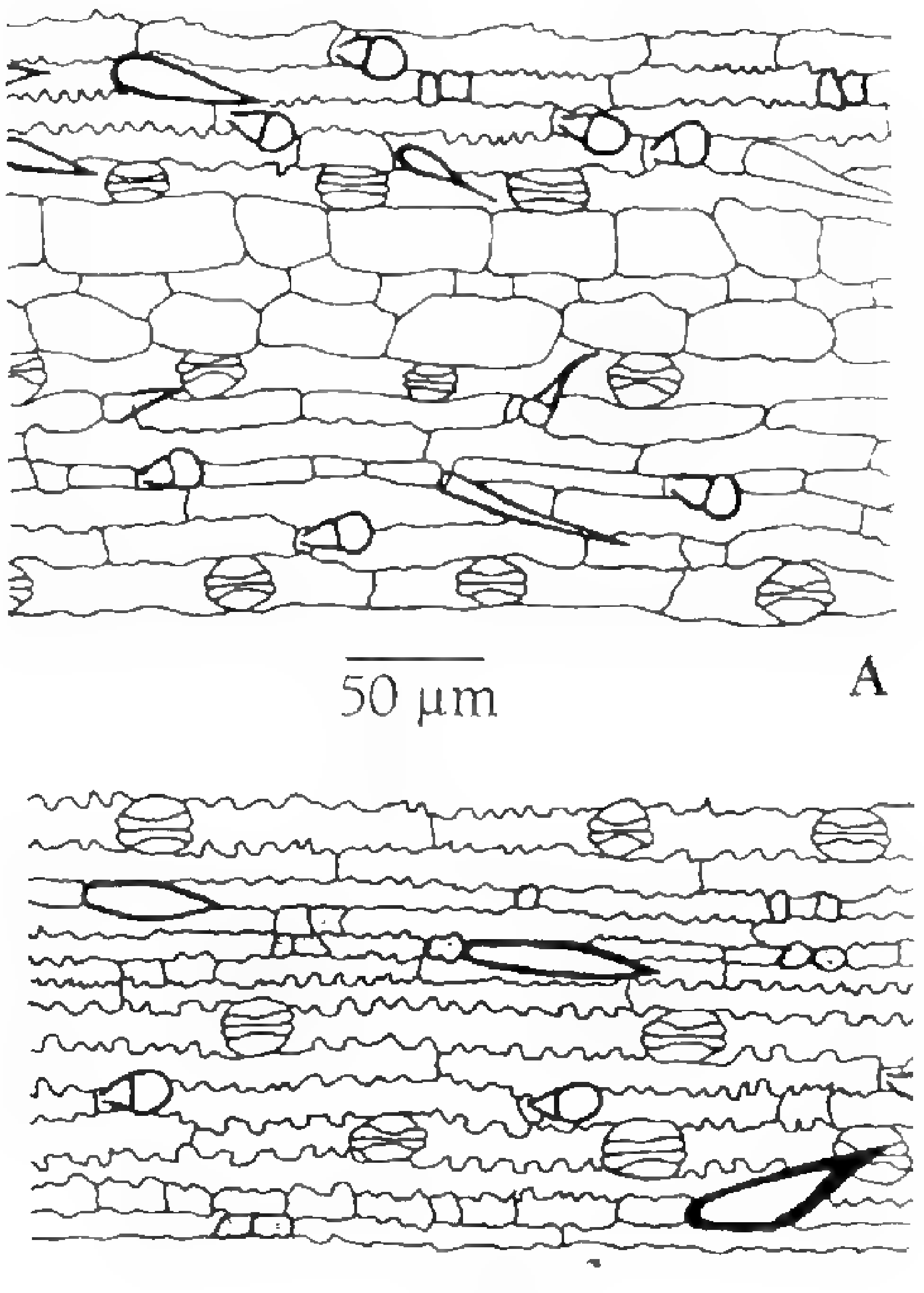

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FIGS. 9-12. Detail of adaxial and abaxial surface of leaf epidermis of *Erioneuron* and *Dasyochloa*. Fig. 9. *E. pilosum*, *Valdés 1653*. Fig. 10. *E. avenaceum*, *Valdés 1623*. Fig. 11. *E. nealleyi*, *Hatch and Valdés 5050*. Fig. 12. *D. pulchella*, *Valdés 1532*, *Morden 672*.

chyma on the primary VB's. The sclerenchyma are associated with the primary VB's forming a girder between the bundle and abaxial epidermis, and sometimes the adaxial epidermis. In the secondary VB's of the adaxial and abaxial epidermis the sclerenchyma are present as a minute strand consisting of few subepidermal fibers. The sclerenchyma cell walls are thick, and the lumen almost excluded. The well-developed sclerenchyma cap is present on the margin of the leaf, but not in contact with the lateral bundle. Chlorenchyma cells are radially arranged around the VB's in one cell layer, and interrupted by sclerenchyma when associated with the bundle. The chlorenchyma of successive VB's is separated by colorless cells and bulliform cells. Colorless cells form a girder-like extension to the opposite epidermis and are associated with and smaller than the bulliform cells. These cells are not inflated. Bulliform cells form a girder with associated colorless cells. The cuticle of epidermal cell walls is thickened and the associated cell wall occupies less than half of the depth of the cells. Prickle hairs present on both epidermes. Macrohairs are present. Papillae are absent on both epidermes.

Abaxial epidermis (Fig. 12b).—Intercostal long cells are 60–150 µm long, is about 10 µm wide, with deeply undulating margins. Stomata occur in 1 row per intercostal zone, and are dome-shaped, with rounded subsidiary cells. Intercostal short cells are solitary or paired and situated between long cells. Papillae are absent. Bicellular microhairs are 20–24 µm long and occur over intercostal long cells in 1 or 2 rows. The proximal cell is about 10 µm long, and the distal cell is about 12 µm long, and appears inflated and rounded. Prickle hairs, attached to short cells, are medium sized with the base as long as the stomata. They occur over the intercostal and costal zones. Macrohairs are present. Costal zones have a row of short cells with sinuous walls. Silica bodies are mostly dumbbell-shaped.

Adaxial epidermis (Fig. 12a).—This epidermis is similar to abaxial surface except for the following: The intercostal zone cells are slightly undulating; prickle and macrohairs are abundant.

The descriptions of *E. pilosum*, *E. avenaceum*, and *D. pulchella* correspond with the anatomical features presented by Sánchez (1979a, 1983) and Caceres (1950).

DISCUSSION

Transverse section.—In general *Erioneuron* is characterized by having a V-shaped lamina with ribs and furrows present. The abaxial ribs in *Erioneuron* are sometimes the same size or larger on the adaxial surface depicting a moniliform structure. However, *Dasyochloa pulchella* has U-shaped lamina with abaxial/adaxial ribs and furrows that form the moniliform structure.

The distribution of sclerenchyma in the leaf appears to be a reliable character relative to taxonomic relationships. The sclerenchyma associated with the VB's sometimes forms a girder between the bundle and the abaxial and/or adaxial epidermis, but generally the girder is represented by small strands. *Dasyochloa pulchella* differs from *Erioneuron* by having well-developed sclerenchyma girders on the abaxial/adaxial epidermis. The sclerenchyma associated with the primary vascular bundle comprising the keel have been a key taxonomic character for the separation of *E. avenaceum* and *E. pilosum* (Sánchez 1979). *Erioneuron pilosum* has a prominent midvein with sclerenchyma occupying more than half of the keel, whereas *E. avenaceum* has one third or less sclerenchyma occupying the midvein.

The bulliform cells of *Erioneuron* species are fan-shaped as in *D. pulchella*, except the central one is smaller. Macrohairs are usually common on the adaxial epidermis of both genera. However, as mentioned by Sánchez (1983), *D. pulchella* macrohairs are more abundant on both epidermes.

Leaf surfaces.—Features of the abaxial and adaxial epidermis are similar in most characters between the two genera. In *Erioneuron*, papillae were present only on adaxial surface, whereas in *D. pulchella*, they were not observed.

Macrohairs are present in all species. However, they are more abundant in *E. nealleyi* on the adaxial surface, and in *D. pulchella* they occur on both surfaces.

A summary of the differences of the anatomical characters are presented in Table 2. The blades of *E. avenaceum* and *E. grandiflorum* had no differences in the anatomy. *Dasyochloa pulchella* has characteristics that differ from all *Erioneuron*. Therefore, these data support the recognition of *Dasyochloa* and *Erioneuron* as anatomically distinct genera.

TABLE 2. Diagnostic characters of the leaf anatomy in the genera *Erioneuron* and *Dasyochloa*. Species are referred to as: A = *D. pulchella*, B = *E. pilosum*, C = *E. avenaceum*, D = *E. grandiflorum*, and E = *E. nealleyi*.

CHARACTER	SPECIES				
	A	B	C	D	E
Transverse Section					
Lamina 1) V-shaped, 2) U-shaped	2	1	1	1	1
Adaxial and abaxial furrows 1) slight-to-deep, 2) moniliform	2	1	1	1	1
Sclerenchyma associated with VB 1) few fibers, 2) a strand, 3) a girder	3	1	2	2	2
Bulliform cells 1) fan-shaped, regular, 2) fan-shaped, irregular	2	1	1	1	1
Epidermis					
Adaxial epidermis with one papillae on long-cells 1) present, 2) absent	2	1	1	1	1
Prickle hairs on adaxial surface 1) absent, 2) present	1	2	2	2	1

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BOOK NOTICE

CONNOR, S. 1994. **New England Natives.** (ISBN 0-674-61350-3, hbk.). Harvard University Press, 79 Garden Street, Cambridge, MA 02138-9983. $39.95. 274 pp.

This book was written to reveal "the evolving interaction between the people and the plants of New England ... by describing the wide range of uses, during different eras, to which men and women have put the various species of trees and shrubs ... in this region and describing the qualities of these plants and noting their distributions ..." Chapter 1, "A place in the forest," is devoted largely to relationships between plants and Native Americans of yesteryear. Chapter 2, "This wooden world," focusses on European settlers. Chapter 3, "Trees in the Marketplace and in the Garden," considers uses and decorative value of trees. And chapter 4, "The New Yankee Forest," discusses ecology and more uses. A prominent member of the volume's *dramatis personae* is the Arnold Arboretum. The book is abundantly illustrated with 24 color plates of plants (mostly trees) and 194 black-and-white illustrations (mostly photographs but also reproductions of old illustrations related to trees and tree products). Well written, the book certainly shows well the "overwhelming significance of wood in the history of the Republic" and "the use of the forest as more than mere scenery." It would be a fine addition to the list of "suggested readings" for any general botany or biology course or course on economic botany. And it is good reading for just about anybody interested in plants and people.—*John W. Thieret.*

ON THE HYBRID NATURE OF *QUERCUS BASASEACHICENSIS* (FAGACEAE, SECT. *QUERCUS*)

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ABSTRACT

Quercus basaseachicensis C. H. Muller, collected by LeSueur in 1936 and named by Muller in 1938, was not recollected until 1985. Since that time this white oak (sect. *Quercus*) has been discovered at several sites in the Sierra Madre Occidental in Chihuahua and extreme northern Durango, Mexico. For the first time fruiting material is described. *Quercus basaseachicensis* occurs with two other white oaks, the low, shrubby, rhizomatous *Q. depressipes* Trel. and the robust shrub or tree *Q. rugosa* Née, and is intermediate between them. Evidence based on habitat, habit, leaf morphology (including pubescence) is presented to indicate the hybrid nature of *Q. basaseachicensis*. The name *Q.* ×*basaseachicensis* C. H. Muller, pro sp., is proposed.

RESUMEN

Quercus basaseachicensis C. H. Muller, que fue colectado por LeSueur en el año 1936 y descrito por Muller en 1938, no ha sido vuelto a recolectado hasta 1985. Desde entonces este roble blanco (secc. *Quercus*) ha sido encontrado en algunos lugares en la Sierra Madre Occidental de Chihuahua y en el norte extremo de Durango, México. Se describen por el primer vez plantas con flores y frutos. *Quercus basaseachicensis* convive con dos otros robles blancos muy diferentes, uno el pequeño, arbusto, rizomatoso *Q. depressipes* Trel., el otro el arbóreo o arbusto grande, *Q. rugosa* Née, siendo intermedio entre los dos. Se presentan evidencias basadas en el hábitat, hábito, morfología y indumento de las hojas para indicar la naturaleza hibrida de *Q. basaseachicensis*. Se propone el nombre *Q.* ×*basaseachicensis* C. H. Muller, pro sp.

INTRODUCTION

Harde LeSueur, from the University of Texas, was the first botanist to collect at what is presently the Parque Nacional "Cascada de Basaseachic" on the west slope of the Sierra Madre Occidental in southwestern Chihuahua, approximately 300 air km. W of Cd. Chihuahua. Among the extensive collections he made in 1936 was a peculiar white oak, which C. H. Muller named *Quercus basaseachicensis* in 1938. LeSeuer's specimens were vegetative and Muller's new species, therefore, necessarily lacked descriptions of flowers and fruit. Nevertheless, on leaf morphology alone Muller placed the new species in the subgenus *Leucobalanus* Engelm. (= subg. *Quercus*) and, with excellent insight, in the series *Reticulatae* Trelease. Muller

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noted that a study of the fruit would probably remove the species from this section, to which he felt it was only distantly related. He also noted that "at present there exists no other series to which the species could be referred, and its characters are not sufficiently plain to serve as the basis of a new series." With no additional information, Camus (1938-39) and Martínez (1956) followed Muller's classification of *Q. basaseachicensis* exactly.

Nearly 50 years passed before this oak was collected again. In 1985, during general floristic collecting at Basaseachic, and in subsequent years of botanical exploration in the northern Sierra Madre Occidental, I and associated collectors discovered about 20 plants referable to *Q. basaseachicensis* (Fig. 1 and Appendix). A few of these were in flower or in fruit. This paper, then, reports upon these collections, provides a description of habit of the plant and its flowers and fruits, and provides morphological and ecological evidence that *Q. basaseachicensis* is a rarely formed hybrid, which at Basaseachic at least shows some segregration or backcrossing to the parental types. A plant closely resembling the isotype was determined to have $2n=24$ chromosomes (Rodriguez & Spellenberg 1992), the usual number in *Quercus*.

The parental species are believed to be the extensively rhizomatous *Q. depressipes* Trel., a patch-forming low shrub, and the robust shrub or tree *Q. rugosa* Née, two distantly related white oaks placed in different series (Trelease 1924; Camus 1938-39; Martínez 1956). This paper follows Nixon's (1993) infrageneric classification. He also notes that those oaks such as *Q. depressipes*, which are from Mexico and the southwestern United States and have connate cotyledons, form the *Glaucoideae* and probably are distinct at the subsectional level from those with free cotyledons, but a classification has yet to be devised. The hybrid between these very different white oaks that is under consideration here has not been observed to form self-perpetuating populations, and for this reason the hybrid name *Q. ×basaseachicensis* C. H. Muller, *pro sp.*, is proposed (basionym: *Q. basaseachicensis* C. H. Muller. 1938. Amer. Midl. Naturalist 19:582; Type: Mexico: Chihuahua, Cascada de Basaseachic, 6 Jul 1936, *LeSueur 549*; holotype: Muller's pers. herb., transferred to BH; isotype: TEX! [photo at NMC]).

ADDITIONS TO DESCRIPTION OF *QUERCUS ×BASASEACHICENSIS*

Shrubs 1–1.8 m tall, few to many stemmed, rarely rather extensively rhizomatous and forming patches up to ca. 5 m across. Staminate aments 15–42 mm long, with 4–20 flowers in the distal 80%, sparingly stellate tomentose; perianth sparingly to rather densely tomentose, 1.5 mm wide, about as long; anthers 3–7, glabrous, tan or reddish brown, 1.0–1.5 mm long. Pistillate flowers 1–4, in distal 1/3 of sparingly stellate pubescent to glabrate peduncle 15–41 mm long, usually only 1(–3) maturing. Cups

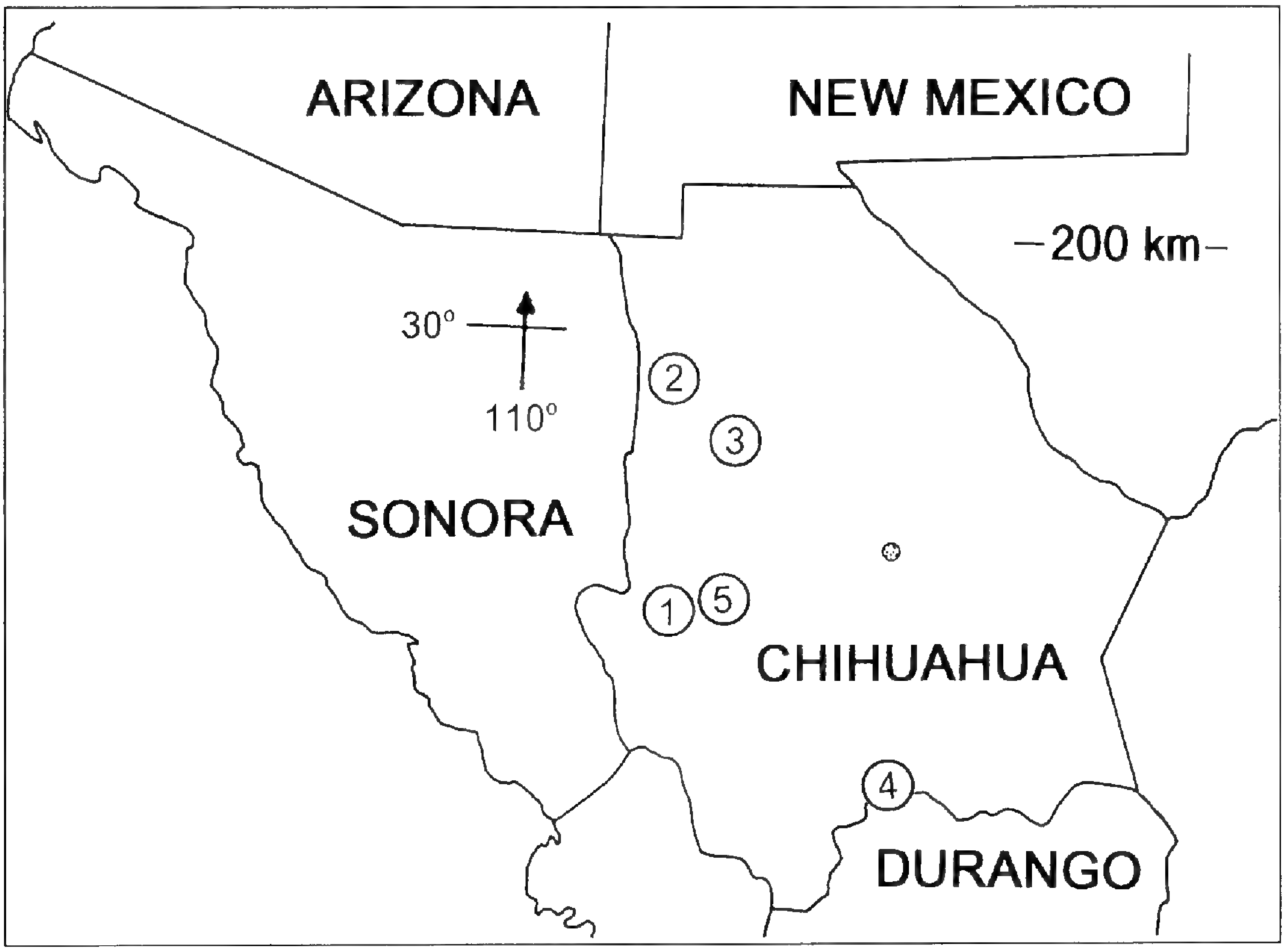


FIG. 1. Locations in the northern Sierra Madre Occidental, northwestern Mexico, of *Quercus ×basaseachicensis*. Numbered circles correspond to sites described in Appendix and following. Site 1, Chihuahua, Municipio Ocampo, Parque Nacional "Cascada de Basaseachic," the type locality. Site 2, Chih., Mcpio. Casas Grandes, 14.4 road km E of Altamirano. Site 3, Chih., Mcpio. I. Zaragoza, 1.1 km E of pass over Sierra Catarina. Site 4, Dgo., Mcpio. Ocampo, 13 km W of crossing of Rio San Juan. Site 5, Chih., Mcpio. Guerrero, 14.4 road km W of Tomochic. The small shaded circle is the location of Cd. Chihuahua, given for reference.

hemispheric, 10–12 mm wide, 8–10 mm deep, the mature scales with reddish or brown densely appressed-pubescent bases, narrowed to thin, glabrate, reddish or tan, round or more or less acute tips that are puberulent on margins. Acorns ovoid, 11–12 mm long, 8–10 mm wide, light brown, about 1/2 included. Cotyledons pale pink, fused by their edges, separate in the center in the basal 2/3.

HYBRID NATURE OF *QUERCUS ×BASASEACHICENSIS*

Oaks are notorious for the frequency of hybridization within subgenera (see, for example, Stebbins 1950, pp. 61–66). Evidence for the hybrid nature of *Quercus ×basaseachicensis* is provided by the habitat and by macro- and micromorphological intermediacy. The hybrid is always uncommon. Presently *Q. ×basaseachicensis* is known from five sites (Fig. 1). In Sites 1–4 both putative parents are immediately sympatric; at Site 5 *Q. ×basaseachicensis* grew immediately beneath *Q. rugosa*, but the nearest *Q. depressipes* (along the highway) was noted at ca. 1.5 km distant.

Habitat. —*Quercus depressipes* and *Q. rugosa* have about the same elevational range in Chihuahua and northern Durango, that is, ca. 1950–2600 m, the latter presently known to extend somewhat higher than the former. *Quercus* ×*basaseachicensis* occurs between 1980 and 2225 m. *Quercus rugosa* commonly occupies sites seeming to be more mesic, commonly in canyons, on north- or northeast-facing slopes, and often on deeper soils. *Quercus* depressipes commonly occurs on open sites, often on thin rocky soils.

As is virtually common knowledge, and as reviewed by Grant (1981, p. 199 ff.), hybrid plants are particularly common in disturbed areas. At Basaseachic (Site 1 in Fig. 1) 12 putative hybrid plants have been located, all along the trail leading from the parking lot to the top of the falls. In this area, *Q. rugosa* is common, *Q. depressipes* is rare. At Basaseachic *Q. depressipes* is common on open rocky slopes with little tree cover, but in the forested area where *Q. basaseachicensis* plants occur *Q. depressipes* is not frequent. It may have been more common here in the past, and is now succumbing to succession after fire (pines in the area are ca.125 years old or younger, and bases of many large *Cupressus* are fire-scarred). Where it occurs in the Sierra Madre, *Q. depressipes* may increase very rapidly in open areas generated by fire (R. Corral D., pers. comm). One intermediate at Basaseachic, a few-stemmed shrub about 1.2 m tall near the top of the stairs where the trail crosses the Río Basaseachic, very closely resembles the isotype (TEX) (Fig. 2) in macromorphology and in the characteristics of the pubescence on the abaxial surface of the leaf (Figs. 4, 6) (in the various collections made during this study, this plant has been designated plant "#2"). No plants referable to *Q.* ×*basaseachicensis* have been found in other areas of the park even after 10 years of general collecting there to detail the flora. At Basaseachic the range of variation in hybrid plants suggests that some are either backcrosses to the parental types, or are later-generation segregates (Fig. 2); at the other sites only more or less exact intermdeiates (F_1s?) are present. All of the plants at Basaseachic are few-stemmed shrubs; none are extensively rhizomatous.

At the northernmost site (Fig. 1, Site 2) two plants referable to *Q.* ×*basaseachicensis* were found where both *Q. depressipes* and *Q. rugosa* are common. Intermediate plants occurred only near the edges of a dirt road. Both intermediate plants were few-stemmed non-rhizomatous shrubs.

In the Sierra Catarina (Fig. 1, Site 3), six plants referable to *Q.* ×*basaseachicensis* occur along a sharply defined contact between *Q. depressipes*, which forms an extensive and continuous patch across the open east face of a hillside, and *Q. rugosa*, which is the dominant tree (also shrub) on the north-facing slopes of a narrow canyon (cf. Boecklen & Spellenberg 1990

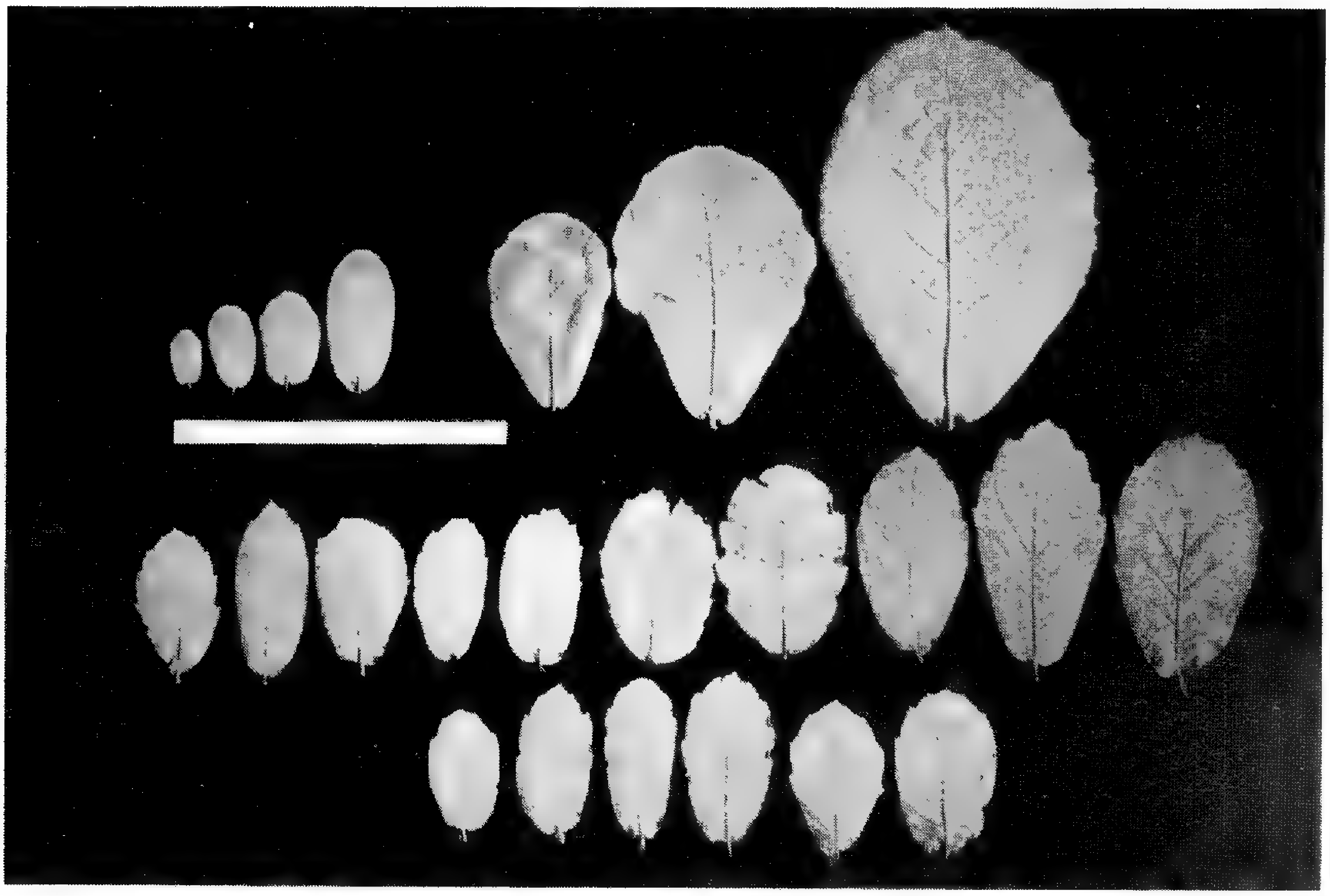


FIG. 2. Comparison of leaves from *Quercus* depressipes, *Q. rugosa*, and putative hybrids. Plants are referenced by collection number; number following hyphen signifies individual plant in population (which is indicated in voucher specimens). See Appendix for locations. Top row, group of four leaves at left, *Q. depressipes* (3 at left from *9589*, right leaf from *8919-6*). Top row, right, group of three leaves, *Q. rugosa* (2 at left from *10038*, right leaf from *11834*). Middle row, *Q. ×basaseachicensis* from Basaseachic (l-r, *8919-8, 8919-6, 9341-2* [possibly from type plant], *10042-4, LeSueur 549* [isotype, TEX], *10042-9, 8974-1, 8989-7, 9588-3, 8919-5*). Bottom row, Q. *×basaseachicensis* from the Sierra Catarina (l-r, *9739-4, 8955-1, 8955-2, 9739-6, 8213-5, 9739-3*). White scale is 10 cm long.

for a more extensive description of this site). Intermediate plants do not occur outside this line of contact. One of these intermediates is extensively rhizomatous, forming a thick patch several meters in diameter. Another four or five intermediate plants occur in a canyon ca. 1/2 km to the northeast where *Q. rugosa* and *Q. depressipes* are intermixed.

Macro- and Micromorphological Comparisons.—Hybrids in oaks are commonly detected by macromorphological intermediacy, particularly by characteristics of the leaves (e.g., Bartlett 1951; Benson, Phillips & Wilder 1967; Cottam, Tucker & Santamour 1982; Hardin 1975; Stebbins, Matzke & Epling 1947; Tucker 1961). In Table 1 several macro- and micromorphological features of *Quercus* depressipes, *Q. rugosa*, and *Q. ×basaseachicensis* are compared. Intermediacy of putative hybrids between *Q. rugosa* and *Q. depressipes* in leaf size and shape was demonstrated by multivariate methods for plants in the Sierra Catarina (Site 3) (Boecklen & Spellenberg 1990), and is evident for two populations in Fig. 2.

Even a casual examination of the abaxial surface of the leaf reveals conspicuous differences between the species, and intermediacy in many of the characters by *Quercus* ×*basaseachicensis*. With a dissecting microscope *Quercus rugosa* is seen to be prominently bullate and minutely papillate (due to the prominently convex surfaces of the epidermal cells), *Q.* ×*basaseachicensis* less so, and *Q. depressipes* not at all bullate, and with the cell surfaces only obscurely convex. The bullate vs. non-bullate nature of the abaxial surface is evident in Figs. 3–5, as are the differences in the convexity of the cells.

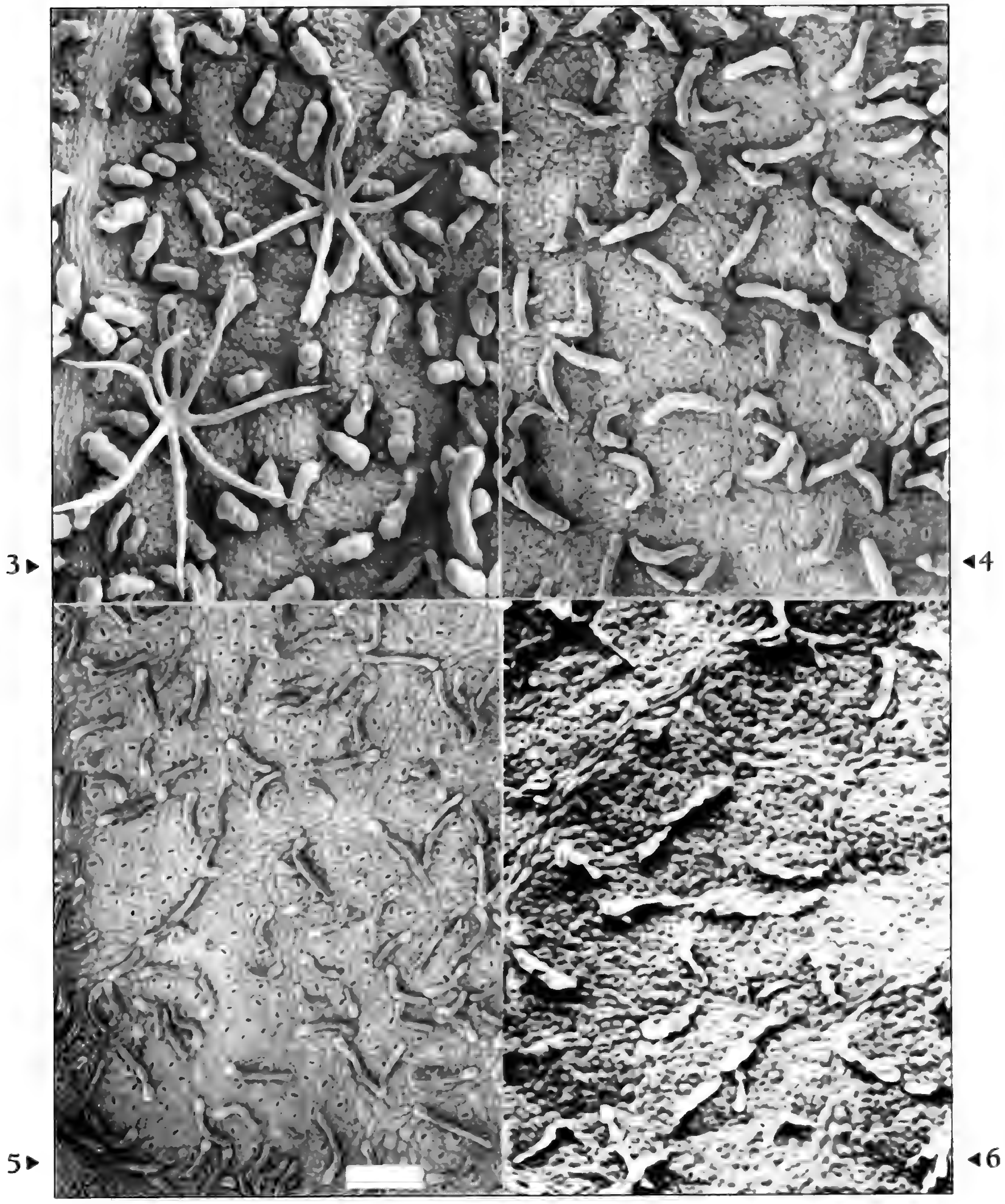
Several authors have shown that characteristics of the indumentum are important in distinguishing oak taxa (e.g., Hardin 1979; Manos 1993; Nixon & Steele 1981; Thomson & Mohlenbrock 1979) and useful in the detection of hybrids (Cottam, Tucker & Santamour (1982). To more critically examine and illustrate features of the indumentum of the abaxial leaf surface, specimens were examined with scanning electron microscopes (ETEC Autoscan 500 at University of New Mexico; Philips 501B at New Mexico State University). Fresh leaf tissue was fixed in FAA, dehydrated, critical point dried, sputter-coated with gold, and photographed at 80x. Material from the isotype was treated in the same manner.

Quercus rugosa has stellate hairs on the abaxial leaf surface (Fig. 3), whereas *Q. depressipes* does not (Fig. 5). The isotype of Q. ×*basaseachicensis* also lacks stellate hairs (Fig. 6), as do most of the plants believed to be hybrids at Basaseachic (Fig. 4). In the Sierra Catarina (Site 3) some intermediates have stellate hairs, others do not. Intermediate plants from sites 2, 4, and 5 all lack stellate hairs.

The species and the intermediates, including the isotype, also differ in the size of a second type of foliar trichome, the small, gold or white vermiform hairs on the abaxial surface of the leaf. Those of *Quercus rugosa* are large, easily seen, and often coalesce in age into dark droplets. The hairs are sufficiently small in *Q. depressipes* that even under a hand lens the leaf must be well lit for one to detect their presence. The hairs differ in length and diameter between *Q. rugosa* and *Q. depressipes* (Table 1), with those of *Q.* ×*basaseachicensis* being intermediate.

CONCLUSION

The comparison of very different kinds of characters made in Table 1 differs little from the character count procedure described by Wilson (1992) and indicates that *Q.* ×*basaseachicensis* probably is, in fact, a hybrid between the very different white oaks *Q. depressipes* and *Q. rugosa*. Hybrid plants are rare and always occur with one, and usually both, the putative parents. Based on leaf characteristics, including features of the indumentum, the plant in Figure 4 (plant #2 in the various Basaseachic collections we have made) may actually be the type plant from which LeSueur collected in 1936. Admittedly, on habit and leaf characteristics it would be difficult at



FIGS. 3–6. Abaxial epidermis of white oaks from Basaseachic (white bar at base of Fig. 5 represents 100 microns). Fig. 3. *Quercus rugosa* (*#11838*), illustrating two stellate hairs and numerous large multicellular vermiform hairs. Fig. 4. *Quercus ×basaseachicensis* (*#11840*, plant 2), showing only middle-size vermiform hairs. Fig. 5. *Quercus* depressipes (*#11839*), showing only minute vermiform hairs. Fig. 6. *Quercus ×basaseachicensis* (*LeSueur 549*, TEX, isotype) showing only middle-size vermiform hairs (collapsed) similar in size and density to those in Fig. 4.

Table 1. Comparison of several macro- and micromorphological attributes of *Quercus depressipes*, *Q. ×basaseachicensis*, and *Q. rugosa*.

Attribute		Species of Oak	
	Q. depressipes	*Q. ×basaseachicensis*	*Q. rugosa*
Habit	Shrub, often extensively rhizomatous (rarely not), forming large patches	Shrub, occasionally fairly rhizomatous, usually not	Tree, occasionally a non-rhizomatous shrub
Height	0.3–(2) m	1–3 m	(2)3–20 m
LF Color	pale bluish green	pale bluish green to deep green	deep, dark green
LF Length	2–4 cm	4–7.5 cm	5–13 cm
LF Width	1–2.3 cm	1.9–5.1 cm	3.8–10.0 cm
LF Margin	Entire, or with 1–3 teeth on each side near apex	Entire to toothed throughout	Usually irregularly toothed throughout, rarely subentire
Abaxial Surface, LF	Smooth, no veins impressed; smallest veinlets colored as areolae	Slightly rugulose the larger veins somewhat impressed; smallest veinlets somewhat paler than areolae	Rugulose, all but the smallest veins impressed; smallest veinlets notably paler than areolae
Abaxial Epidermis, LF	Smooth, cells very slightly convex	From rather smooth and with cells slightly convex to rather bullate and cells strongly convex	Strongly bullate and microscopically papillate with cells strongly convex
Pubescence, Abaxial Surface, LF	Appearing glabrous, but with very minute golden vermiform hairs; no stellate hairs	Minutely pubescent, with small golden vermiform hairs, some plants also with sparse stellate hairs	Noticeably pubescent, with large golden vermiform hairs and with stellate hairs
Length, Vermiform Hairs	0.05–0.13 mm	0.09–0.21 mm	0.13–0.33 mm
Diameter, Vermiform Hairs	ca. 10 microns	ca. 20 microns	ca. 30 microns
Fruiting Inflorescence	peduncle 0.7–2.5 cm, fruits 1–2 near tip, often only 1 maturing	peduncle 2–4 cm, fruits 1–4 in upper 30%, often only 1 maturing	peduncle (2)6–13 cm, fruits 1–7 in upper 60% most maturing
Cotyledons	connate (except in center near base); flesh white	connate at margins, center free; flesh pale pink	free; flesh deep pink

best to eliminate another common white oak, *Q. arizonica* Sarg., which occurs at Basaseachic sympatrically with *Q. rugosa*, as a parent instead of *Q. rugosa*. Characteristics of the pistillate inflorescence (Fig. 7) and the cotyledons provide insight. *Quercus ×basaseachicensis* has rather long peduncles in the pistillate inflorescence (Fig. 7), generally longer than those of *Q. depressipes* and shorter than those of *Q. rugosa* (Table 1). In *Q. arizonica* the

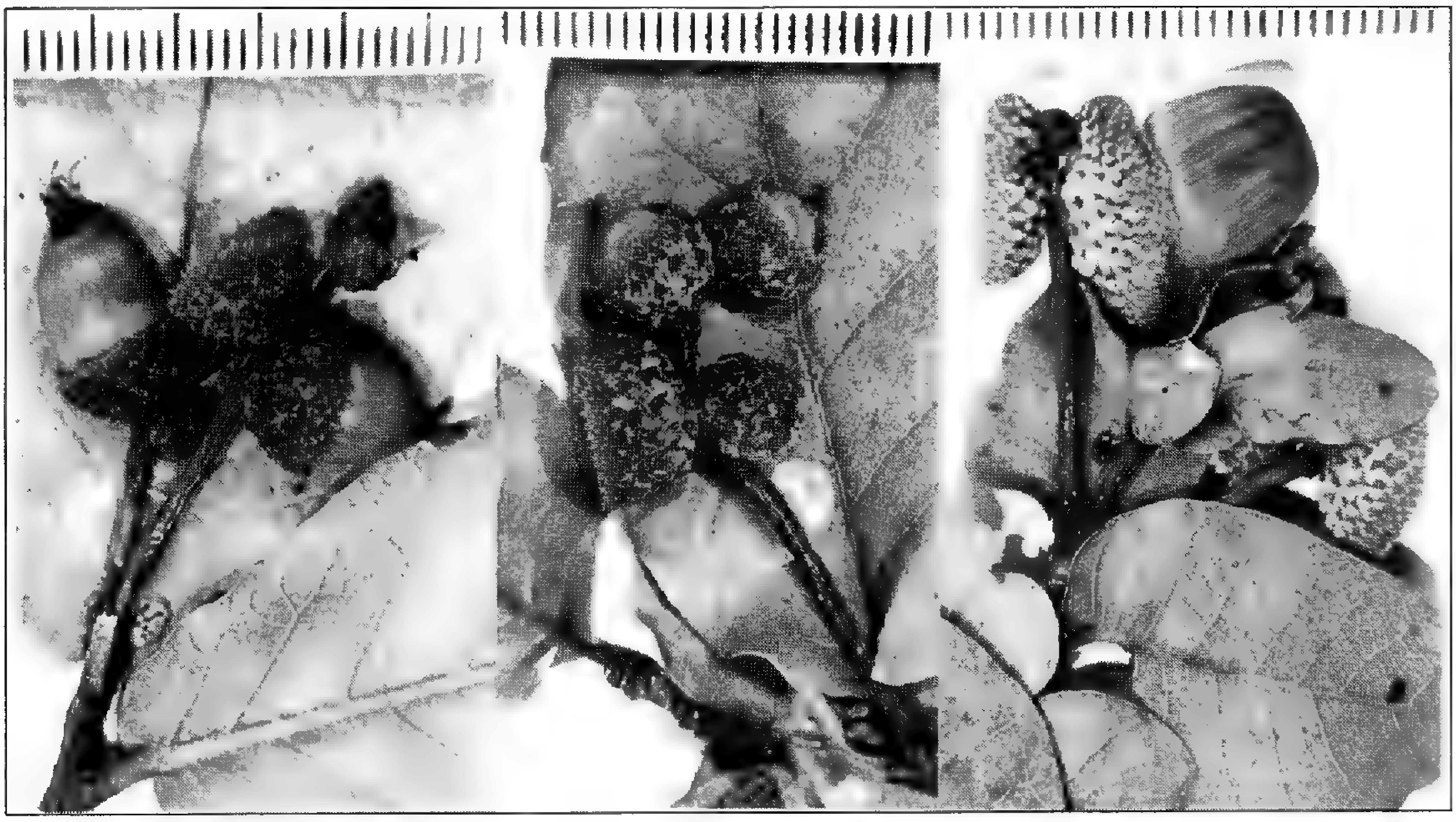


FIG. 7. Comparison of fruiting inflorescences of *Quercus rugosa* (*10038*) (left), *Q.* ×*basaseachicensis* (*9341-2*) (middle), *Q. depressipes* (*8598*) (right). Inflorescence from *Q. rugosa* is at short end of range of variation; that from *Q. depressipes* is from long end. Units of scale at right in mm. Photos from specimens at NMC. All specimens cited in appendix except that of *Q. depressipes*, which is: *Spellenberg & Zimmerman 8598*, Chihuahua, Mcpio. Bocoyna, S edge of village of Bocoyna, 12 Sep 1986.

peduncle rarely exceeds 11 mm in length. Plant #2 at Basaseachic has only partially connate cotyledons, as do several plants from the Sierra Catarina (Site 3). In *Q. arizonica* and *Q. depressipes* cotyledons are nearly or completely connate; in *Q. rugosa* they are distinct. At Site 3 *Q.* ×*basaseachicensis* occurs along a precise and very narrow line of contact between *Q. rugosa* and *Q. depressipes*, and west of Casas Grandes (Site 2) Q. ×*basaseachicensis* occurs where *Q. depressipes* and *Q. rugosa* are intermixed. In neither case is *Q.* ×*basaseachicensis* closely associated with *Q. arizonica.* At site 4, in northern Durango, *Q. arizonica* is also present and intermixed with *Q. rugosa* and *Q. depressipes*. At this site parentage of the intermediate is certainly open to question.

ACKNOWLEDGMENTS

Gratitude is expressed to numerous individuals. Mr. Toutcha Lebgue of the Universidad Autonoma de Chihuahua and Mr. Rafael Corral of the Escuela Superior de Agricultura "Hermanos Escobar" in Juárez both helped in aspects of the field work of this project and are co-collectors on many of the collections. Dr Billie Turner kindly gave permission to examine fragments of the isotype at the University of Texas by SEM. Esteban Muldavin prepared cores of several pines at Basaseachic to determine age of trees. An anonymous reviewer provided valuable comments. A National Science Foundation grant (DEB-9209109) to Drs. Bill Boecklen and Dan Howard helped with some of the costs of field work. A NMSU Arts and Sciences Mini-grant #92-027 financed SEM work done by Hank Adams and Mark Cunningham at NMSU and Angela Welford at UNM. Considerable assistance was provided by the NMSU Foundation "Friends of the Herbarium" fund.

APPENDIX

Specimens seen for this paper, with herbaria of deposition (CHIH – Univ. Autonoma de Chihuahua; ESAHE = Colegio de Graduados, Escuela Superior Agricultura "Hermanos Escobar" in Juarez [now closed; possibly to be transferred to Univ. Autonoma de Cd. Juarez]). Collection numbers are those of Spellenberg and various associates. Sites of collections are shown on Figure 1.

SITE 1—Chihuahua, Mcpio. Ocampo, Parque Nacional "Cascada de Basaseachic," 108°12'30"W, 28°10'N, elev. 1980 m, in association with various oaks and pines.

Q. basaseachicensis: *LeSueur 549*. 7-6-36 (TEX!, isotype); *8467*, 26 Apr 1985 (BH, DAV, CHIH, SAHE, NMC); *8794*, 4 Oct 1986 (NMC); *8919*. 16 Oct 1986 (NMC); *9341*, BH, IBUG, NMC, TEX); *9588*, 1 Aug 1988 (CAS, CIIDIR, IEB, NMC); *9638*, 1 Aug 1988 (NMC); *9660*, 2 Aug 1988 (ASU, MEXU, NMC, US); *10042*, 28 Oct 1989 (MEXU, UC); *10924*, 26 Sep 1991 (MEXU, MO, NMC, NY); *11840*, 17 Jun 1993 (BRIT, DAV, RSA)

Q. depressipes : *8469*, 27 Apr 1987 (MEXU); *8919*, 16 Oct 1986 (NMC); *9589*, 1 Aug 1988 (CAS, CIIDIR, IEB, NMC); *9643*-A, 1 Aug 1988 (NMC); *10799*, 25 Jun 1991 (F); *11839*, 7 Jun 1993 (NMC)

Q. rugosa: *8917*, 16 Oct 1986 (NMC); *9341*, 12 Sep 1987 (BH, BRIT, CAS, IEB, NMC); *9590*, 1 Aug 1988 (NMC, UC, US); *10038*, 28 Oct 1989 (CIIDIR, MEXU, NMC); *10926*, 26 Sep 1991 (NMC); *11838*, 17 Jun 1993 (F)

SITE 2—Chihuahua, Mcpio. Casas Grandes, 14.4 road km E of Altamirano, 43 km W of junction with Casas Grandes-7 Colonia Juárez road, ca. 108°40'W, 29°40'N, elev. 2225 m, in association with various oaks and pines.

Q. basaseachicensis: *9192*, 10 Jun 1987 (CIIDIR, DAV, MEXU, NMC)

Q. depressipes: *9191*, 10 Jun 1987 (CIIDIR, MEXU, NMC)

Q. rugosa: *9190*, 10 Jun 1987 (CIIDIR, MEXU, NMC)

SITE 3—Chihuahua, Mcpio. I. Zaragoza, 25 km SW of Buenaventura, 1.1 km E of pass over Sierra Catarina, 107°38'W, 29°46'N, elev. 2290 m, in association with various oaks and pines.

Q. basaseachicensis: 7956, 8 Feb 1985 (DAV, MEXU, NMC); *8940*, 11 Nov 1986 (ENCB, MO); 8955, 16 Nov 1986 (BRIT, COLO, DAV, F, NMC, RM, SRSC); *9213*, 18 Aug 1987, (ARIZ, CAS, CIIDIR, IBUG, MEXU, NMC, NY, UNM, US); *9738*, 23 Sep 1988 (BH, MEXU, NMC, NY); *9739*, 23 Sep 1988 (ASU, IEB, INIF, MT, NMC, RSA, TEX); *10936*, 12 Oct 1991 (GH)

Q. depressipes: 7955, 8 Feb 1985 (MEXU, NMC); *10060*, 30 Oct 1989 ARIZ, BRIT, CAS, CIIDIR, MEXU NMC); *8941*, 14 Nov 1986 (BH, F, IEB); *9212*, 18 Aug 1987, (MEXU, NMC, NY); *9740*, 23 Sep 1988 (IBUG, NMC)

Q. rugosa: *8939*, 11 Nov 1986 (ASU, IBUG); *8954*, 16 Nov 1986 (COLO, DAV, F, IEB, INIF, NMC, NY, SRSC); 8956, 16 Nov 1986 (MEXU, NMC); *10059*, 30 Oct 1989, (ARIZ, BRIT, CAS, CIIDIR, MEXU, NMC)

SITE 4—Durango, Mcpio. Ocampo, on road between Hidalgo de Parral and Guadalupe y Calvo, 13 km W of crossing of Río San Juan, 24 km E of El Vergel, 106°12'W, 26°40'N, elev. 2280 m, with various oaks and pines.

Q. basaseachicensis: *8543*, 12 Jul 1986 (CAS, CIIDIR, MEXU, NMC)
Q. depressipes: *8542*, 12 Jul 1986 (MEXU, NMC)

SITE 5—Chihuahua, Mcpio. Guerrero, 14.4 road km W of Tomochic, ca. 108°58'W, 28°21'N, elev. 1950 m, in association with various oaks and pines.

Q. basaseachicensis: *9660*, 2 Aug 1988 (ASU, MEXU, NMC, US)
Q. rugosa: *9659*, 2 Aug 1988 (NMC)

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BOOK NOTICES

LI, SHIYOU and DENT T. ADAIR. 1994. XI Shu. **A Promising Anti-tumor and Anti-viral Tree for the 21st Century.** (ISBN 0-938361-11-2, hbk.). The Tucker Center, College of Forestry, P.O. Box 6109, SFA Station, Nacogdoches, TX 75962, (409) 468-4600 voice; 409-468-1195 fax. $45.00. 268 pp., 18 color & 6 b&w photos, 6 × 9.

This book is a monograph about Xi Shu and camptothecins. It includes two parts. Part I includes two sections and 13 chapters of text: 1) **Camptothecins:** drug discovery history, comparisons with taxols, mechanisms of action, preclinical and clinical trials in cancer treatment, anti-viral activity, other uses, and drug sources; and 2) **Xi Shu:** botany, geography, ecology, reproduction, growth, protection, harvest, and further research. Part II is a bibliography of over 1,300 citations on Xi Shu and camptothecins worldwide.

The book also presents 18 color and 6 black and white photographs showing the tree growing in its natural range in China and as cultivated in the United States. In addition, there are 17 illustrations and maps.

A foreword is provided by Dr. Monroe E. Wall (Chief Scientists of the Research Triangle Institute, North Carolina), the discoverer of drugs camptothecin and taxol. And a preface is provided by Dr. Beppino C. Giovanella of Stehlin Foundation for Cancer Research.

HOPKINS, WILLIAM G. 1995. **Introduction to Plant Physiology.** (ISBN 0-471-54547-3, hbk.). John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158, (212) 850-6336. $75.95. 464 pp. Illustrated.

"*Introduction to Plant Physiology* is a text for undergraduate students studying the subject of plant physiology for the first time. Like most texts, it has grown out of 30-years experience teaching plant physiology to undergraduate students. It assembles and explains, in a narrative format, underlying concepts of plant physiology within a framework of historical origins and modern approaches. The text assumes that the student has completed a first course in botany (or biology with a strong botanical component) and chemistry. It is a appropriate for a one-semester course in plant physiology for general students, and as a first course for those interested in advanced study in plant physiology, environmental plant physiology, or physiological plant ecology." The chapers include: 1) Introduction: The Organization of Plants and Plant Cells; 2) Plant Cells and Water; 3) Water Relations of the Whole Plant; 4) Plants and Inorganic Nutrients; 5) Roots, Soils, and Nutrient Uptake; 6) Plants and Nitrogen; 7) Light and Pigments: An Introduction to Phytobiology; 8) Leaves and Photosynthesis; 9) Bioenergetics and the Light-Dependent Reactions of Photosynthesis; 10) Photosynthesis: Carbon Metabolism; 11) Translocation and Distribution of Photoassimilates; 12) Cellular Respiration: Retrieving the Energy in Photoassimilates; 13) Carbon Assimilation and Productivity; 14) Regulation of Plant Development; 15) The Role of Hormones in Plant Development; 16) Biochemistry and Mode of Action of Hormones; 17) Photomorphogenesis—Responding to Light; 18) Plant Movements—Orientation in Space; 19) Measuring Time: Photoperiodism and Rhythmic Phenomena; 20) Temperature and Plant Development; 21) The Physiology of Plants Under Stress; and 22) Plant Physiology and Biotechnology.

NOMENCLATURAL CHANGES IN *SETARIA* AND *PASPALIDIUM* (POACEAE: PANICEAE)

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ABSTRACT

A historical perspective and discussion of the generic relationships is presented for *Paspalidium* and *Setaria*. It is concluded that species of *Paspalidium* are best treated as *Setaria*. A list of accepted taxa previously placed in *Paspalidium* is given. Nineteen new combinations (*Setaria albovillosa*, S. *aversa*, *S. basiclada*, *S. clementii*, *S. constricta*, *S. criniformis*, *S. gausa*, *S. globoidea*, *S. spartela*, *S. grandispiculata*, *S. inaequalis*, *S. jubiflora*, *S. paludivaga*, *S. rara*, *S. reflexa*, *S. retiglumis*, *S. scabrifolia*, *S. tabulata*, *S. uda*) and one new name (*Setaria brigalow*) are proposed.

RESUMEN

Se presenta una perspectiva histórica y una discusión de las relaciones genéricas de *Paspalidium* y *Setaria*. Se concluye que las especies de *Paspalidium* están mejor tratadas en *Setaria*. Se ofrece una lista de los taxa aceptados colocados previamente en *Paspalidium*. Se proponen diez y nueve combinaciones nuevas (*Setaria albovillosa*, *S. aversa*, *S. basiclada*, *S. clementii*, *S. constricta*, *C. criniformis*, *S. gausa*, *S. globoidea*, *S. spartela*, *S. grandispiculata*, *S. inaequalis*, *S. jubiflora*, *S. paludivaga*, *S. rara*, *S. reflexa*, *S. retiglumis*, *S. scabrifolia*, *S. tabulata*, *S. uda*) y un nombre nuevo (*Setaria brigalow*).

INTRODUCTION

The generic distinction between *Paspalidium* Stapf and *Setaria* P. Beauv. has been a topic of academic interest among agrostologists knowledgeable in the phenetic relationship between these genera. *Setaria* includes about 114 species (Webster 1993) concentrated in the tropics and sub-tropics of the world. Presence of bristles, disarticulation at the base of the spikelets, indurate upper floret, and a muticous upper floret are characters that separate *Setaria* from other genera of the Paniceae R. Br. (Webster 1992). *Paspalidium* includes about 28 species. It is concentrated in Australia where Webster (1987) recognized 23 species. The remaining five species are native to Asia and Africa.

Stapf (1920) separated *Paspalidium* from *Setaria* on inflorescence form and structure. That is, *Paspalidium* was characterized by racemose primary branches and *Setaria* by a contracted spike-like panicle. Subsequent authors used similar characters and the presence or absence of bristles to separate the genera.

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Hitchcock and Chase (1910) separated *Panicum* subgenus *Paurochaetum* from other species of *Panicum* on the presence of a point or bristle extending beyond the uppermost spikelet in subg. *Paurochaetum*. Pilger (1940) placed subgenus *Paurochaetum* as a section of *Setaria*. Hitchcock (1951) separated *Setaria* from *Panicum* on the presence of bristles forming an involucre in *Setaria*, but retained *Paurochaetum* in *Panicum*. Rominger (1962) did not discuss *Paspalidium* but placed *Paurochaetum* as a subgenus of *Setaria*.

Veldkamp (1980) noted that *Paspalidium* was probably not distinct from *Setaria*. Clayton and Renvoize (1986) did not formally place *Paurochaetum*. They recognized both *Setaria* and *Paspalidium* but indicate that intermediate species make the distinction arbitrary.

A complete comparative treatment of the 23 Australian *Paspalidium* was presented by Webster (1987). I stated the following: "Contrary to what the various flora treatments in North America, Africa, and Australia lead one to believe, *Paspalidium* cannot be distinguished from *Setaria* on the presence or absence of bristles and the spikelet characteristics are essentially identical. The bristle to spikelet relationships in *Setaria* are so varied that it cannot be used to separate the genera." I tentatively distinguished these genera on the arrangement of the primary inflorescence branches. *Paspalidium* was characterized by secund or distichous primary branches, whereas in *Setaria* the primary branches could originate from any point on the main axis (i.e. quaquaversal). This character was applied in subsequent publications distinguishing among the Paniceae genera (Webster 1988; Webster & Valdes-Reyna 1988; Webster et al. 1989; Webster 1992).

Davidse and Pohl (1992) stated that *Paspalidium* is characterized by abaxial spikelets born in unilateral spikes. They made new combinations in *Paspalidium* for *Setaria* chapmanii and six West Indian species with an inflorescence form similar to the Australian *Paspalidium*. The New World mainland taxa with similar inflorescence characteristics to those of the Australian and West Indian "*Paspalidiums*" groups were retained in *Setaria*.

Webster (1993) stated that "when the full range of variation in *Setaria* is considered, it is morphologically identical to *Paspalidium*." Finally, Veldkamp (1994) concluded that *Paspalidium* cannot be delimited from *Setaria*. He reduced it to *Setaria*, and transferred the Southeast Asian species to *Setaria*, including the type species of *Paspalidium*.

In review, all species of *Paspalidium* possess a bristle terminating a branch. The spikelets are arranged in a tight or loose arrangement on the branches depending on the number of spikelets and the length of the pedicels. In some species, bristles subtend all spikelets whereas in others only the terminal spikelet of a branch is subtended by a bristle. There is continuous variation between these forms. A wide range in variation for these characters is also found in *Setaria*. As in *Paspalidium*, the bristle to spikelet relationship is correlated to the development of the primary branches. Species with elongate or pronounced primary branches frequently have some spikelets that lack subtending bristles. However, a bristle will terminate the primary and secondary branches. Arrangement of the primary branches (i.e. secund, distichous, and quaquaversal) is difficult to apply and the generic significance is open to question. Since the genera cannot be satisfactorily separated, *Paspalidium* is best treated as a synonym of *Setaria*. A comprehensive phylogenetic study of *Setaria* is required before a decision is made concerning the recognition of subgenera and sections within *Setaria*.

The following is an alphabetical list of accepted species with new combinations where needed.

SPECIES LIST

Setaria albovillosa (S.T. Blake) R.D. Webster, comb. nov. *Paspalidium albovillosum* S.T. Blake, Proc. Roy. Soc. Queensland 62:96. 1952. TYPE: *Blake 10947* (HOLOTYPE: BRI!; ISOTYPE: CANB!).

Paspalidium radiatum var. *hirsutum* Vickery, Contr. New South Wales Natl. Herb. 1:334. 1951. TYPE: *C.O. Cross NSW no. 8944* (HOLOTYPE: NSW!).

Distribution.—Australia: woodlands of Queensland and New South Wales.

Setaria aversa (Vickery) R.D. Webster, comb. nov. *Paspalidium aversum* Vickery, Contr. New South Wales Natl. Herb. 1:331. 1951. TYPE: *T.F. Mau s.n.* (HOLOTYPE: NSW no. 8992!).

Distribution.—Australia: woodlands of Queensland and New South Wales.

Setaria basiclada (Hughes) R.D. Webster, comb. nov. *Paspalidium basicladum* Hughes, Bull. Misc. Inform. 318. 1923. TYPE: *Steward 200* (HOLOTYPE: K!).

Distribution.—Australia: shrublands, grassland, and arid regions of Western Australia, Northern Territory, South Australia, and Queensland.

Setaria brigalow R.D. Webster, nom. nov. *Paspalidium caespitosum* C. E. Hubb., Bull. Misc. Inform. 446. 1934, non *Setaria caespitosa* Hack. & Arechav. 1894. TYPE: *Hirschfeld s.n.* (HOLOTYPE: K!). This species is commonly know as "Brigalow Grass" and occurs in the Brigalow vegetation region of Australia.

Distribution.—Australia: woodlands to arid shrublands of Queensland and New South Wales.

Setaria chapmanii (Vasey) Pilg. in Engl. & Prantl, Nat. Pflanzenfam. (ed. 2) 14e:72. 1940. *Paspalidium chapmanii* (Vasey) R. W. Pohl, Novon 2:106. 1992. *Panicum* chapmanii Vasey, Bull. Torrey Bot. Club 11:61. 1884, as *P. "chapmani."* TYPE: *Chapman s.n.* (LECTOTYPE, selected by Hitchcock & Chase 1910, US!).

Distribution.—United States: Florida. Mexico: Yucatan. West Indies: Cuba and Bahamas.

Setaria clementii (Domin) R.D. Webster, comb. nov. *Paspalidium clementii* (Domin) C. E. Hubb., Bull. Misc. Inform. 447. 1934. *Panicum clementii* Domin, J. Linn. Soc., Bot. 41:272. 1912. TYPE: *E. Clement s.n.* (HOLOTYPE: either BM or PR).

Distribution.—Australia: arid grasslands and shrublands of Western Australia, Northern Territory, South Australia, Queensland, and New South Wales.

Setaria constricta (Domin) R.D. Webster, comb. nov. *Paspalidium constrictum* (Domin) C. E. Hubb., Bull. Misc. Inform. 447. 1934. *Panicum constrictum* Domin, Biblioth. Bot. 20(85):302. 1915. *Panicum flavidum* var. *tenuis* Benth., Fl. Austral. 7:474. 1878. TYPE: *Domin II* 1910 (HOLOTYPE: PR).

Distribution.—Australia: arid grasslands and shrublands of Western Australia, Northern Territory, South Australia, Queensland, and New South Wales.

Setaria criniformis (S.T. Blake), R.D. Webster, comb. nov. *Paspalidium criniforme* S.T. Blake, Proc. Roy. Soc. Queensland 62:98. 1952. TYPE: *S.T. Blake 5282* (BRI).

Paspalidium gracile (R. Br.) Hughes var. *debile* Vickery, Contr. New South Wales Natl. Herb. 1:331. 1951. TYPE: *J.H. Camfield 5*, 1901 (NSW no. 9168!).

Distribution.—Australia: woodlands and shrublands of Queensland and New South Wales.

Setaria distans (Trin.) Veldkamp, Blumea 39:376. 1994. *Paspalidium distans* (Trin.) Hughes, Bull. Misc. Inform. 317. 1923. *Panicum distans* Trin., Spec. Gram. 2:t. #172. 1829, non Saltz. ex Steud. 1853. TYPE: *R. Brown 6098* (HOLOTYPE: K; ISOTYPE: BM!).

Panicum commixtum Steud., Syn. Pl. Glum. 1:59. 1853. TYPE: *d'Urville s.n.* (HOLOTYPE: P). *Paspalidium radiatum* Vickery, Contr. New South Wales Natl. Herb. 1:332. 1950. TYPE: *E. Cheel 3*, 1907 (HOLOTYPE: NSW, K). *Paspalidium disjunctum* S.T. Blake, Proc. Roy. Soc. Queensland 84:65. 1973. TYPE: *S.T. Blake 19899* (HOLOTYPE: BRI).

Distribution.—Australia: woodlands of Queensland and New South Wales. Malesia: New Guinea.

Setaria distantiflora (A. Rich.) Pilg. in Engl. & Prantl, Nat. Pflanzenfam. (ed. 2) 14e:72. 1940. *Paspalidium distantiflorum* (A. Rich.) Davidse & R. W. Pohl, Novon 2:106. 1992. *Panicum distantiflorum* A. Rich. in Sagra, Hist. Fis. Cuba, Bot. 11:302. 1850. TYPE: *Sagra s.n.* (HOLOTYPE: P).

Distribution.—West Indies: Cuba and Bahamas.

Setaria flavida (Retz.) Veldkamp, Blumea 39:376. 1994. *Paspalidium flavidum* (Retz.) A. Camus in Lecomte, Fl. Gen. de l'Indo-Chine 7:419. 1922. *Panicum flavidum* Retz., Obs. Bot. 4:15. 1786. TYPE: *Koenig s.n.* (HOLOTYPE: LD?).

Distribution.—India, southeast Asia, Pacific islands, and Australia (Queensland).

Setaria gausa (S.T. Blake) R.D. Webster, comb. nov. *Paspalidium gausum* S.T. Blake, Proc. Roy. Soc. Queensland 84:68. 1973. TYPE: *S.T. Blake 19914* (HOLOTYPE: BRI).

Distribution.—Australia: woodlands of Queensland and New South Wales.

Setaria geminata (Forssk.) Veldkamp, Blumea 39:377. 1994. *Paspalidium geminatum* (Forssk.) Stapf, Fl. Trop. Afr. 9:585. 1920. *Panicum geminatum* Forssk., Fl. Aegypt.-Arab. 18. 1775. TYPE: *Forsskal s.n.* (HOLOTYPE: C).

Distribution.—Native to Africa and Asia, now widely introduced in the tropics and subtropics of the world.

Setaria geminata (Forssk.) Veldkamp var. **paludivaga** (Hitchc. & Chase) R.D. Webster, comb. nov. *Paspalidium geminatum* (Forssk.) Stapf var. *paludivagum* (Hitchc. & Chase) Gould, Southw. Naturalist 15:391. 1971. *Paspalidium paludivagum* (Hitchc. & Chase) Parodi, Gram. Bonaer. ed. 3. 85, 89. 1939. *Panicum paludivagum* Hitchc. & Chase, Contr. U.S. Natl. Herb. 15:132. 1910. TYPE: *Nash 746* (HOLOTYPE: US!).

Distribution.—Wet areas of United States (Florida), Mexico, Guatemala, and West Indies.

Setaria globoidea (Domin) R.D. Webster, comb. nov. *Paspalidium globoideum* (Domin) Hughes, Bull. Misc. Inform. 317. 1923. *Panicum globoideum* Domin, Repert. Spec. Nov. Regni Veg. 10:119. 1911. TYPE: *Wuth s.n.* (LECTOTYPE: K).

Distribution.—Australia: woodlands of Queensland and New South Wales.

Setaria grandispiculata (B. K. Simon) R.D. Webster, comb. nov. *Paspalidium grandispiculatum* B. K. Simon, Austrobaileya 1:465. 1982. TYPE: *Peart 1990* (HOLOTYPE: BRI!; ISOTYPES: CANB!, K, L, MO, NSW!).

Distribution.—Australia: woodlands of Queensland.

Setaria inaequalis (F. Muell.) R.D. Webster, comb. nov. *Paspalidium inaequale* (F. Muell.) Hughes, Bull. Misc. Inform. 317. 1923. *Panicum inaequale* F. Muell., Frag. 8:189. 1874. TYPE: *Mueller s.n.* (HOLOTYPE: MEL; ISOTYPE: K).

Distribution.—Australia: tropical woodlands of Queensland.

Setaria jubiflora (Trin.) R.D. Webster, comb. nov. *Paspalidium jubiflorum* (Trin.) Hughes, Bull. Misc. Inform. 317. 1923. *Panicum jubiflorum* Trin., Gram. Pan. Diss. 2:130. 1826. *Panicum flavidum* var. *jubiflorum* (Trin.) Domin, Biblioth. Bot. 20(85):300. 1915. TYPE: *Lindley s.n.* (HOLOTYPE: CGE?).

Distribution.—Australia: arid grassland to sub-humid woodlands of Western Australia, Northern Territory, South Australia, Queensland, and New South Wales.

Setaria leonis (Ekman ex Hitchc.) Léon, Contr. Ocas. Mus. Hist. Nat. Colegio "De La Salle" 8:163. 1946. *Paspalidium leonis* (Ekman ex Hitchc.) Davidse & R. W. Pohl, Novon 2:106. 1992. *Panicum leonis* Ekman ex Hitchc., Man. Grasses W. Ind. 295. 1936. TYPE: *Ekman 13155* (HOLOTYPE: US!).

Distribution.—West Indies: Cuba.

Setaria ophiticola (Hitchc. & Ekman) Léon, Contr. Ocas. Mus. Hist. Nat. Colegio "De La Salle" 8:163. 1946. *Paspalidium ophiticola* (Hitchc. & Ekman) Davidse & R. W. Pohl, Novon 2:106. 1992. *Panicum ophiticola* Hitchc. & Ekman in Hitchc., Man. Grasses W. Ind. 293. 1936. TYPE: *Ekman 12712* (HOLOTYPE: US!).

Distribution.—West Indies: Cuba.

Setaria pradana (Léon ex Hitchc.) Léon, Contr. Ocas. Mus. Hist. Nat. Colegio "De La Salle" 8:164. 1946. *Paspalidium pradanum* (Léon ex Hitchc.) Davidse & R. W. Pohl, Novon 2:106. 1992. *Panicum pradanum* Léon ex Hitchc., Man. Grasses W. Ind. 294. 1936. TYPE: *Léon 11710* (HOLOTYPE: US!).

Distribution.—West Indies: Cuba.

Setaria punctata (Burm. f.) Veldkamp, Blumea 39:381. 1994. *Paspalum punctatum* (Burm. f.) Stapf ex Ridl., Fl. Malay Penins. 5:218. 1925. *Paspalidium punctatum* (Burm. f.) A. Camus in Lecomte, Fl. Gen. Indo-Chine 7:419. 1922. *Panicum punctatum* Burm. f., Fl. Ind. 26. 1768. TYPE: *Plukenet* (LECTOTYPE, selected by Clayton & Renvoize 1982, BM).

Paspalidium mucronatum (Roem. & Schult.) Ohwi, Acta Phytotax. Geobot. 11:33. 1942. *Panicum mucronatum* Roem. & Schult., Syst. Veg. 2:425. 1817. TYPE: *Heyne* (B, probably destroyed).

Distribution.—Africa, Asia, and Pacific Islands.

Setaria rara (R. Br.) R.D. Webster, comb. nov. *Paspalidium rarum* (R. Br.) Hughes, Bull. Misc. Inform. 318. 1923. *Panicum rarum* R. Br., Prodr. 189. 1810. TYPE: *R. Brown 6100* (HOLOTYPE: K).

Distribution. —Australia: arid grasslands and sub-humind woodlands of Western Australia, Northern Territory, Queensland, and New South Wales.

Setaria reflexa (R.D. Webster) R.D. Webster, comb. nov. *Paspalidium reflexum* R.D. Webster, Australian Paniceae 166. 1987. TYPE: *Latz 4847* (HOLOTYPE: NT).

Distribution.—Australia: arid grasslands of Western Australia, Northern Territory, and South Australia.

Setaria retiglumis (Domin) R.D. Webster, comb. nov. *Paspalidum retiglume* (Domin) Hughes, Bull. Misc. Inform. 317. 1923. *Panicum retiglume* Domin, Repert. Spec. Nov. Regni Veg. 10:119. 1911. TYPE: *Mueller s.n.* (HOLOTYPE: MEL; ISOTYPE: K).

Distribution.—Australia: woodlands of Western Australia, Northern Territory, and Queensland.

Setaria scabrifolia (S.T. Blake) R.D. Webster, comb. nov. *Paspalidium scabrifolium* S.T. Blake, Proc. Roy. Soc. Queensland 84:69. 1973. TYPE: *Blake 19983* (HOLOTYPE: BRI).

Distribution.—Australia: woodlands of Queensland.

Setaria spartellum (S.T. Blake) R.D. Webster, comb. nov. *Paspalidium spartellum* S.T. Blake, Proc. Roy. Soc. Queensland 62:97. 1952. TYPE: *Blake 9939* (HOLOTYPE: BRI!).

Paspalidium gracile (R. Br.) Hughes, Bull. Misc. Inform. 318. 1923 *Panicum gracile* R. Br., Prodr. 190. 1810, non *Setaria gracilis* Kunth (1824), nec Spreng. ex Trin. (1835). TYPE: *R. Brown 6096* (HOLOTYPE: K).

Distribution.—Australia: woodlands, shrublands, and grasslands of Western Australia, Northern Territory, Queensland, and New South Wales.

Setaria subtransiens Hitchc. & Ekman in Hitchc., Man. Grasses W. Ind. 351. 1936. *Paspalidium subtransiens* (Hitchc. & Ekman) Davidse & R. W. Pohl, Novon 2:106. 1992. TYPE: *Ekman 16828* (HOLOTYPE: US).

Distribution.—West Indies: Cuba.

Setaria tabulata (Hack.) R.D. Webster, comb. nov. *Paspalidium tabulatum* (Hack.) C. E. Hubb., Bull. Misc. Inform. 448. 1934. *Panicum tabulatum* Hack., Bot. Jahrb. Syst. 6:234. 1885. TYPE: *Naumann s.n.* (HOLOTYPE: K).

Distribution.—Australia: shrublands and grasslands of Western Australia.

Setaria uda (S.T. Blake) R.D. Webster, comb. nov. *Paspalidium udum* S.T. Blake, Proc. Roy. Soc. Queensland 62:98. 1952. TYPE: *S.T. Blake 16659* (HOLOTYPE: BRI; CANB).

Distribution.—Australia: tropical woodlands of Northern Australia and Queensland.

Setaria utowanaea (Scribn.) Pilg. in Engl. & Prantl, Nat. Pflanzenfam. (ed. 2) 14e:72. 1940. *Paspalidium utowanaeum* (Scribn.) Davidse & R. W. Pohl, Novon 2:106. 1992. *Panicum utowanaeum* Scribn. in Millsp., Publ. Field Columbian Mus., Bot. Ser. 2:25. 1900. TYPE: *Millspaugh 702* (HOLOTYPE: F).

Distribution.—West Indies: Greater and Lesser Antilles.

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A TAXONOMIC INVESTIGATION OF *CUSCUTA ATTENUATA* (CUSCUTACEAE) AND RELATED TAXA

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ABSTRACT

Examination of the taxonomic relationships of the rare parasitic vine *Cuscuta attenuata* Waterf. to other species of the genus reveals that it should be positioned in subsect. *Indecorae* Yunck. rather than *Lepidanche* Engelm. as previously placed. Analyses of morphological variation, via univariate analysis, UPGMA clustering, principal component analysis, and discriminant analysis, indicate that it is distinct from *C. compacta* Juss. and *C. cuspidata* Engelm. but morphologically similar to *C. indecora* Choisy, especially var. *longisepala* Yunck. Results obtained in a program of interspecific hybridizations reveal that *C. attenuata* is reproductively isolated from the other taxa. These data suggest that *C. attenuata* merits continued recognition as a distinct species.

RESUMEN

El examen de las relaciones taxonómicas de la rara parásita *Cuscuta attenuata* con otras especies del género revela que debe ser colocada en la subsect. *Indecorae* en vez de la subsect. *Lepidanche* como se había hecho previamente. Los análisis de la variación morfológica, mediante análisis univariante, agrupamiento UPGMA, análisis de componentes principales y análisis discriminante, indican que es distinta de *C. compacta* Juss. y de *C. cuspidata* Engelm., aunque morfológicamente semejante a *C. indecora* Choisy, especialmente a la var. *longisepala* Yunck. Los resultados obtenidos en un programa de hibridaciones interespecíficas revela que *C. attenuata* está aislada reproductivamente de los otros taxa. Estos datos sugieren que *C. attenuata* debe continuar reconociéndose como una especie distinta.

INTRODUCTION

Because of its rarity and uncertain taxonomic status, *Cuscuta attenuata* Waterf. has merited much attention (Tyrl et al. 1978; Taylor & Taylor 1980; Prather 1990; Prather & Tyrl 1993). The species was described from plants

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collected from two neighboring populations in the Red River floodplain of extreme southeastern Oklahoma (Waterfall 1971). Prior to 1989 the species was known from only four populations within a few km of one another (Tyrl et al. 1978; Taylor & Taylor 1980). Because of its limited geographical distribution, it was considered to warrant possible designation as an endangered species and was declared a Category 1 species by the U. S. Fish & Wildlife Service's Office of Endangered Species (1980 FR 45:82500; 1985 FR 50:39526). Prather (1990) and Prather and Tyrl (1993) reported four extant and six historical populations in Kansas, Oklahoma, and Texas. As a result, the status of the species was modified to Category 2 (1993 FR 58:51159).

Waterfall (1971) tentatively placed *C. attenuata* in subsect. *Lepidanche* Engelm. on the basis of his interpretation that the calyx was polysepalous. He suggested, however, that formation of a new subsection to accommodate the species might be appropriate because its capsule shape and the distribution of its floral bracts were not consistent with Yuncker's circumscription of subsect. *Lepidanche* (Yuncker 1965). Tyrl et al. (1978) echoed Waterfall's uncertainty about the species' relationships and called for taxonomic investigations of the species and its putative relatives.

Among the species of subsect. *Lepidanche*, Waterfall stated that *C. attenuata* most closely resembled *C. compacta* Juss. but distinguished them on the basis that: (1) *C. attenuata* has a pedicel while *C. compacta* does not, (2) *C. attenuata* has only one floral bract which is at the base of the pedicel while *C. compacta* has 1–10 bracts which are situated along the length of the pedicel, and (3) *C. attenuata* has lanceolate, attenuate sepals while *C. compacta* has ovate, obtuse sepals (Table 1). Waterfall also stated that *C. attenuata* resembled *C. cuspidata* Engelm. in the presence of pedicels, which all other species in the subsect. *Lepidanche* lack. They are different in that *C. cuspidata* has a much more open inflorescence; ovate, cuspidate sepals; and usually one or two bracts along the pedicel (Table 1).

During a preliminary examination of herbarium specimens, including the holotype, it was discovered that the calyx of *C. attenuata* is gamosepalous and not polysepalous as Waterfall stated in his diagnosis. Because of this fusion, *C. attenuata* clearly seems better placed within subsect. *Indecorae* Yunck. rather than in subsect. *Lepidanche*. The two subsections are not thought to be closely related though both are positioned within sect. *Cleistogrammica* Engelm. (Yuncker 1932, 1965). With the exception of its somewhat dense inflorescence, all of the characters of *C. attenuata* are better accomodated in subsect. *Indecorae* (Table 1).

Within the subsection, *C. attenuata* is morphologically similar to *C. indecora* var. *longisepala* Yunck., and specimens of *C. attenuata* key to var.

TABLE 1. Comparison of morphological characters of *Cuscuta* species.

	Calyx	Bracts	Inflorescences
Subsection ***Lepidanche***			
C. compacta	polysepalous, ovate, obtuse	1–10 along pedicel	compact
C. cuspidata	polysepalous, ovate, cuspidate	1 at base and 1–2 along pedicel	open
Subsection ***Indecorae***			
C. attenuata	gamosepalous, lanceolate, attenuate	1 at base of pedicel	somewhat compact
C. indecora			
var. *indecora*	gamosepalous, triangular-ovate, acute-obtuse	1 at base of pedicel	open
var. *longisepala*	gamosepalous, lanceolate, acute	1 at base of pedicel	open

longisepala in Yuncker's 1965 key. Waterfall's description of *C. attenuata* (Waterfall 1971) and Yuncker's description of *C. indecora* var. *longisepala* (Yuncker 1965) are similar for every character state. In 1965, Yuncker examined one of the specimens identified in this study as *C. attenuata* (*C.J. Eskew 1395*, OKL). Recognizing the distinctiveness of the specimen, he made the following annotation: "*C. indecora* Choisy. The long narrow calyx lobes would make it var. *longisepala* Yunck. However, the specimen looks teratological and may not be the variety but only an abnormal form."

Cuscuta indecora is widespread in North and South America and is highly variable throughout its range (Hunziker 1950; Yuncker 1965; Beliz 1986). The infraspecific classification is somewhat controversial and Yuncker (1920, 1932, 1965) accepted different varieties in each of his treatments. *Cuscuta indecora* var. *longisepala* occurs throughout much of the range of *C. indecora*, including South America where the variation is similar to that found in North America (Hunziker 1950). Beliz (1986) does not mention *C. indecora* var. *longisepala* or list it in synonymy. Variability over the range of *C. indecora* is not discussed nor were representative specimens west of Arizona cited.

The few chromosome numbers known for taxa of the two subsections are invariant. *Cuscuta indecora* and *C. glomerata* Choisy (subsect. *Lepidanche*) are both reported as $n=15$ (Freeman & Brooks 1988; Pinkava et al. 1974) while *C. attenuata* is reported as $2n=30$ (Prather & Tyrl 1993).

An investigation of the relationship of *C. attenuata* to other taxa of *Cuscuta* by means of analyses of morphological variation and a program of interspecific hybridization was undertaken in an attempt to clarify the taxonomic position and rank of the species.

MATERIALS AND METHODS

Analyses of morphological variation.—To examine morphological variation within and between taxa, 186 herbarium specimens of *Cuscuta* from DUR, ECSC, LL, NLU, NOSU, NWOSU, OCLA, OKL, OKLA, SMU, TAES, TEX, TULS, UARK, and the herbarium at Cameron University in Lawton, Oklahoma were examined—10 of *C. attenuata*; 50 each of *C. compacta*, *C. cuspidata*, and *C. indecora* var. *indecora*; and 26 of *C. indecora* var. *longisepala* (Prather 1990).

In a preliminary analysis, five flowers each were examined on several specimens of each taxon. It was determined that variation among flowers of the same plant was negligible, therefore one flower was used from each specimen, which was treated as an OTU. One individual per population was examined. The data recorded for each specimen are presented in Prather (1990). Because *Cuscuta* lacks roots and well-developed leaves, and because stem features could not be accurately scored from herbarium specimens, only floral characters were used.

One flower, with its pedicel and bract(s), was removed from each specimen. To minimize variation resulting from flower age, all flowers selected had dehiscing anthers, a stage which lasts only a short time (Prather & Tyrl 1993). Observations were made after softening each flower by boiling in water to facilitate examination of the inner floral parts (Yuncker 1920). Samples were examined with a dissecting microscope at a magnification of 30x to score characters. Measurements were recorded to the nearest 0.1 mm using an ocular micrometer. Many of the measurements were incorporated in the analyses as ratios to minimize the effect of size which may be influenced by environmental factors. Forty-four characters were scored for each sample. The first 27 characters (Table 2) were qualitative and therefore suitable for use in all analyses. Characters 28–44 (Table 3) were qualitative characters and thus could only be used in the multivariate analyses.

For characters 1 and 5–27 an unprotected LSD test was performed. Characters 2–4 were excluded because the values were invariant among individuals of at least one taxon. The multivariate analyses comprised UPGMA clustering, a principal component analysis, and a discriminant analysis. Statistical Analysis System (SAS Institute, Inc. 1985) was employed to perform these analyses except the unprotected LSD tests which were performed using Statview (Abacus Concepts, Inc. 1992). The UNIVARIATE procedure of SAS was used to confirm that the assumption normality of the LSD test was not violated. The UPGMA clustering analysis was performed using the AVERAGE option of the CLUSTER procedure on data that had been standardized by the STD option which changes the mean to zero and the standard deviation to one. The varimax rotation method was used in the principal component analysis. Because the other statistical methods

TABLE 2. Means, standard deviations, minima, maxima, and results of the unprotected LSD test of characters 1–27.

	Mean (S.D.)	Min. - Max.	Significance*
	1. Pedicel Length (mm)		
C. attenuata	1.2 (±0.49)	0.6–2.2	I,L
C. i. longisepala	2.6 (±1.3)	0.5–5.8	A,M,S
C. i. indecora	2.3 (±0.98)	0.8–4.9	A,M,S
C. compacta	1.0 (±0.42)	0.3–1.8	I,L,S
C. cuspidata	1.6 (±1.0)	0.2–4.0	I,L,M
	2. Number of Bracts at Pedicel Base**		
C. attenuata	1.0 (±0.00)	1–1	
C. i. longisepala	1.0 (±0.00)	1–1	
C. i. indecora	0.9 (±0.24)	0–1	
C. compacta	1.1 (±0.35)	1–2	
C. cuspidata	1.0 (±0.14)	0–1	
	3. Number of Bracts Along Pedicel**		
C. attenuata	0.0 (±0.00)	0–0	
C. i. longisepala	0.0 (±0.00)	0–0	
C. i. indecora	0.0 (±0.14)	0–1	
C. compacta	2.8 (±1.3)	1–7	
C. cuspidata	0.7 (±0.88)	0–3	
	4. Number of bracts at Pedicel Apex**		
C. attenuata	0.0 (±0.00)	0–0	
C. i. longisepala	0.0 (±0.00)	0–0	
C. i. indecora	0.0 (±0.00)	0–0	
C. compacta	1.6 (±0.50)	1–2	
C. cuspidata	1.2 (±0.82)	0–3	
	5. Bract Length/Calyx Length		
C. attenuata	0.82 (±0.22)	0.56–1.27	–
C. i. longisepala	0.78 (±0.19)	0.45–1.11	I,M,S
C. i. indecora	0.91 (±0.24)	0.50–1.63	L
C. compacta	0.89 (±0.13)	0.59–1.15	L
C. cuspidata	0.85 (±0.14)	0.44–1.13	L
	6. Bract Length/Bract Width		
C. attenuata	2.2 (±0.53)	1.1–3.3	I,L^1,M,S
C. i. longisepala	1.8 (±0.38)	1.3–2.6	A^1,I,M,S
C. i. indecora	1.4 (±0.30)	1.0–2.3	A,L,M,S
C. compacta	0.72 (±0.12)	0.39–0.99	A,I,L,S
C. cuspidata	1.2 (±0.23)	0.78–1.8	A,I,L,M
	7. Calyx Length (mm)		
C. attenuata	2.6 (±0.52)	1.5–3.2	I,L,M,S
C. i. longisepala	2.1 (±0.44)	1.6–2.9	A,I,S
C. i. indecora	1.4 (±0.27)	0.8–2.0	A,L,M,S
C. compacta	2.1 (±0.25)	1.7–2.6	A,I,S
C. cuspidata	1.7 (±0.17)	1.3–2.1	A,I,L,M
	8. Calyx Tube Length/Total Calyx Length		
C. attenuata	0.22 (±0.06)	0.12–0.32	I,L,S
C. i. longisepala	0.33 (±0.12)	0.13–0.53	A,I,M,S
C. i. indecora	0.50 (±0.11)	0.31–0.73	A,L,M,S
C. compacta	0.20 (±0.09)	0.05–0.53	I,L,S
C. cuspidata	0.13 (±0.04)	0.07–0.20	A,I,L,M

TABLE 2. *(Continued)*

	Mean (S.D.)	Min. - Max.	Significance*
	9. Calyx Length/Calyx Width		
C. attenuata	2.7 (±0.45)	2.2–3.8	I,L^1,M,S
C. i. longisepala	2.2 (±0.65)	1.1–4.0	A^1,I,M,S
C. i. indecora	1.4 (±0.30)	0.96–2.3	A,L,M,S^1
C. compacta	1.1 (±0.19)	0.20–1.6	A,I,L,S
C. cuspidata	1.3 (±0.16)	0.95–1.7	A,I^1,L,M
	10. Corolla Length/Calyx Length		
C. attenuata	1.2 (±0.16)	1.0–1.4	I,L,M,S
C. i. longisepala	1.6 (±0.33)	1.0–2.3	A,I,M,S
C. i. indecora	2.2 (±0.37)	1.5–3.3	A,L,M
C. compacta	1.8 (±0.23)	1.4–2.4	A,L,I,S
C. cuspidata	2.2 (±0.33)	1.4–3.2	A,L,M
	11. Corolla Tube Length/Total Corolla Length		
C. attenuata	0.58 (±0.04)	0.53–0.64	L^1,M
C. i. longisepala	0.54 (±0.05)	0.46–0.63	A^1,I^1,M,S
C. i. indecora	0.57 (±0.04)	0.46–0.67	L^1,M,S^1
C. compacta	0.72 (±0.06)	0.59–0.86	A,I,L,S
C. cuspidata	0.61 (±0.12)	0.46–1.4	I^1,L,M
	12. Corolla Lobe Length/Corolla Lobe Width		
C. attenuata	3.3 (±0.42)	2.8–4.3	I,M,S^1
C. i. longisepala	3.1 (±0.36)	2.4–3.8	I^1,M,S
C. i. indecora	3.0 (±0.29)	2.4–3.6	A,L^1,M,S
C. compacta	3.7 (±0.45)	2.9–5.0	A,I,L
C. cuspidata	3.8 (±0.57)	2.0–4.8	A^1,I,L
	13. Corolla Length (mm)		
C. attenuata	3.4 (±0.42)	2.8–4.3	I,M^1,S^1
C. i. longisepala	3.1 (±0.34)	2.4–3.8	M,S
C. i. indecora	3.0 (±0.30)	2.4–3.6	A,M,S
C. compacta	3.7 (±0.45)	2.9–5.0	A^1,I,L
C. cuspidata	3.8 (±0.57)	2.0–4.8	A^1,I,L
	14. Number of Fringes Per Corolla Appendage		
C. attenuata	26.8 (±3.3)	24–35	M
C. i. longisepala	24.7 (±6.6)	6–36	M
C. i. indecora	26.6 (±5.8)	17–46	M
C. compacta	13.2 (±2.1)	7–18	A,I,L,S
C. cuspidata	26.4 (±4.8)	16–36	M
	15. Length of Corolla Appendage (mm)		
C. attenuata	1.8 (±0.43)	1.0–2.6	I^1,M
C. i. longisepala	1.9 (±0.63)	1.2–4.6	I^1,M
C. i. indecora	1.6 (±0.27)	1.1–2.2	A^1,L^1,M,S
C. compacta	2.3 (±0.30)	1.5–3.4	A,I,L,S
C. cuspidata	2.1 (±0.44)	1.0–2.8	I,M
	16. Appendage Length/Length of Corolla Tube		
C. attenuata	0.92 (±0.16)	0.56–1.1	–
C. i. longisepala	1.1 (±0.40)	0.83–2.9	I,M,S
C. i. indecora	0.94 (±0.12)	0.68–1.3	L,M
C. compacta	0.86 (±0.09)	0.74–1.1	I,L,S^1
C. cuspidata	0.91 (±0.13)	0.37–1.5	L,M^1

TABLE 2. *(Continued)*

	17. Proportion of Appendage Fused to Corolla		
C. attenuata	0.45 (±0.07)	0.33–0.55	S
C. i. longisepala	0.42 (±0.09)	0.27–0.71	S
C. i. indecora	0.44 (±0.07)	0.31–0.65	S
C. compacta	0.46 (±0.09)	0.29–0.78	S
C. cuspidata	0.61 (±0.06)	0.49–0.77	A,I,L,M
	18. Appendage Length/Appendage Width		
C. attenuata	1.6 (±0.28)	1.3–2.2	I^1,M,S
C. i. longisepala	1.8 (±0.32)	1.4–3.0	M,S
C. i. indecora	1.8 (±0.26)	1.2–2.4	A^1,M,S
C. compacta	4.2 (±0.65)	2.3–5.6	A,I,L,S
C. cuspidata	3.8 (±0.61)	2.7–5.6	A,I,L,M
	19. Filament Length (mm)		
C. attenuata	0.8 (±0.2)	0.5–1.0	I,L^1,M,S^1
C. i. longisepala	0.7 (±0.1)	0.4–0.9	A^1,I^1,M
C. i. indecora	0.6 (±0.2)	0.3–0.9	A,L^1,M,S^1
C. compacta	0.2 (±0.1)	0.1–0.4	A,I,L,S
C. cuspidata	0.7 (±0.2)	0.4–1.0	A^1,I^1,M
	20. Anther Length (mm)		
C. attenuata	0.8 (±0.1)	0.7–1.0	M,S
C. i. longisepala	0.7 (±0.2)	0.4–1.1	M
C. i. indecora	0.7 (±0.1)	0.5–1.0	M
C. compacta	0.4 (±0.1)	0.1–0.6	A,I,L,S
C. cuspidata	0.7 (±0.1)	0.4–0.9	A,M
	21. Filament Length/Anther Length		
C. attenuata	0.99 (±0.17)	0.71–1.3	I^1,M
C. i. longisepala	0.96 (±0.24)	0.50–1.4	I^1,M
C. i. indecora	0.80 (±0.27)	0.38–1.8	A^1,L^1,M,S
C. compacta	0.54 (±0.28)	0.20–2.0	A,I,L,S
C. cuspidata	0.96 (±0.24)	0.50–1.5	I,M
	22. Anther Length/Anther Width		
C. attenuata	1.3 (±0.18)	1.1–1.6	S
C. i. longisepala	1.3 (±0.19)	0.91–1.6	S
C. i. indecora	1.4 (±0.21)	0.92–1.8	M,S
C. compacta	1.2 (±0.26)	0.74–1.7	I,S
C. cuspidata	1.9 (±0.34)	1.1–2.7	A,I,L,M
	23. Longer Style Length (mm)		
C. attenuata	1.4 (±0.45)	0.8–2.0	I,S
C. i. longisepala	1.1 (±0.38)	0.5–1.8	S
C. i. indecora	1.1 (±0.30)	0.6–2.1	A,M,S
C. compacta	1.3 (±0.30)	0.6–2.0	I,S
C. cuspidata	2.3 (±0.63)	1.3–3.9	A,I,L,M
	24. Longer Style Length/Shorter Style Length		
C. attenuata	1.1 (±0.06)	1.0–1.2	M,S
C. i. longisepala	1.1 (±0.07)	1.0–1.3	M,S
C. i. indecora	1.1 (±0.10)	1.0–1.4	M,S
C. compacta	1.3 (±0.19)	1.0–2.1	A,I,L
C. cuspidata	1.3 (±0.16)	1.0–1.8	A,I,L

Table 2. *(Continued)*

	25. Stigma Length/Stigma Width		
C. attenuata	0.73 (±0.08)	0.61–0.85	–
C. i. longisepala	0.75 (±0.08)	0.57–0.91	S[1]
C. i. indecora	0.75 (±0.08)	0.55–0.86	S
C. compacta	0.75 (±0.08)	0.56–0.94	S
C. cuspidata	0.70 (±0.09)	0.46–0.89	I,L[1],M
	26. Ovary Length (mm)		
C. attenuata	1.4 (±0.25)	1.0–1.7	I,L[1],S
C. i. longisepala	1.2 (±0.21)	0.8–1.6	A[1],M,S
C. i. indecora	1.2 (±0.20)	0.8–1.6	A,M,S
C. compacta	1.4 (±0.17)	1.0–1.8	I,L,S
C. cuspidata	0.8 (±0.18)	0.5–1.2	A,I,L,M
	27. Ovary Length/Ovary Width		
C. attenuata	1.0 (±0.13)	0.80–1.2	I,M[1],S
C. i. longisepala	0.97 (±0.15)	0.74–1.4	I,M,S
C. i. indecora	0.84 (±0.12)	0.54–1.1	A,L,M
C. compacta	1.1 (±0.10)	0.80–1.2	A[1],I,L,S
C. cuspidata	0.81 (±0.13)	0.60–1.3	A,L,M

*No significant difference between taxa except those listed under significance and the taxa labelling the row; $p<0.01$ unless otherwise indicated. A = *C. attenuata*, I = *C. indecora* var. *indecora*, L = *C. indecora* var. *longisepala*, M = *C. compacta*, and S = *C. cuspidata*.

**Not tested because the values for some taxa were invariant.

[1] Significant only at $p<0.05$

had established that *C. compacta* and *C. cuspidata* were easily distinguished from *C. attenuata*, only *C. attenuata* and the two varieties of *C. indecora* were examined in the discriminant analysis. Prior probability of the discriminant analysis was set proportional to the number of specimens of each taxon used in the analysis.

Interspecific hybridizations.—Parasitized host plants of all taxa were transported to the plant growth facility at OSU and maintained as described previously (Prather & Tyrl 1993). Attempts to maintain *C. compacta* in the laboratory were unsuccessful because transplanting its woody hosts was not possible and cuttings did not survive under laboratory conditions. Pollen of *C. compacta*, therefore, was collected from five individuals in the field and used immediately in crosses in the laboratory. Vouchers of all populations used were deposited in OKLA.

Individual flowers of *C. attenuata* were emasculated before anther dehiscence and mature pollen from individuals of another taxon was manually transferred to the stigmas (Radford et al. 1974). Reciprocal crosses with all taxa, except *C. compacta*, were performed in the same manner. Twenty crosses were performed between *C. attenuata* and *C. compacta*, 9 between *C. attenuata* and *C. cuspidata*, 16 between *C. attenuata* and *C. indecora* var. *indecora*, and 25 between *C. attenuata* and *C. indecora* var. *longisepala*.

TABLE 3. Qualitative morphological characters (28–44) of *Cuscuta* which were used in the multivariate analyses.

No.	Character	No.	Character
28.	Bract orientation	37.	Presence of calyx papillations
29.	Calyx orientation	38.	Presence of calyx laticifers
30.	Corolla orientation	39.	Shape of corolla margin
31.	Shape of bract margin	40.	Shape of corolla apex
32	Shape of bract apex	41.	Presence of corolla papillations
33.	Presence of bract laticifers	42.	Inflexing of corolla lobe tips
34.	Overlap of calyx lobes	43.	Orientatin of styles
35.	Shape of calyx margin	44.	Presence of stylopodium
36.	Shape of calyx apex		

RESULTS AND DISCUSSION

On the basis of univariate and multivariate analyses, *C. attenuata* is a morphologically distinctive taxon albeit similar to *C. indecora*, particularly var. *longisepala*. Means, standard deviations, and minimum and maximum values for all characters are given in Table 2, as well as LSD test results between all taxa for those characters tested. As revealed by the univariate analysis, the means of four characters are significantly different ($p<0.01$) between *C. attenuata* and each of the other taxa (Table 2, Fig. 1). The mean of *C. attenuata* differs significantly ($p<0.05$) from that of *C. compacta*, *C. cuspidata*, and *C. indecora* var. *indecora*, for over half of the characters (15, 16, and 15, respectively); and from *C. indecora* var. *longisepala* for one-third of the characters.

Multivariate analyses revealed that *C. attenuata* is distinct from *C. compacta* and *C. cuspidata* but morphologically similar to *C. indecora*. In the UPGMA analysis, *C. compacta* and *C. cuspidata* each formed distinct groupings. However, *C. attenuata*, *C. indecora* var. *indecora* and *C. indecora* var. *longisepala* did not form distinct groupings, but rather one large cluster.

In the principal component analysis, the first three components explained 56.4% of the variation (Fig. 2). The remaining variation was accounted for by the other factors in 1–4% increments. The first principal component, which accounted for 31.1% of the variation, was weighted for characters 28, 29, 34, and 41. The second principal component, which accounted for 18.2% of the variation, was weighted for characters 14, 21, 31, 32, 39, and 40. The third principal component, which accounted for 7.1% of the variation, was weighted for characters 5, 7, 9, 10, and 37. As in the UPGMA analysis, *C. compacta* and *C. cuspidata* formed distinct clusters and the three remaining taxa did not. The third principal component was weighted for characters which dealt with variation in the calyces. For those characters, *C. indecora* var. *longisepala* was always intermediate between *C. indecora* var. *indecora* and *C. attenuata*.

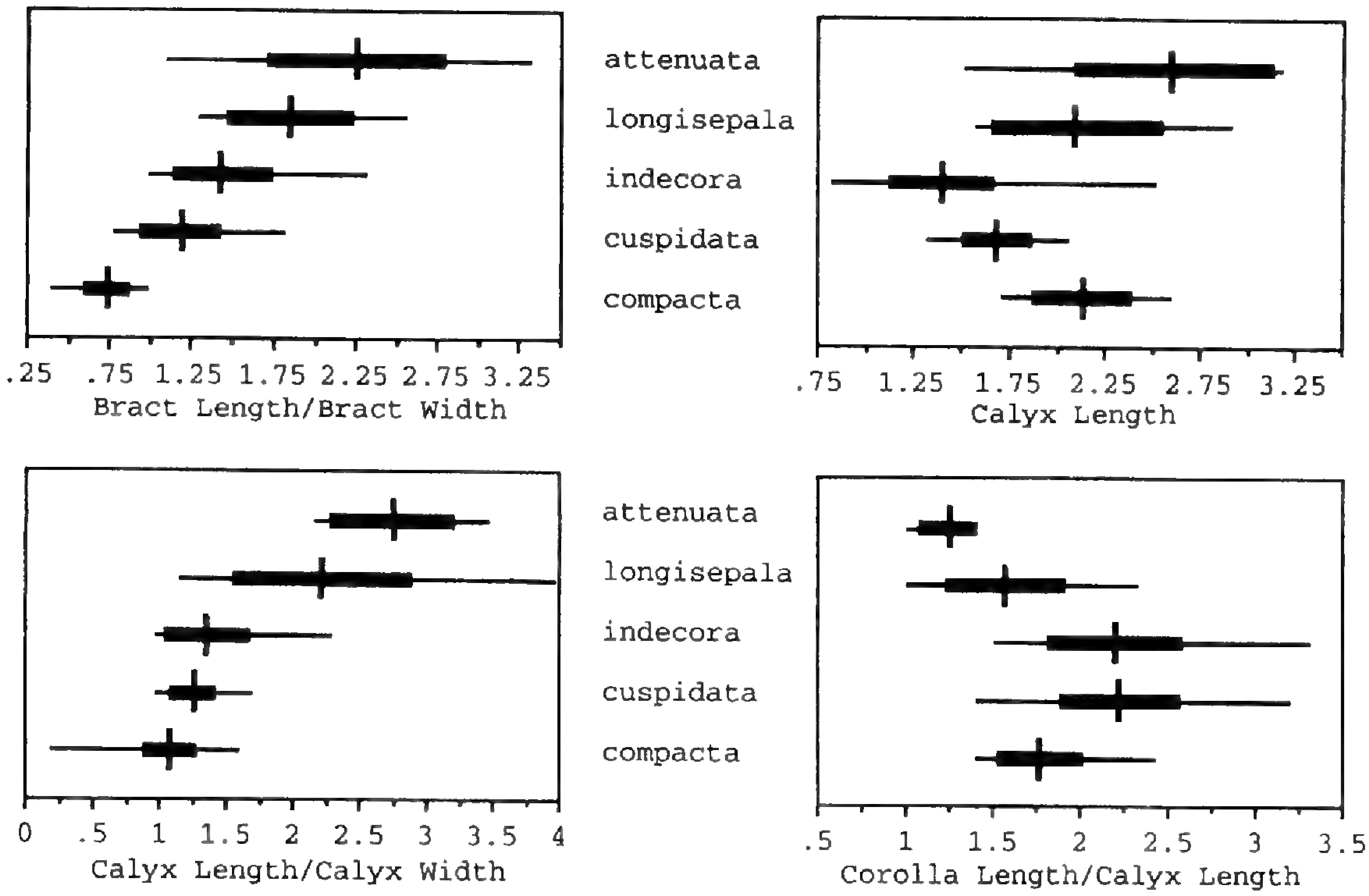

FIG. 1. Univariate analysis of morphological characters in *Cuscuta* taxa. Means (vertical lines), standard deviations (broad horizontal lines), and minima and maxima (narrow horizontal lines) of the four characters for which the means of *C. attenuata* differ significantly ($p<0.01$) from each of the other taxa. Names in the center are epithets except indecora (=*C. indecora* var. *indecora*) and longisepala (=*C. indecora* var. *longisepala*), and apply to the figures on each side.

The discriminant analysis yielded probabilities of >.93 that each specimen was appropriately designated, and thus demonstrated that *C. attenuata* and the two varieties of *C. indecora*, can be distinguished.

Interspecific hybridizations.—None of the crosses between *C. attenuata* and any of the other taxa, including both varieties of *C. indecora*, produced fruits or seeds. In a related study, populations of *C. attenuata* were shown to be interfertile using these same methods (Prather & Tyrl 1993), and in some cases even the same individuals. These intraspecific crosses produced 81–92% fruit set and 38–45% seed set. The lack of fruit and seed set from all interspecific crosses, but high rate of success of intraspecific crosses, suggests that *C. attenuata* is reproductively isolated from the other taxa.

Taxonomic implications.—Although once thought to be related to *C. compacta* and *C. cuspidata*, *C. attenuata* is definitely distinct from these species and should be positioned in subsect. *Indecorae* on the basis of its fused sepals rather than in subsect. *Lepidanche* as proposed by Waterfall (1971). On the basis of the systematic data generated in this study, it is concluded that *C. attenuata* is a distinct species albeit morphologically similar to *C. indecora*. In the absence of reproductive isolation we might treat *C. attenuata* as a variety of *C. indecora*.

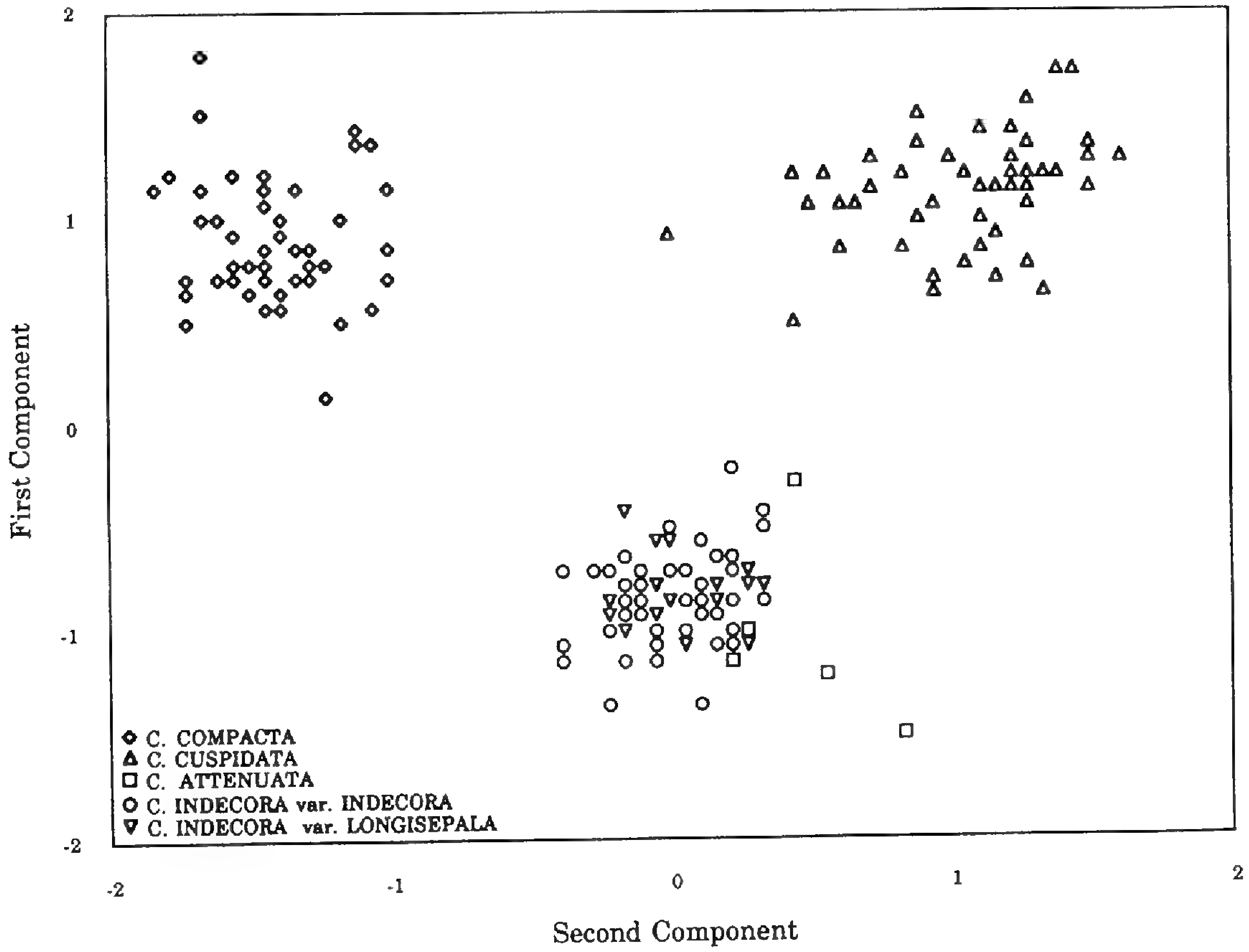

FIG. 2. Principal components analysis of morphological characters in *Cuscuta* taxa. First component plotted against the second component.

The addition of *C. attenuata* to subsect. *Indecorae* brings its total number of species to five: *C. attenuata* parasitizing *Iva annua* in Kansas, Oklahoma, and Texas; *C. coryli* Engelm. parasitizing a wide variety of hosts in the central and eastern U.S.; *C. stenolepis* Engelm. parasitizing unknown hosts in Ecuador; *C. warneri* Yunck. parasitizing *Phyla cuneifolia* in Utah and Arizona; and *C. indecora* with two recognized varieties: var. *indecora* occurring on a wide variety of herbaceous hosts and widespread in North and South America and the West Indies, and var. *longisepala* parasitizing a wide variety of herbaceous hosts in the southwestern U.S., Mexico, and South America (Yuncker 1965). Interestingly, *C. warneri* is also listed as a Category 2 species and is thought to be extinct (1993 FR 58:51159).

ACKNOWLEDGMENTS

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A NEW SPECIES OF *DIRCA* (THYMELAEACEAE) FROM THE SIERRA OF NORTHEASTERN MEXICO

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ABSTRACT

A newly discovered population of *Dirca* from the Sierra Madre Oriental of Tamaulipas, Mexico, is described and illustrated here as ***D. mexicana*** sp. nov. It expands the genus to three species and it is first of the genus known to occur in Mexico. The new species is similar to *D. palustris* of the eastern United States in its long calyx tube with abruptly flaring limb, but its greatest overall similarity is with the rare and restricted *D. occidentalis* of the San Francisco Bay region in west-central California. *Dirca mexicana* resembles the latter in its bud scales with whitish pubescence, sessile flowers and fruits, distinctly lobed calyces, and persistent pubescence on the young twigs and abaxial leaf surfaces. The new species differs from *D. occidentalis* in its flowers with a longer, narrower tube, shorter limb and lobes, and shorter style and filaments; the two population systems are separated by more than 2500 kilometers. *Dirca mexicana* is separated from the closest population of *D. palustris* by more than 1100 kilometers.

KEY WORDS: *Dirca*, Thymelaeaceae, Mexico

RESUMEN

Una población de *Dirca* recientemente descubierta en la Sierra Madre Oriental de Tamaulipas, México, se describe e iconografía aquí como ***D. mexicana*** sp. nov. Con ello se eleva a tres el número de especies en el género, siendo ésta la primera que se conoce en México. La nueva especie se parece a *D. palustris,* del este de los Estados Unidos, por su largo tuba del caliz con limbo abruptamente acampanado, pero su mayor parecido general es con la rara y restringida *D. occidentalis* de la región de la Bahía de San Francisco en la región centro-oeste de California. *Dirca mexicana* se parece a esta última en las escamas de las yemas con pubescencia blanquecina, flores y frutos sésiles, cálices netamente lobulados y la pubescencia persistente en las ramas jóvenes y en el envés de las hojas. La nueva especie difiere de *D. occidentalis* por sus flores con un tubo más largo y más estrecho, con limbo y lóbulos más cortos, y estilo y filamentos más cortos. Los dos sistemas de poblaciones están separados por más de 2500 kilómetros. *Dirca mexicana* está alejada más de 1100 kilómetros de la población de *D. palustris* más próxima.

The genus *Dirca* L. has previously included only two species, *D. palustris* L., scattered but widespread in the eastern United States and adjacent Canada, and *D. occidentalis* A. Gray, endemic to six counties of the San Francisco Bay region in west-central California (McMinn & Forderhase 1935; Vogelman 1953; Nevling 1962; various floristic manuals; Fig. 1). On a

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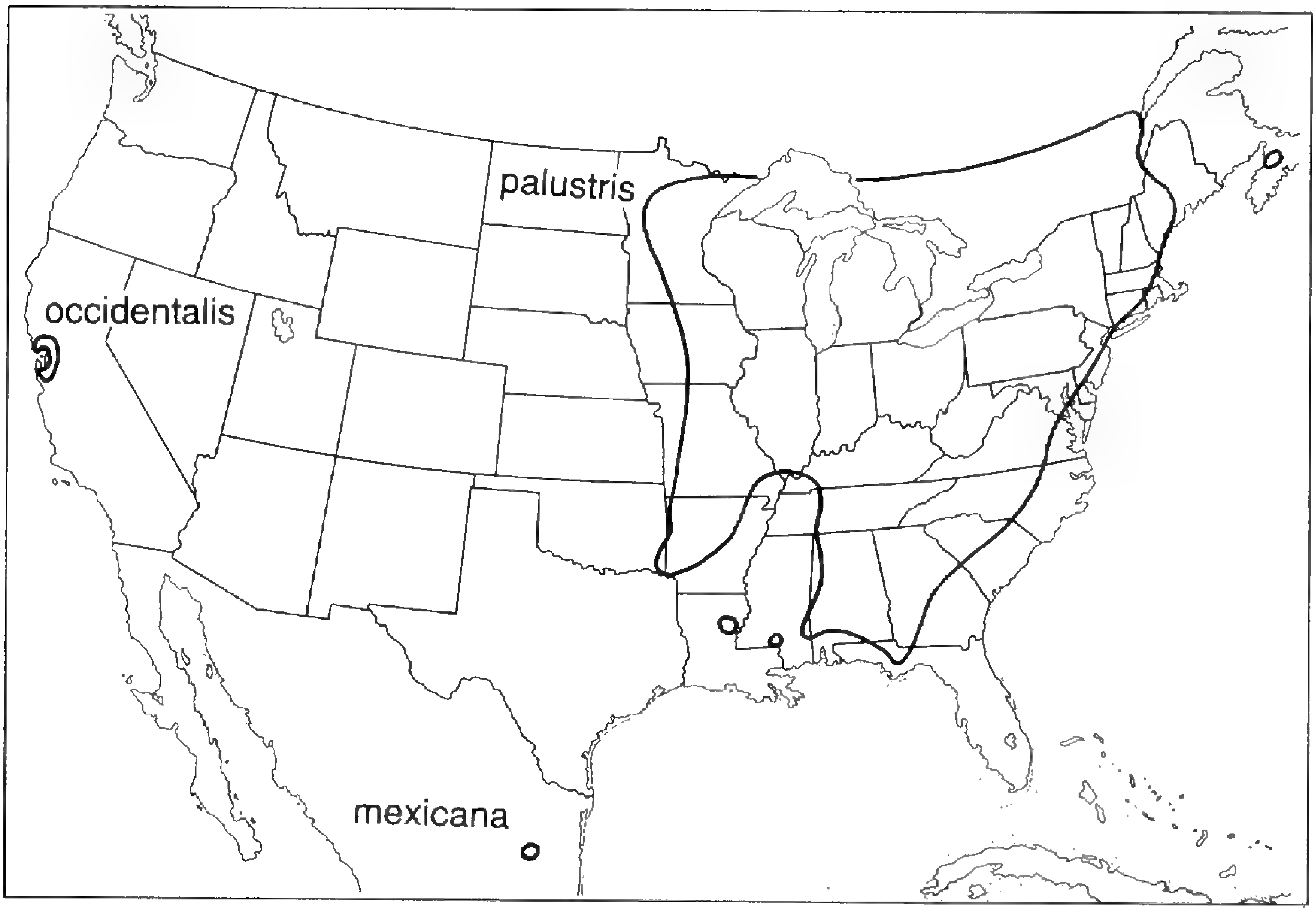

FIG. 1. Geographic distribution of the three species of *Dirca*.

botanical reconnaissance in September 1994 in the Sierra Madre Oriental of Tamaulipas, Mexico, we observed a population of low shrubs that we recognized as *Dirca*, but the plants were sterile and not identifiable to species. In early March 1995 we were able to study the population at peak flowering and beginning of fruit. The Mexican plants most closely resemble *D. occidentalis*, but there are several consistent morphological differences between them and they are geographically disjunct by more than 2500 kilometers (California/Tamaulipas, see Fig. 1). The closest known populations of *Dirca palustris*, at the southwestern corner of its range in eastern Louisiana, Arkansas, and southeastern Oklahoma, are more than 1100 kilometers disjunct from the Mexican plants. We believe that it is justifiable and desirable to recognize this Mexican population as a species distinct from both of its more northern relatives.

Dirca mexicana Nesom & Mayfield, sp. nov. (Fig. 2)

Differt a *Dircae occidentali* A. Gray calycibus tubo longiore angustiore limbo breviore, filamentis supra medium calycis insertis, et stylis ac filamentis brevioribus.

Woody shrubs 6–20 dm tall, averaging ca. 16 dm, from a single trunk branched near the base, with spreading, flexuous branches, the stems 2–3(–5) cm wide near the base of the plant, the ultimate branches 2–3 mm wide, bark smooth and grayish to reddish-brown, the current year's growth

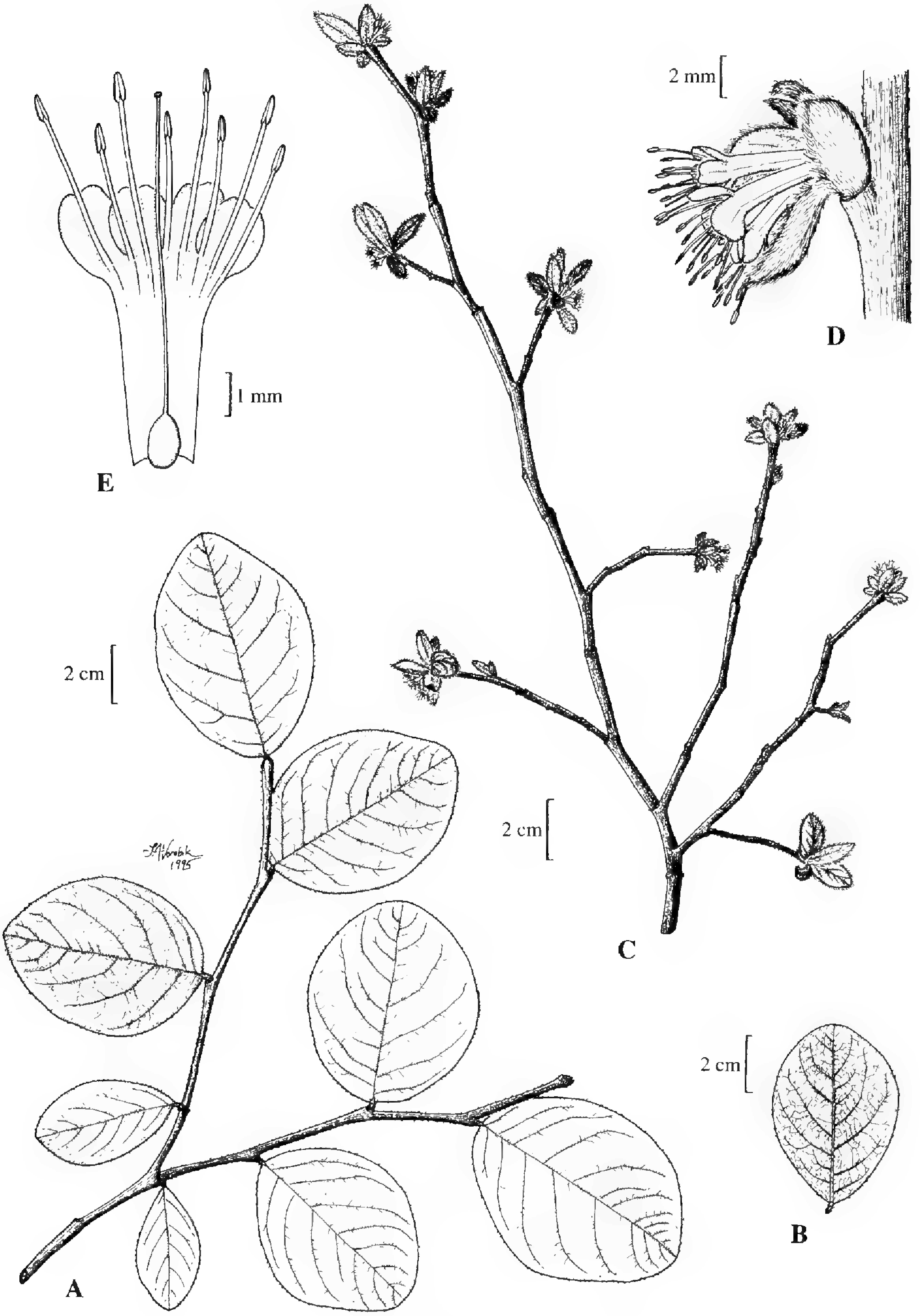

FIG. 2. Branches and details of *Dirca mexicana*. A and B. Sterile branch and leaf (*Mayfield 2085*). C-E. Flowering branch, flower cluster, and single flower, opened (*Nesom 7863*).

persistently loosely and sparsely pubescent, glabrous below. Leaves deciduous, alternate, entire, at maturity broadly elliptic to slightly ovate, basally rounded, 4–8 cm long, 2.5–6.0 mm wide, 1.3–1.7 times longer than wide, the largest distally situated on the branchlets, glabrous above, the lower surface persistently sparsely strigose-sericeous on the lamina and along the veins, petioles 1–2 mm long. Buds covered by the enlarged petiole base, mixed (flowers and leaves), the apical apparently falsely terminal, the 4 bud scales whitish-sericeous, forming a foliaceous, deciduous involucre to the flowers. Flowers appearing before or concurrently with the leaves, sessile in axillary and apical fascicles, deflexed to somewhat more nodding at full anthesis, the axillary fascicles invariably producing 3 flowers, the apical fascicles sometimes apparently "twinned" with (5–)6 flowers; corolla absent, not represented by infracalycular structures; calyx (7–)8–10 mm long, petaloid, the tube narrow but slightly widening distally, 5–7 mm long, abruptly expanded into a flaring limb 2–4 mm long, the tube/limb ratio (of length) (1.5–)1.7–3.0, the 4 calyx lobes 1.5–3.0 mm long, the lobes and limb yellow, the tube lighter yellow and drying creamy; stamens 8, filaments inserted within the calyx tube essentially at a single level (at the throat, 2.0–3.5 mm below the lobe apex), the longest exserted 2–3 mm above the calyx lobes, those inserted below the lobes 1–2 mm longer than those inserted below the sinuses, the thecae 0.4–0.8 mm long, basifixed; "hypogynous disc" or "disc" (sensu Heinig 1951) a ring of connate, irregular, slightly fleshy scales ca. 0.2–0.4 mm high and wide, basally adnate to the inner surface of the calyx base; stigma minutely capitate, above the level of the pre-dehiscent anthers on a fully elongated style, equalled or slightly surpassed by the dehiscing anthers. Fruits drupaceous, 1-seeded, pyriform to ovoid, sessile, green when young, mature fruits not observed.

TYPE: MEXICO. TAMAULIPAS. Municipio. Hidalgo: along mountainous road from Sta. Engracia (Tamaulipas) to Dulces Nombres (Nuevo Leon), Arroyo Obscuro, 2.0 road mi NE of Los Caballos toward Canada El Mimbre, 15.0 road mi W of lowermost crossing of arroyo El Mimbre, 23°59'09"N, 99°28'37"W, ca. 1800 m, 3 Mar 1995, *Guy Nesom 7863* with Mark Mayfield and Greg Anderson (HOLOTYPE: MEXU; ISOTYPES: AAU, ANSM, ARIZ, ASU, BH, BRIT, CAS, CHAP, COLO, CONN, DAV, DUKE, ENCB, F, FSU, FTG, GA, GH, GUADA, IEB, K, KANU, LSU, M, MICH, MO, MSC, NCU, NLU, NY, OBI, OKL, OS, OSC, P, RM, RSA, S, TENN, TEX, UARK, UAT, UC, UCR, UNL, US, VDB, WIS, WTU, XAL.

Additional collection examined: MEXICO. TAMAULIPAS: type locality, [sterile, leaves only], 23 Sep 1994, *Mayfield 2085* with Nesom (TEX).

Description of the locality.—The site at which *Dirca mexicana* was observed and collected (Arroyo Obscuro) is a steeply sloping, north-facing, mesic cove surrounding a rocky watercourse. The area is limestone with karstic tendencies. The elevation near the road is ca. 1800 meters, but plants of

Dirca extend to at least ca. 20 meters (elevation) above the road and to at least 80 meters below it. They may well occur over a broader area than we investigated, particularly downslope, but this is the only locality where *Dirca* was encountered along the 35 kilometer road from Sta. Engracia to Dulces Nombres. Indeed, we found no other site along this road with a similar physical and floristic definition.

The dominant canopy trees at the site are *Carya ovata* (P. Miller) K. Koch, *Pinus patula* Schlecht. & Cham., *Pseudotsuga menziesii* (Mirb.) Franco, and *Quercus laurina* H. & B. Large trees of these reach about 20–25 meters in height, with tall *Pseudotsuga* perhaps reaching 30 meters. Judging from stumps in the area, particularly large individuals (presumably of *Pseudotsuga* and *Pinus*) have been removed by logging. Large trees of *Carpinus caroliniana* Walt. and *Liquidambar styraciflua* L. are scattered at the locality but do not reach the full height of the canopy. The woody understory includes the following: *Cornus urbiniana* Rose, *Croton virletianus* Muell.-Arg., *Garrya macrophylla* Benth., *Ilex* aff. *rubra* S. Wats., *Litsea pringlei* Bartlett, *Persea pododaenia* Blake, *Philadelphus calcicolus* Hu, and *Taxus globosa* Schlecht. Most of the canopy species are deciduous and were just beginning to break bud at this site; the understory includes a predominance of evergreen species. Arboreal bromeliads, including three species of *Tillandsia*, are conspicuous. Ferns form a major part of the herbaceous flora at this site; among the most common are species of *Adiantum*, *Woodwardia*, *Botrychium*, *Phanerophlebia*, *Polypodium*, and *Polystichum*. Other common herbs include species of *Chimaphila*, *Chiropetalum*, *Goodyera*, *Sisyrinchium*, and *Stachys*.

Characteristics of the population and biological observations.—We observed 800–1000 plants (by estimate) at the *Dirca* site, where they occur for about 300 meters along the road and adjacent slopes on the east side of the watercourse. They tend to be densely clustered in more open-canopy microsites, occurring most abundantly toward bottom of cove, but the plants occur singly and more scattered over a larger area. We did not unearth any plants, but there was no indication that they reproduce clonally. A report of rhizome production in *D. occidentalis* (McMinn & Forderhase 1935) has not been corroborated by more recent observations (Spongberg pers. comm.).

The entire population of *Dirca mexicana* is strongly synchronous in flowering. Had we arrived 3 or 4 days later, it is likely that we would have been unable to observe floral features, as the flowers appear to wither quickly with the onset of fruit maturation. The flowers appear to be weakly protogynous and there is evidence that they also may be self-compatible. Initially, before full development of the calyx, the style (with apical stigma) usually is elongated past the level of the anthers. At this time, the stigma appears slightly moist and presumably receptive; we also observed that many at this stage appear to have pollen attached. At full anthesis, the filaments have raised the open anthers to the level of the stigma or slightly beyond it. Further, there is little time separating intial receptivity of the stigma and dehiscence of the anthers, and little distance between the stigma and open anthers.

Visiting the flowers were one species of bee (individuals ca. 7 mm in length) and at least four species of butterflies. Pollination is effective, judging from the apparently ubiquitous deposition of pollen on the stigmata of pre-staminate flowers. Bees and butterflies were probing inside the flowers, and although it seems highly likely that nectar was available to them (probably produced by the hypogynous disc), its production was not evident in numerous flowers that we examined. Nor could we detect any fragrance (*D. occidentalis* was noted by Howell [1970] to be fragrant). Fruit maturation was beginning only on a few plants and we were unable to make an estimate of the success of fruit and seed production.

We did not determine what feature or features account for the remarkable rarity of *Dirca mexicana*. All of the other species yet identified from Arroyo Obscuro are found in other sites in the same general area—none except the *Dirca* could be considered rare (but see comments below regarding *Viburnum*). Rarity, however, also is a feature of both other species of the genus, particularly *D. occidentalis* (Stebbins 1942; Johnson 1994). *Dirca palustris* is widespread but of uncommon occurrence.

Morphological comparisons.—*Dirca mexicana* resembles *D. occidentalis* in most of the features that have been used to distinguish the latter from *D. palustris* (Vogelmann 1953; see key below): vestiture, presence or absence of a peduncle and pedicel, and the distal morphology of the calyx. The flowers of *D. mexicana*, however, are more similar in general configuration to those of *D. palustris*: both have a relatively long and narrow tube with a shorter, abruptly widening limb, the staminal filaments are inserted above the middle of the calyx, and the style and anthers are exserted for a relatively short length. In *D. occidentalis*, the tube is shorter than the broadly funnelform limb, the staminal filaments are inserted below the middle of the calyx, and the style and stamens are long-exserted. Vogelman (1953, p. 80) emphasized the taxonomic usefulness of the level of filament insertion, which in turn is indicative of the throat position and flower shape: "In most instances this character alone is sufficient to distinguish the two species." The comparative illustrations furnished by Vogelmann, however, do not accurately represent this difference, nor does the detailed illustration of *D. palustris* in Cronquist (1981, p. 635); those by Holm (1921) are more similar to our own observations. Differences between the new species and *D. occidentalis* are summarized in the following key.

1. Bud scales with brown or reddish-brown pubescence; young twigs and both leaf surfaces completely glabrous; flowers and fruits pedicellate, the whole cluster often pedunculate; calyx margin merely crenulate-undulate, without distinct lobes; eastern United States .... *D. palustris*
1. Bud scales with whitish pubescence; young twigs and abaxial leaf surfaces persistently pubescent; flowers and fruits sessile; calyx distinctly and deeply lobed; San Francisco Bay region of California or northeastern Mexico .... (2)
    2. Calyx tube 2–4 mm long, broadened into a broadly funnelform limb 4–6 mm long; staminal filaments inserted below the middle of the calyx, anthers exserted 3–4(–5) mm above the flower at maturity; style and stigma (1–)2–4 mm above the anthers at maturity; San Francisco Bay region .... *D. occidentalis*
    2. Calyx tube 5–7 mm long, abruptly broadened into a flaring limb 2–4 mm long; staminal filaments inserted above the middle of the calyx, anthers exserted 2–3 mm above the flower at maturity; style and stigma about level with the anthers at maturity; sierra of northeastern Mexico .... *D. mexicana*

Biogeographic pattern.—It does not seem possible at this point to provide a morphologically based hypothesis of relationship among the three species of *Dirca*, because the genus appears to be relatively isolated, its closest relatives (and thus the evolutionary polarity of character states) difficult to specify (see Domke 1934; Nevling 1959). Still, it is surprising to find a greater overall similarity between *D. mexicana* and *D. occidentalis*, in view of the well-known pattern of close relationship and disjunction between species of the eastern and southeastern United States and the sierra of northeastern Mexico (Miranda & Sharp 1950; Graham 1973). In the immediate area of *Dirca mexicana* are numerous species that are disjunct from their primary range in the eastern United States (e.g.): *Carpinus caroliniana*, *Carya ovata*, *Chimaphila umbellata* (L.) W. Barton, *Desmodium glutinosum* (Muhl. ex Willd.) Wood, *Liquidambar styraciflua*, *Pedicularis canadensis* L., and *Polystichum acrostichoides* (Michx.) Schott. In addition, there is a rare and yet undescribed species of *Viburnum* (Nesom in prep.) in the close vicinity that apparently is most closely related to *V. obovatum* Walt. of the southeastern United States. Another recently recognized, disjunct species from the same area of Tamaulipas, *Scrophularia* sp. nov. (Mayfield and Nesom submitted), is closely similar to *S. marilandica* L. of the eastern U.S. species and *S. californica* Cham. & Schlect. of the Pacific region. *Taxus globosa*, one of the understory species at the *Dirca* site, also has close relatives widely separated in the eastern and western United States.

Biotic disjunctions between the eastern and western United States, similar to that in *Dirca*, are well known though not particularly common (e.g., Sharp 1951; Wood 1970), and other examples can easily be added (e.g., *Sericocarpus*, *Ionactis*). This pattern is emphasized by the recent discovery of a second species of *Neviusia* in California (Shevock et al. 1992), both species extremely rare. In contrast, clearly established disjunctions of extant plants from the western United States to the Sierra Madre Oriental of Mexico are unknown to us. Numerous disjunctions exist between the Sierra Madre Oriental and S.M. Occidental, but most or all of these appear to be derivatives of the general pattern described by McVaugh (1952), where the evolutionary antecedents occupy a more southern position. A few Mexican species have a broken but still somewhat continuous distribution from the eastern sierra through northern Coahuila into the mountains of southwestern Texas and southeastern New Mexico (e.g., *Populus tremuloides* Michx., *Pseudotsuga menziesii* [Mirb.] Franco, and see Nesom 1993).

In the broadest view of the origin of *Dirca mexicana*, the simplest hypothesis is that it belongs to the floristic element with its closest evolutionary ties to the flora remaining in the southeastern United States, the geographic continuity between them probably established during the middle to late Miocene (Graham 1973). The disjunction between *D. palustris* and *D. occidentalis* may be considerably older, as a vegetation probably including these species was spread across North America through much of the Tertiary, beginning as early as the Eocene (Graham 1972, 1993). In a contrasting view, Axelrod (1975) hypothesized that the closely related disjuncts found in eastern Mexico, the Appalachians, and the West coast of the United States represent remnants of a continuous forest earlier spread into Mexico and more simultaneously fragmented as a result of a spreading dry climate in the mid-Oligocene. Evaluation of the latter theory is difficult at present because of the lack of evidence for northern temperate elements in Latin American prior to the Late Tertiary. These elements have not been recovered from the Oligo-Miocene Simojovel Group of Chiapas, Mexico; *Quercus* first appears in Panama in the Mio-Pliocene, and in South America *Alnus* arrives by about one million years ago and *Quercus* not until about 340,000 years ago. Many eastern North America disjuncts were present in eastern Mexico by the middle Pliocene, and global paleotemperature history suggests that cooling in the middle Miocene may have been an appropriate time for their principal introduction.

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collecting trips and for the example of his remarkable intelligence and continuing vigor.

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BOOK NOTICE

FAUTIN, DAPHNE GAIL, DOUGLAS J. FUTUYMA, and FRANCES C. JAMES. 1994. **Annual Review of Ecology and Systematics, Volume 25.** (ISSN 006-4162, hbk.). Annual Reviews, Inc., 4139 El Camino Way, Palo Alto, CA 94303-0139. $47.00 US, $52.00 elsewhere. 686 pp.

"Chapters in this volume directly relevant to application of ecological and systematic knowledge are those by Schulze et al., who apply new technology to some pressing global issues, Chambers and MacMahon, who compare natural and managed systems, and Leigh Brown and Holmes on HIV. Holt and Lawton and Kuris and Lafferty, among others, explicitly relate principles they discuss to human concerns. Linkages between and among chapters in this volume abound. Concern with evolution, the interface between ecology and systematics, is implicit in many chapters; it is explicit in those by Moran on complex life cycles, Moreno on genetic architecture, Raff et al. on metazoan phylogeny, and Vrijenhoek on unisexual fishes, and in that by Vermeij entitled "The Evolutionary Interaction among Species: Selection, Escalation, and Coevolution." "Three chapters concern systematics of particular groups, two of them plants—legumes by Doyle, and Mesembryanthemaceae by Ihlenfeldt." There are 25 chapters: 1) Algal Nutrient Limitation and the Nutrition of Aquatic Herbivores; 2) Genetic Architecture, Genetic Behavior, and Character Evolution; 3) Molecular Approaches to Population Biology; 4) Unisexual Fish: Model Systems for Studying Ecology and Evolution; 5) Cooperation and Conflict in the Evolution of Signal Interactions; 6) Evolutionary Biology of Human Immunodeficiency Virus; 7) Metapopulation Dynamics and Genetics; 8) Community Structure: Larval Trematodes in Snail Hosts; 9) The Evolutionary Interaction Among Species: Selection, Escalation, and Coevolution; 10) The Systematics of Coral Genus *Acropora*: Implications of New Biological Findings for Species Concepts; 11) A Day in the Life of Seed: Movements and Fates of Seeds and Their Implications For Natural and Managed Systems; 12) The Evolution of Vocalization in Frogs and Toads; 13) Phylogeny of the Legume Family: An Approach to Understanding the Origins of Nodulation; 14) Using DNA Sequences to Unravel the Cambrian Radiation of the Animal Phyla; 15) Genetics and Ecology of Whales and Dolphins; 16) Fisheries Ecology in the Context of Ecological and Evolutionary Theory; 17) Ecology and Evolution of Reproduction in Milkweeds; 18) The Nature and Consequences of Indirect Effects in Ecological Communities; 19) Integrative Approaches to Evolutionary Ecology: *Anolis* Lizards as Model Systems; 20) The Ecological Consequences of Shared Natural Enemies; 21) Diversification in an Arid World: The Mesmembryanthemaceae; 22) Genetic Divergence, Reproductive Isolation, and Marine Speciation; 23) Adaptation and Constraint in Complex Life Cycles of Animals; 24) Male Parental Behavior in Birds; 25) Relationships Among Maximum Stomatal Conductance, Ecosystem Surface Conductance, Carbon Assimilation Rate, and Plant Nitrogen Nutrition: A Global Ecology Scaling Exercise. A subject index is included.

MISCELLANEOUS NOTES ON *HAPLOPHYTON* (APOCYNACEAE: PLUMERIEAE: HAPLOPHYTINAE)

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ABSTRACT

The genus *Haplophyton* has typically been regarded as monotypic by various authors. A close examination of herbarium specimens coupled with field observations in Chiapas, Mexico, has uncovered new evidence that strengthens the recognition of two distinct species, *H. cimicidum* and *H. crooksii*. Further evidence suggests that *Haplophyton* should be removed from the subtribe Alstoniinae and placed back into its own subtribe, the Haplophytinae. Distribution maps and a key to the species are provided.

KEY WORDS: *Haplophyton, Alstonia*, Haplophytinae, Alstoniinae, Apocynaceae

RESUMEN

El género *Haplophyton* ha sido tratado como monotípico por varios autores. Un cuidadoso examen de especímenes de herbario junto con observaciones de campo en Chiapas, México, ha puesto de manifiesto nuevas evidencias que refuerzan el reconocimiento de dos especies distintas: *H. cimicidum y H. crooksii*. Otras evidencias suplementarias sugieren que *Haplophyton* debería ser sacado de la subtribu Alstoniinae para volverlo a colocar en su propia subtribu Haplophytinae. Se ofrecen mapas de distribución y una clave de especies.

De Candolle (1844) described *Haplophyton* as a monotypic genus based upon *H. cimicidum*. Benson (1942) added a variety to the species, var. *crooksii*, later elevating it to the rank of species (Benson 1943) when material of mature seeds was examined. Benson (1954) regarded *H. crooksii* as a distinct taxon because of its smaller leaves and smaller discontinuously ridged seeds. Various authors (Johnston 1990; Kartesz 1994; Leeuwenberg 1994; Pichon 1950), however, disregarded these differences and recognized only *H. cimicidum*. My examination of the specimens housed at LL, TEX coupled with field observations in Chiapas, Mexico, however, has uncovered new evidence that strengthens the recognition of two distinct species.

The genus *Haplophyton* is placed in the subfamily Plumerioideae because of its undifferentiated free anthers and indole alkaloides. These characters, in particular the indole alkaloides, are regarded as indicative of a monophyletic lineage (Leeuwenberg 1994). In addition, sinistrorse aestivation of the corolla (overlapping of the petals in bud to the left) distinguishes the

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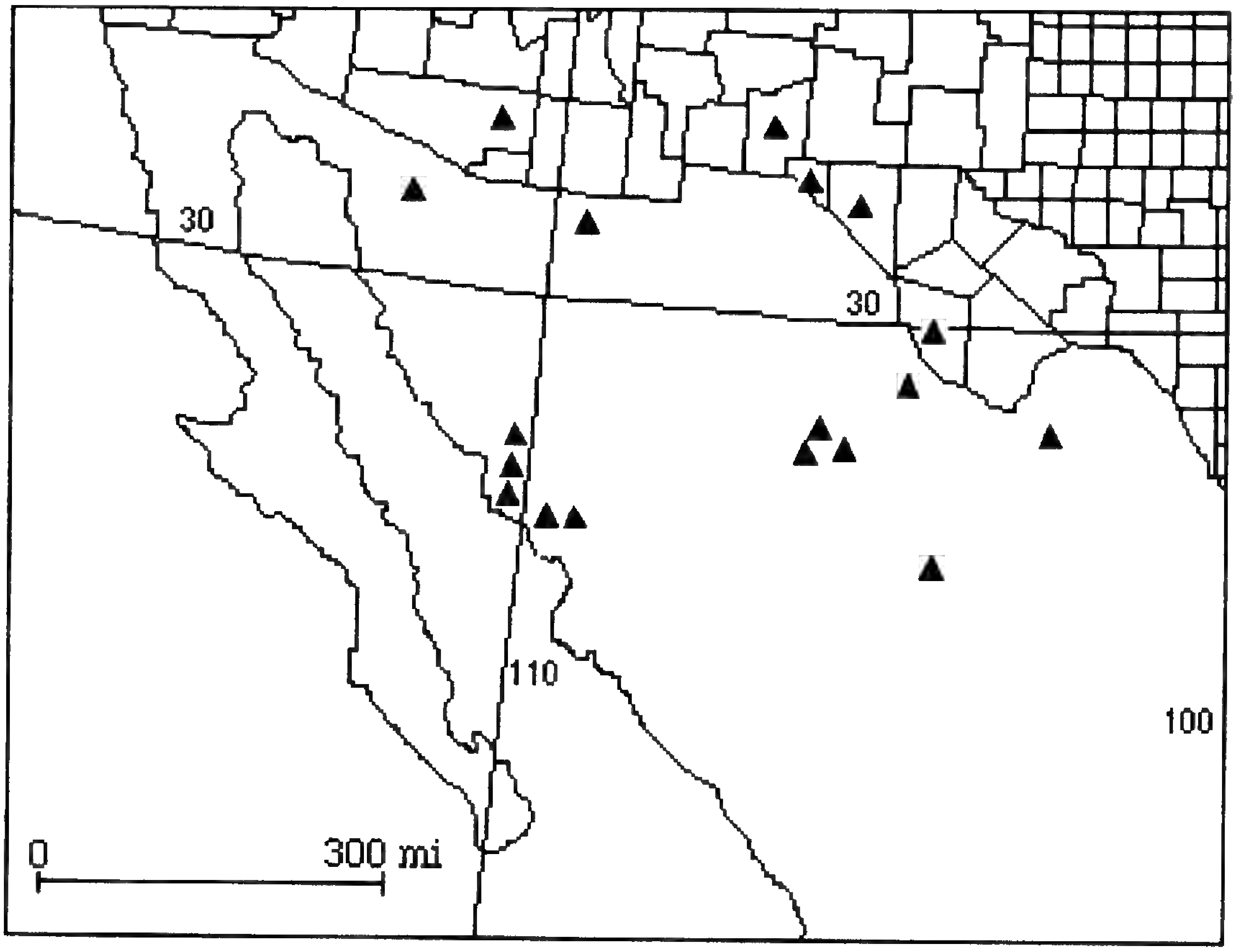

FIG. 1. Documented distribution of *Haplophyton crooksii*.

Plumerioideae from the Apocynoideae, which has dextrorse aestivation (overlapping of the petals in bud to the right) (Leeuwenberg 1994). The aestivation of *Haplophyton*, however, has been under considerable question. De Candolle (1844) described *Haplophyton* as sinistrorsely contorted, while Bentham and Hooker (1873) listed the taxon as having a dextrorse aestivation. Pichon (1950) also pointed out that *Haplophyton* had a "curious" dextrorse aestivation. Woodson (1938) on the other hand reported a sinistrorse aestivation for *Haplophyton*, as did Standley and Williams (1969), and Correll and Johnston (1970). Benson (1942, 1943, 1954) did not describe the aestivation. An examination of herbarium specimens, however, reveals that the above reports are all correct. The southwestern United States and northern Mexican (Fig. 1) members of *Haplophyton* have an aestivation to the left, while the Guatemalan and southern Mexican (Fig. 2) members have an aestivation to the right. The correlation of this character with the allopatric distribution of the two populations provides strong evidence that *Haplophyton* is comprised of two distinct species. My field studies in El Chorreadero, Chiapas (*Williams & Plum, 95-34*) confirm that southern populations have a dextrorse aestivation.

When de Candolle (1844) described *Haplophyton cimicidum* he reported a sinistrorse aestivation, and listed as the type a specimen from Tehuantepec, Oaxaca. Topotypes from this region, however, have a dextrorse aestivation.

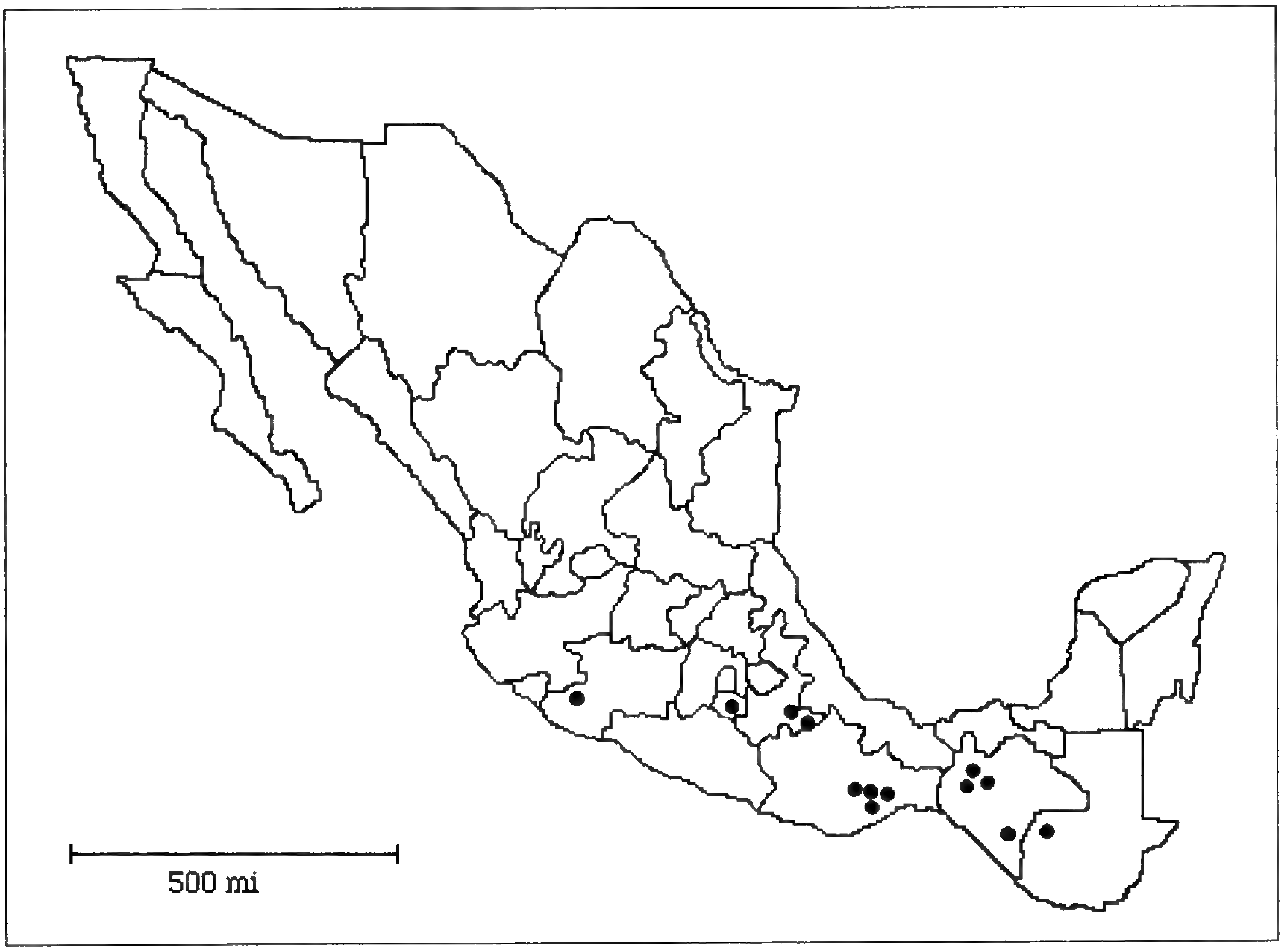

FIG. 2. Documented distribution of *Haplophyton cimicidum*.

Because I have not had an opportunity to examine the type, its aestivation remains at present undetermined. I suspect, however, that it is to the right and that the reports of a sinistrorse aestivation are either from specimens examined from the north or are the result of the presupposition that all Plumerioideae flowers have aestivation to the left.

Differences in the corolla tube and calyx dimensions have not until now been discussed as segregating factors between the two species, but my examination of herbarium specimens shows that *H. cimicidum* possesses a longer corolla tube than *H. crooksii*, as well as smaller calyx lobes. An examination of the seeds, in particular their size and surface structures, also supports Benson's (1943) assertions that the two species are distinct. A character that seems to tentatively hold true is the color of the coma which is typically golden yellow in *H. cimicidum* and charcoal grey in *H. crooksii*.

The populations in Guaymas, southwestern Sonora, superficially resemble *H. cimicidum* in leaf size; accordingly Benson (1943, 1954) recognized them as such. A close inspection of these individuals, however, shows that their aestivation is to the left and that the seeds are 6–8 mm long, placing them with *H. crooksii*.

With its sinistrorse aestivation, larger calyx lobes, smaller corolla tube, smaller seeds, and isolated geographical range, it seems evident that

Haplophyton crooksii constitutes a distinct element from *H. cimicidum* and, consequently, necessitates the recognition of two species for *Haplophyton*.

KEY TO SPECIES OF *HAPLOPHYTON*

1\. Petals of the bud overlapping to the right; leaves 22–65 mm long, 11–26 mm wide; corolla tube 8–10 mm long; sepals 3–5 mm long, less than half the length of corolla tube; seeds 8–11 mm long, vertical ridges of seeds continuous; coma yellowish; Guatemala and southern Mexico .... 1. *H. cimicidum*

1\. Petals of the bud overlapping to the left; leaves 11–35 (50) mm long, 3–12 mm wide; corolla tube 6–8 mm long; sepals 4–11 mm long, longer than or equal to half the length of corolla tube; seeds 6–8 mm long, vertical ridges of seeds broken by transverse grooves; coma white to charcoal grey; south western United States and northern Mexico .... 2. *H. crooksii*

1. Haplophyton cimicidum A. DC., Prodr. 8:412. 1844. TYPE: MEXICO. OAXACA: Tehuantepec, 1833, *Andrieux 250* (HOLOTYPE: G-DC).

Representative specimens. GUATEMALA. HUEHUETENANGO: between the villages of Nenton and Llano Grande (15°48'N; 91°45'W), growing in dry subtropical forest, 16 Nov 1993, *Castillo 1638* (F).

MEXICO. CHIAPAS: steep wooded slopes 9 km N of Tuxtla Gutiérrez along road to El Sumidero, 27 Oct 1965, *Breedlove 13850* (TEX); steep canyon, tropical deciduous forest, 15 km SW of Suchiapa, along road to Villa Flores, 750 m, 26 Sep 1972, *Breedlove 28068* (TEX); El Chorreadero, 200 yds. outside entrance to waterfall park, along road, growing in the open, below rocky hillside with *Capraria frutescens*, 7 Jan 1995, *Williams & Plum 95-34* (TEX). MORELOS: in limestone soil on side of the ruins of Xochicalco, 16 Aug 1947, *Rodrigo 710B* (TEX). MICHOACAN: in El Carrizo, 30 km SW of Tepalcatepec, 570 m, 25 Aug 1980, *Núñez 2496* (TEX). OAXACA: tropical deciduous forest on SE slopes of Sierra Madre del Sur, 22 km W of Tequisistlán on Pan-Am hwy to Oaxaca, 1000 m, (16°23' N; 95°45'W), 4 Jul 1969, *Marcks 993* (TEX); 55 mi SE of Oaxaca along road to Tehuantepec, in mountains 9 mi NW of La Junta, 13 Sep 1971, *Clarke 20463-1* (TEX); 52 km S of Tecomavaca, along the road to Oaxaca, 31 Jul 1985, *Salinas F-2671* (TEX); open areas 9–10 km E of La Ventosa along Pan-Am hwy (rt 190), 50 m, 16 Jul 1959, *King 1717* (TEX); ruinas del Cerro Guiengola (16°21'N; 95°19' W), 450 m, 26 Nov 1986, *Torres 533* (TEX); La Huerta, 20 km NE of Tepelmeme of Morelos, 9 Oct 1970, *Cisneros 2560* (TEX); 15 km N of La Ventosa, 120 m, 25 Nov 1986, *Mendoza 2768* (TEX). PUEBLA: 4 km S of Coxcatlán, 1100 m, 29 Jul 1983, *Chiang 2370* (TEX); about 6.5 km SW of Axusco (18°12'N; 97°12'W), 27 Jun 1987, *Salinas 4079* (TEX).

2. Haplophyton crooksii (L. D. Benson) L. D. Benson, Amer. J. Bot. 30:630. 1943. BASIONYM: *Haplophyton cimicidum* var. *crooksii* L. D. Benson, Torreya 42:9. 1942. TYPE: U.S.A. ARIZONA: Pima Co.: "prison road" soldier trail hwy, Santa Catalina Mts, 27 Dec 1939, *Crooks & Darrow s.n.* (HOLOTYPE: ARIZ; ISOTYPE: B).

Representative specimens. U.S.A. ARIZONA: **Pima Co.**: end of Roger road, Rincon foothills, E of Tucson, 3200 ft, 25 Aug 1985, *Van Devender 85-179* (TEX). NEW MEXICO: **Dona Ana Co.**: Dona Ana Mts, ca 15 mi N of Las Cruces, S slope of Summerford Mt, 26 Aug 1973, *Todsen s.n.* (TEX). TEXAS: **El Paso Co.**: Franklin Mts, 1.1 mi W jct Trans-Mountain road (loop 375) and Gateway S (31°53'N; 106°27'W), southern exposure of granite boulders, 4600 ft, 26 Aug 1978, *Worthington 3207* (TEX). **Hudspeth Co.**: limestone crevices throughout the canyon at the head of the Davis Arroyo, an intermontane basin in the Quitman Mts, 17 Apr 1976, *Butterwick 2377* (TEX). **Presidio Co.:** near mouth of narrow canyon draining S slope of the W Chinatis, among igneous boulders, 4800 ft, 14 Jun 1977, *Butterwick 3857b* (TEX).

MEXICO. CHIHUAHUA: ca 20 km ENE of Ciudad Jiménez, in limestone arroyo in canyon NW of summit of Sierra de Chupaderos (27°12'N; 104°43'W), 5100 ft, 2 Oct 1973, *Henrickson 13765* (TEX); ca 31 mi NW of Julimes in SW facing canyon above Rancho El Recuerdo in Sierra de Carrasco (28°47'N; 105°09'W), 4400 ft, 15 Sep 1973, *Henrickson 12941* (TEX); 46 km W of Ojinaga on hwy to Chihuahua City and S 2 km to the deep canyon of Rio Conchos in the Sierra de Pegüis (29°32'N; 104°48'W), 1000 m, 20 Oct 1972, *Chiang et al. 9757* (TEX); S slope and top of Sierra del Roque, NNE of Julimes approached from Mina Las Playas via Rancho El Saucito (28°39'N; 105°18'W), 19 Jun 1973, *M.C. Johnston et al. 11386B* (TEX). COAHUILA: S side of Cerro San José de las Piedras (28°42' N; 102°51'W), 1000–1400 m, 8 Jun 1972, *Chiang et al. 7555* (TEX); 0.5 km E of Matrimonio Viejo, E end of limestone ridge (27°08'N; 103°07'W), 1125 m, 2 Sep 1972, *Chiang 9122* (TEX). SONORA: Sierra Bojihuacame SE of Obregon, 800–2000 ft, 17–25 Oct 1954, *Gentry 14482* (TEX); talus slope of low basaltic hill, 15 mi S of La Palma, between La Palma and Guaymas, 2 Sep 1941, *Wiggins 226* (TEX); Río Mayo area, hill with microwave tower, 9 mi NW of Alamos and 4 mi SSW of Piedras Verde (27°07'N; 109°02'W), 500–700 m, 6 Sep 1989, *Sanders 9435* (TEX); Cañon de Nacapules, 6 km NE of Bahîa San Carlos, deep riparian canyon, 19 Oct 1984, *Felger 84-122* (TEX).

In his classification of *Haplophyton*, Pichon (1950) erected the monogeneric subtribe, Haplophytinae. He discussed its affiliation with the Catharanthinae, but ended by questioning the relationship, remarking that "the lignification of the branches [in *Haplophyton*] seems to be rather rapid and the plant has nothing in common in this point of view with the Catharanthinae" (Pichon 1950; p. 161). Leeuwenberg (1994) subsequently positioned *Haplophyton* with *Alstonia* R. Br. in the Alstoniinae, near the Catharanthinae, on the basis that both genera are the only two taxa in the Plumerioideae to possess hairy seeds. Seed pubescence in the Alstoniinae, however, is heteromorphic. *Haplophyton* has seeds with both apical and basal coma, while *Alstonia* has seeds with either membranous ciliations (sect. *Tonduzia*) or with both apical and basal coma (sect. *Monuraspermum*) (Monachino 1949).

The dextrorse aestivation found in *Haplophyton*, suggests a close relationship with *Alstonia*, which also displays dextrorse aestivation. Indeed, *Haplophyton cimicidum* may be related to the Oceanic species of *Alstonia* (sect. *Monuraspermum*), which have flowers with dextrorse aestivation and seeds with both apical and basal coma (Monachino 1949). Presently, however, it is not known whether or not dextrorse aestivation in *Haplophyton* is ancestral or derived.

Alstonia is the only other genus in the tribe Plumerieae, besides the genera of the Catharanthinae (excluding *Vinca* (Lawrence 1959)), to retain a reflexed membranous appendage basal to the stigma throughout its ontogeny (Pichon 1950). Woodson (1928) noted, however, that a swollen region occurs below the stigmas of *Haplophyton*. In his view, this character probably represents a primitive stage of the more complex appendage found in the Catharanthinae. Preliminary studies of *Haplophyton* herbarium specimens, by the author, reveal that the style heads of immature buds have a membranous skirt below them. This feature, however, was not present in mature (opened) flowers in either the field or herbarium specimens.

Pichon (1950) also suggested an affiliation between *Haplophyton* and *Anechites*, stating that the two genera are unique in the family by having hairs with multicellular bases (Fallen 1983). Pichon, however, placed each of these genera in monotypic subtribes, suggesting that their relationships were unresolved. *Anechites* was subsequently positioned in the subtribe Condylocarpinae of the subfamily Plumerioideae (Leeuwenberg 1994).

Haplophyton differs from *Alstonia* sect. *Monuraspermum* in being a suffruticose herb (vs. tree), having alternate (vs. whorled) leaves, hairs with multicellular bases (vs. simple), no nectary (vs. an annular nectary), solitary flowers (vs. cymous), and its restriction to the New World (vs. Oceania). These differences suggest that *Haplophyton* is not related to *Alstonia*. Until further evidence is presented, the most suitable and conservative course favors placing *Haplophyton* in the monogeneric subtribe Haplophytinae (Pichon 1950) of the tribe Plumerieae, and not with *Alstonia* in the Alstoniinae (Leeuwenberg 1994) whose resemblance to *Haplophyton* is at present questionable.

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BOOK NOTICES

RICE, ELROY L. 1995. **Biological Control of Weeds and Plant Diseases. Advances in Applied Allelopathy.** (ISBN 0-8061-2698-1, hbk.). University of Oklahoma Press, 1005 Asp Avenue, Norman, OK 73019, (405) 325-5111. $55.00. 448 pp, 14 figures.

"*Biological Control of Weeds and Plant Diseases. Advances in Applied Allelopathy,* is a timely study, by a world-renowned authority, of the production, by plants and microorganisms, of compounds that affect the growth, health, and population biology of other plants and microorganisms. Elroy L. Rice focuses on new developments in allelopathy in agriculture and forestry, where the deleterious side effects of synthetic pesticides necessitate more widespread use of biological control techniques."

"Summarizing the explosion of knowledge during the last decade, Rice adds his own insights to the various topics reviewed. He tells how, in many cases, biological control can be substituted for chemical control with no decrease in crop yields, and how, in other cases, only a minimum of research remains to be done before the data are conclusive."

The following chapters are included: 1) Introduction and Allelopathic Effects of Crop Plants on Crop Plants; 2) Allelopathic Effects of Weeds on Crop Plants; 3) Other Roles of Allelopathy in Agriculture; 4) Allelopathy in the Biological Control of Weeds; 5) Allelopathy in Bacterial and Fungal Diseases of Plants; 6) Allelopathy in the Biological Control of Plant Diseases: Host Plants A–M; 7) Allelopathy in the Biological Control of Plant Diseases: Host Plants N–Z; 8) Allelopathy in Forestry.

FREY, KENNETH J., ED. 1995. **Historical Perspectives in Plant Science.** (ISBN 0-8138-2284-X, hbk.). Iowa State University Press, 2121 S. State Avenue, Ames, IA 50014-8300, 1-800-862-6657. $44.95. 216 pp., 6 × 9, illus.

Historical Perspectives in Plant Science is a compilation of lectures presented at the 1991 Plant Science Lecture Series sponsored by the Iowa State University Departments of Agronomy, Botany, Forestry, Horticulture, and Plant Pathology. The lecture series brought together eight scholars who have been called the "makers of plant science history" over the past half century.

The subject matter covered is restricted to higher plants with some agricultural importance. Included is a general overview of plant science, development of the history of plant physiology, plant pathology, quantitative genetics, cytogenetics, molecular biology, and the history of plant breeding methodology and accomplishments. The eight chapters include: 1) Biological Revolutions of Thought during the Twentieth Century, by G. Ledyard Stebbins; 2) Historical Developments in Biological Nitrogen Fixation, by Robert H. Burris; 3) Historical Perspectives on Contributions of Quantitative Genetics to Plant Breeding, by Bruce Griffing; 4) Contributions of Plant Pathology to the Biological Sciences, by Arthur Kelman; 5) Perspectives on Germplasm Manipulation, by Ralph Riley; 6) Current Perspectives: The Impact of Biotechnology on Plant Improvement, by Charles S. Levings III, Kenneth L. Korth, and Gerty Cori Ward; 7) Plant Breeding—A Vital Part of Improvement in Crop Yields, Quality, and Production Efficiency, by John W. Dudley; and 8) Historical Perspectives on Plant Breeding Methodology, by Neal F. Jensen.

NEW TAXA OF RHAMNACEAE FROM CHINA

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ABSTRACT

Sageretia yunlongensis G.S. Fan & L.L. Deng sp. nov. from Yunlong Xian, Yunnan, China and *Rhamnus hemsleyanus* Schneid. var *paucinervatus* G.S. Fan & L.L. Deng var. nov. from Wuyi Shan Mountain, Fujian, China, are described and illustrated.

KEY WORDS: New taxa; Rhamnaceae; China

RESUMEN

Se describen e ilustran *Sageretia yunlongensis* G.S. Fan et L.L. Deng del condado de Yunlong en Yunnan (China) y *Rhamnus hemsleyanus* Schneid. var. *paucinervatus* G.S. Fan et L.L. Deng var. nova de la montaña Wuyi Shan en Fujian (China).

Sageretia yunlongensis G.S. Fan & L.L. Deng, sp. nov. (Fig.1)

Species haec praesertim habitu *S. henryi* Dumm. et Sprag. valde similis, a qua differt foliis oblongo-ellipticis, 10–15 cm longis, 4.5–6.5 cm latis; axibus inflorescentiarum et foliis subtus et costis super folia et petiolis pilosis.

Shrub 4 m tall, unarmed; branchlet cylindric. Leaf thick and papery, oblong-elliptic, 10–15 cm long, 4.5–6.5 cm broad, obtuse-rounded to short-acute at apex, rounded at base, pubescent beneath; the midrib pubescent above; the lateral veins 7–8 per side, impressed above, raised beneath; petiole thick, 14–20 mm long, densely pubescent. Inflorescence paniculate, 9–10 cm long in fruit; axis of inflorescence densely pubescent, persistent in fruit; flower unknown. Fruit globose, 3–4 mm diam.; pyrenes 2–3; stem of fruit 2–3 mm long.

TYPE: CHINA. YUNNAN: Yunlong Xian, 1300 m alt., *Yin Wu-Yuan et al. 161*, 26 Oct 1987 (HOLOTYPE: SWFC). PARATYPES: CHINA. Tibet, Motuo Xian, *Tibet Team 74-1702*, 17 Aug 1974 (KUN).

This new species is similar to *Sageretia henryi* Dumm. & Sprag., but it is easily recognized by its oblong-elliptic, 10–15 cm long, 4.5–6.5 cm broad leaf, and axis of the inflorescence, the lower leaf surface, the midrib above, and the petiole with pubescence.

Rhamnus hemsleyanus Schneid var **paucinervatus** G.S. Fan & L.L. Deng, var. nov.

A typo recedit nervis lateralibus paucioribus, 4–5 jugis; petiolis glabris.

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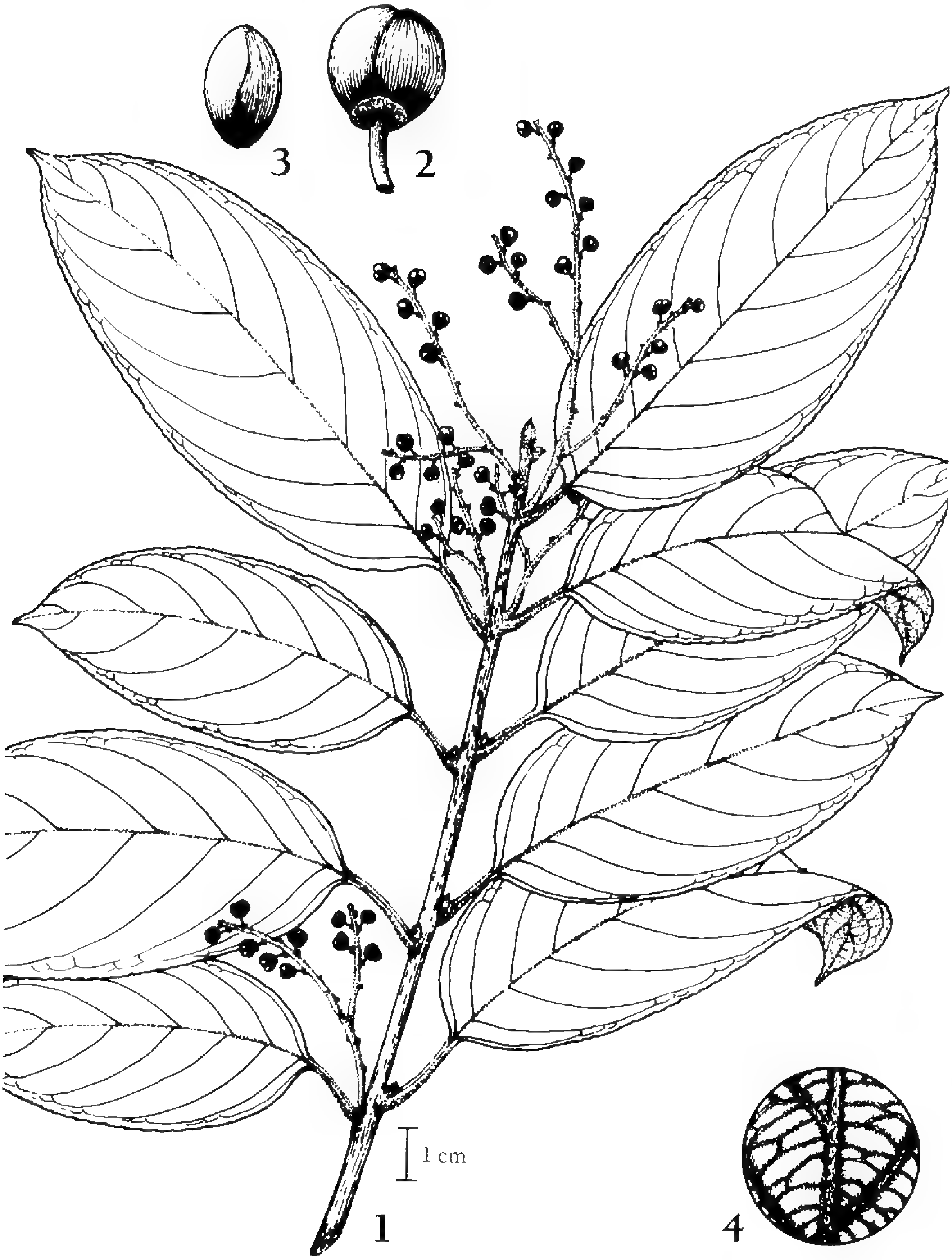

FIG. 1. *Sageretia yunlongensis* G.S. Fan & L.L. Deng, sp. nov. 1. Sheet with fruits, 2. Fruit, 3. Seed, 4. amplified lower surface of leaf.

The new variety is similar to var. *hemsleyanus*, but it can be recognized by its fewer lateral nerves (4–5 pairs) and glabrous petioles.

TYPE: CHINA. FUJIAN: Wuyi Shan Mountain, *Wang Min-Jing, et al. 1823*, 9 Nov 1956 (HOLOTYPE: NAS). PARATYPES: 8 Nov 1956, *Wang Min-Jing 1782*, 19 Apr 1955, *3326* (NAS).

AMUR HONEYSUCKLE (*LONICERA MAACKII*; CAPRIFOLIACEAE): ITS ASCENT, DECLINE, AND FALL

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ABSTRACT

A 150-year chronology of interaction between *Lonicera maackii* and people reveals the diverse roles of arboreta, botanical gardens, and government agencies in plant introduction and eventual naturalization. The species' biology, horticultural value, and conservation use are described.

RESUMEN

Una cronología de 150 años de interacción entre *Lonicera maackii* y la gente revela los roles diversos que han tenido los arboreta, jardines botánicos, y agencias del gobierno en la introducción y eventual naturalización de esta planta. Se describe la biología de esta especie, su valor en horticultura, y su uso para conservación.

In an effort to understand how non-indigenous plants occupy new geographic areas, two processes have received the most attention: population spread as documented from herbarium records (Forcella 1985) and population growth as mediated by plant traits and community-level interactions (Mack 1985). Although most plant invasions result from accidental or intentional introduction by people, relatively little attention has been given to human cultures and the historical and extant exchange systems contributing to plant invasion. A description of these systems, when they operate with plants that eventually escape and become naturalized, may be useful for understanding rates and areal extent of the invasion process.

We present here a 150-year chronology of events that eventually led to introduction and naturalization of the eastern Asiatic shrub *Lonicera maackii* (Rupr.) Herder (Caprifoliaceae), Amur honeysuckle, in North America. Throughout most of this time *L. maackii* was highly valued in gardens and conservation plantings. However, the tendency of the species to naturalize and spread beyond points of original introduction established it as a woody "weed" of concern in eastern U.S. The documented history of interaction between Amur honeysuckle and people is both extensive and varied. The chronology given here may be of value as regulatory decisions are made about future plant introductions.

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The addition of *L. maackii* to the alien flora of North America can be traced to three historical interactions between the plant and *Homo sapiens*: (1) Discover the plant, classify it, and describe it as a member of the flora of eastern Asia; (2) Introduce the plant to western horticulture for its attractive foliage, abundant flowers, and showy fruits; and (3) Use the plant to achieve conservation goals, e.g., soil stabilization and/or wildlife-habitat improvement. These three interactions contributed to widespread introduction, thus necessitating a fourth and final one: control or remove the plant from the many biotic communities that have been invaded.

AMUR HONEYSUCKLE: ITS PEREGRINATIONS

From the Pacific to Western Europe: The Russian Role

In the mid 19th century, Russian possessions in coastal eastern Asia were all north of the 55th parallel, a somewhat less than hospitable region. To extend their holdings into more favorable areas, the Russians initiated a series of southward explorations into the relatively greener pastures of Manchuria (Bretschneider 1898). This area, then "but loosely held in the feeble grasp of the Chinese government," had excellent harbors and abundant resources, including timber. Among the targets was the territory north of the Amur River and that bounded by the Amur and Ussuri rivers, the Sea of Japan, and the Korean frontier. Russia eventually annexed these lands by treaty from China in 1858 and 1860, thus extending its domain south to the latitude of present-day Vladivostok.

One of the scientific expeditions sent to explore the valley of the Amur began at Irkutsk in April 1855, returning to Irkutsk 9 months later (Bretschneider 1898). Accompanying the expedition was a naturalist, Richard Maack (1825-1886), professor in the *Gymnasium* of Irkutsk. Maack is remembered today primarily in the name of a genus of Fabaceae, *Maackia*, and in the specific epithets of several species, including one in *Lonicera*.

Among the species that Maack found along the Amur in June was the yet-to-be-described Amur honeysuckle; he made but a single collection of the plant—in the Bureja Range north of the Amur about midway between Khabarovsk and Blagoveshchensk (Maximowwicz 1878; Ruprecht 1857). His specimens of woody plants from the trip were sent to St. Petersburg, where they provided the basis for part of the first publication devoted to plants of "Amurland" (Ruprecht 1857), that area on both sides of the Amur between ca. 42° and 55° north and 131° and 141° east (Maximowicz 1859). In that work the honeysuckle was described as a new species, *Xylosteum maackii*, by Ruprecht (Ruprecht 1857). Maack (1859) gave an account of his journey along the Amur; in this work is the first published illustration (at least in western literature) of Amur honeysuckle (Fig. 1). The species was soon included in Maximowicz's *Primitiae florae Amurensis* (Maximowicz

FIG. 1. The earliest drawing of Amur honeysuckle (*Lonicera maackii*) in western literature. Reproduced from Richard Maack's *Journey on the Amur* (1859).

FIG. 2. One of two earliest herbarium specimens (center of sheet) of Amur honeysuckle (*Lonicera maackii*). The collection, *Fortune A34*, was made by Robert Fortune in China in 1845, probably at Amoy, and deposited in the Herbarium of the Royal Botanic Gardens, Kew.

1859), the first flora of Amurland, written after Maximowicz's first trip (1853-1857) to eastern Asia. Five years after publication of the flora, the species was transferred to *Lonicera* as *L. maackii* (Ruprecht) Herder (Herder 1864).

Maximowicz did not see the plant in nature before he wrote *Primitiae florae Amurensis*. However, in a later expedition (1859-1864) he obtained specimens of it for St. Petersburg from five localities (Herder 1878): near the mouth of the Amur, at St. Olga Bay, and at three sites near Vladivostok.

We do not accept reports (e.g., Bretschneider 1898) that Maack "introduced" *L. maackii* to cultivation at the St. Petersburg Botanic Garden; Boom (1959), Rehder (1949b), and Wyman (1969) even date this event as "1860." We conclude that Maack did not bring seeds or living plants of *L. maackii* to the Garden from either of his trips (1855, 1859). If he had brought back such propagules, these would have produced blooming plants much earlier than 1883, the date recorded in *Gartenflora* (Regel 1884) for the first European flowering of the plant, at the St. Petersburg Garden. This beginning of the plant's ascent in western horticulture was some 24 years after Maack's last return from eastern Asia. The species comes into flower in 3 to 5—not 24—years from seed (Lorenz et al. 1989). The flowering of other eastern Asiatic woody plants raised from seeds that Maack *did* send to St. Petersburg (e.g., species of *Clematis*, *Pyrus*, *Deutzia*, and *Syringa*) was reported in the early 1860s (Bretschneider 1898).

According to Thatcher (1922), plants of *L. maackii* were introduced to St. Petersburg from Manchuria—introducer unknown—in 1880; these plants could well have been the ones that came into flower in 1883. (That *seeds* were the introduced propagules was maintained by Anonymous [1924].)

Regel's (1884) report of the flowering of *L. maackii* in St. Petersburg in 1883 was soon translated abridged, and published in horticultural works in England (e.g., Anonymous 1884a, 1884b; Nicholson 1888) and the United States (Bailey 1900; Davis 1899); the authors of these reports obviously had not seen living examples of the plant. However, within a decade after the 1884 article, detailed morphological data obtainable only from *live* plants were published in Germany (Dippel 1889; Koehne 1893), indicating cultivation in that country. In 1896 at least one German nursery grew *L. maackii* (Cole, pers. comm.). The National Botanic Gardens, Glasnevin, Dublin, Ireland, purchased plants of Amur honeysuckle from the French nursery Lemoine in 1889 (Nelson, pers. comm.). The plant was cultivated at Kew in 1896 (Royal Gardens 1896), in Ukraine in 1898 (Kokhno 1986), and in the Botanical Garden in Darmstadt, Germany, in 1900 (Purpus 1900). The Purpus article contains the earliest photograph of the species known to us.

The seeds or plants for these early European introductions almost certainly trace their source ultimately to St. Petersburg. The herbarium and garden there had long been receiving plant materials collected by Russian travellers in central and eastern Asia. Duplicates of these collections were sent to other major European botanical gardens (Bretschneider 1898). As many botanical gardens do, the one at St. Petersburg published annually a list of seeds available; *L. maackii* first appeared in the garden's list, its *Delectus seminum*, in 1887 (Hortus Botanicus Imperialis Petropolitanus 1887).

Within a few decades, Amur honeysuckle was growing in botanical gardens through much of Europe. Seeds of the plant eventually were offered in the seed lists of various European gardens for the first time in the following years: Cambridge, 1913 (Cambridge University Botanic Garden 1913); Oslo, 1917 (Universitet Botanske Have 1917); Dublin, 1919 (Royal Botanic Gardens, Dublin, 1919); Copenhagen, 1924 (Horto Universitatis Hauniensis 1924); Edinburgh, 1924 (Royal Botanic Garden, Edinburgh, 1924); Amsterdam, 1929 (Jardin Botanique de l'Université d'Amsterdam 1929); and Paris, 1931 (Muséum d'Histoire Naturelle 1931).

From the Pacific to Western Europe: The English Role

The earliest recorded observation of *L. maackii* by a European is not that of Maack but appears to be that of Robert Fortune, who in the mid 1840s collected the species in China. *Where* in China the specimen came from, either Amoy or somewhere in "northern China," has been a matter of debate. The specimen (two sheets at Kew) has but scant data: "A" and "34" (Fig. 2). Bretschneider (1894, 1898) concluded that the "A" stands for Amoy, which Fortune did indeed visit. The specimen may well have been collected in a garden because Fortune spent much time searching gardens for new plants to introduce to Europe.

Several authors (e.g., Anonymous 1929, 1934; Bean 1973; Thatcher 1922; Wilson 1929) maintained that the first introduction of *L. maackii* into Great Britain was in 1900 by E.H. Wilson; it was one of the species he collected in China during his first trip there for the James Veitch Nursery. We were, however, unable to reconcile this date and method of introduction with the statement in Bretschneider (1898) that the St. Petersburg Garden sent to the "greater botanical institutions in Europe and America, *especially to Kew*" (italics ours), seeds and plants and also duplicate specimens from the collections it received from central and eastern Asia. Because *L. maackii* was growing at St. Petersburg since about 1880 and was first listed in the Garden's *Delectus seminum* in 1887, we wondered why propagules of the plant had not been sent to Kew before 1900. After reading in Truelove (1917) that *L. maackii* was listed in "1894" in the Kew "*Hand-List of Trees and Shrubs*," we finally obtained a copy of that work (date actually 1896 for volume 2, the one of concern) and found that *L. maackii* is indeed listed there (Royal Gardens 1896). We suggest that seeds from St. Petersburg were sent to Kew some time before 1896 and that the plant or plants from those seeds languished, unheralded, among their congeners in the garden. However, what might be called the "effective" introduction of *L. maackii* into Britain was apparently that in 1900 by Wilson for the Veitch nursery, which then extolled and disseminated it in Britain and elsewhere (Allan 1974). Once the Veitch propaganda machine was activated in its behalf, the plant received many notices in horticultural literature, largely favorable until recently in North America. The company exhibited specimens of Amur honeysuckle at a meeting of the Royal Horticultural Society in 1907 where they received an Award of Merit (Floral Committee 1908; see Anonymous [1915] for a drawing of *L. maackii* made from the 1907 Veitch specimens.). A similar award was bestowed on the plant in 1915 (Floral Committee 1916). Amur honeysuckle was one of the few plants to which, until that time, such a double award had been made (Truelove 1917). Early mentions of the plant in continental European periodicals include one in the Belgian *Tribune Horticole*, with a photograph supplied by Veitch (Anonymous 1909), and one in the French *Revue Horticole*, reporting introduction of the species into France apparently through the agency of Veitch (Mottet 1907). Veitch sent seeds of the plant to the United States Department of Agriculture (U.S.D.A.) as early as 1908 (U.S.D.A. 1909).

From the Pacific and Western Europe to North America

The earliest North American record of Amur honeysuckle we have located is in archives of the Dominion Arboretum, Ottawa: plants were received there in 1896 from Spaeth Nurseries in Germany (Cole, pers. comm.). The first U.S. record is in archives of the New York Botanical Garden: seeds of Amur honeysuckle from Russia were accessioned there in 1898 (Riggs, pers. comm.) (Table 1).

This first U.S. record of *L. maackii* came about through the agency of the then newly organized Section of Foreign Seed and Plant Introduction (S.P.I.) of the U.S.D.A., which was mandated to procure, propagate, and distribute new and valuable seeds and plants. In 1897 the U.S.D.A. dispatched Niels E. Hansen as an agricultural explorer to Russia in search of cold-hardy forage plants. The trip, Hansen's first for the U.S.D.A., extended from June 1897 to March 1898 (Hansen 1909; Taylor 1941). Unilaterally expanding his charge, Hansen sent about 930 accessions of forage, shrub, and tree seeds to Washington, DC, between December 1897 and June 1898 (U.S.D.A. 1899a, 1899b). Some of the seeds were delivered before facilities were ready for their storage and dissemination (Fairchild 1938).

Distribution of seeds received by the Section was started soon after they were received at Washington. One of the first recipients of seeds was the New York Botanical Garden: the "PIE" in the 1898 entry for *L. maackii* in the Garden archives indicated one of the first "Plant Introduction Experiments"—i.e., seed distributions—initiated by the S.P.I.

The seeds and plants imported by the S.P.I. were numbered consecutively starting in "Inventory No. 1," 1898. Hansen's collections are listed in the first two inventories (U.S.D.A. 1899a, 1899b). The data for number 246 in Inventory I are "*Lonicera maackii.* From Russia. Received through Prof. N.E. Hansen, December, 1897." A similar entry, dated January 1898, is number 391 in this first inventory. Seeds of Amur honeysuckle were thus among the first few hundred accessions received by the S.P.I.

The geographical origin of the seeds of *L. maackii* sent by Hansen is an intriguing mystery. According to the inventory data (U.S.D.A. 1899a, 1899b), the sources of Hansen's collections seemed to have spanned much of Russia from St. Petersburg and Odessa to the Pacific. Origins of most of the seeds, including those of Amur honeysuckle, are given in broad terms, often simply "from Russia." More exact data are given for a few species: some came from "Sea Province [now Primorski Krai or Maritime Territory], South Ussurie, Siberia" and some from "Amur." However, in spite of data indicating far eastern Russia, Hansen's 1897-1898 journey did *not* extend into that part of Asia.

The Russian segment of his journey began and ended at St. Petersburg via Tashkent, Semipalatinsk, and Omsk (Taylor 1941). Apparently the farthest east he travelled was when he visited Kuldja (or Kulja; also known as Gulja, Ining, and Yining), a Chinese city in western Sinkiang within ca. 50 miles from the Russian border. (A rather difficult-to-interpret map showing the routes of Hansen's several Asiatic trips was published in Hansen [1909]).

Even though the exact western Chinese range of *L. maackii* is uncertain, the species is not known to occur in that small portion of China visited by Hansen in 1897-1898 (Hsu and Wang 1988). The seeds he sent to Washington, then, must have come from some botanical garden, forestry station, or agricultural school/station in central or eastern Russia; he visited such establishments whenever he had the opportunity. For example, in August 1897 he was at the St. Petersburg Garden (U.S.D.A. 1899b); seeds of Amur honeysuckle certainly were available to him there from the stock maintained by the Garden for exchange.

Thinking that Hansen's seeds marked simply "from Russia" might have been obtained from St. Petersburg, we obtained a photocopy of the garden's 1899 *Delectus seminum* (the *Delectus* for 1897—the year of Hansen's visit there—and for 1898 were not available to us). The list (Hortus Botanicus

Imperialis Petropolitanus 1899) contains a most impressive number of entries—some 3000 of them; some of the species represented among Hansen's seeds are in the *Delectus*, but most are not. *Lonicera maackii* is there, as it is in the 1887 *Delectus*. St. Petersburg, then, could have been the source of Hansen's Amur honeysuckle seeds, but they could have come from some other locality in Russia.

After Hansen introduced Amur honeysuckle, the U.S.D.A. imported it from foreign countries and released it in the U.S. at least eight times through 1927 (Table 1). Some of the introductions were from British botanical gardens; others were collected from native habitats in Manchuria by U.S.D.A. employees. The success of this introduction effort was indicated by the fact that in 1931 Amur honeysuckle was available from at least eight commercial nurseries throughout the U.S. (Farrington 1931). The history of introduction published by the U.S.D.A. indicates that plants of the honeysuckle now naturalized throughout eastern U.S. represent a mixture of genotypes of diverse origins.

Beginning in the 1960s and culminating in five official introductions up to 1984, the U.S.D.A. Soil Conservation Service (S.C.S) sponsored a program to develop improved cultivars of Amur honeysuckle. It was hoped that these cultivars would further traditional goals of the S.C.S.: soil stabilization/reclamation and wildlife-habitat improvement. From plants already naturalized in various parts of the U.S., genotypes were selected for more abundant fruit production, propagated vegetatively, and then cultivated in seed production blocks at various plant materials centers around the country (Sharp and Belcher 1981). Seeds were made available by request. The most successful of these cultivars is 'Rem-Red' (Lorenz et al. 1989).

AMUR HONEYSUCKLE: ESCAPE AND NATURALIZATION

In the New World

The earliest hint we have located of the plant's escape in the New World is in archives of the Morton Arboretum near Chicago, which mention its weedy tendencies: "weed in arboretum since 1924, when first brought in" (Swink, pers. comm.). This early hint of the plant's decline in favor at Morton has accelerated toward a fall, the current situation there being well stated by Swink and Wilhelm (1994): "It would be difficult to exaggerate the weedy potential of this shrub." Floyd Swink has remarked to us that the spread of *L. maackii* in the arboretum is "unbelievable ... it would take a full-time worker to keep Amur honeysuckle and *Rhamnus cathartica* under control."

A host of full-time workers would be required to keep Amur honeysuckle "under control" in the Greater Cincinnati region (including far northern Kentucky) from which the plant was first reported for Ohio by E. Lucy

TABLE 1. A chronology of documented *L. maackii* introductions into North America.

Date	Seed or Plant Origin	Destination	Collector	Reference
1897	Spaeth Nurseries, Germany	Dominion Arboretum Ottawa, Canada	?	(Cole, pers. comm.)
1898	Russia	Washington, D.C.	N.E. Hansen	(U.S.D.A. 1899a)
1908	Chelsea, United Kingdom	Washington, D.C.	J. Veitch	(U.S.D.A. 1909)
1912	Kew, United Kingdom	Washington, D.C.	D. Prain	(U.S.D.A. 1913)
1913	Cambridge Botanic Garden	Washington, D.C.	R.I. Lynch	(U.S.D.A. 1914)
1916	Arnold Arboretum	Washington, D.C.	H.C. Skeels & D.W. Van Fleet	(U.S.D.A. 1921)
1921	Kew, United Kingdom	Washington, D.C.	D. Prain	(U.S.D.A. 1923)
1923	Echo and Tiehlingo, Manchuria	Washington, D.C.	A.D. Woeikoff	(U.S.D.A. 1926)
1926	Harbin, Manchuria	Washington, D.C.	P.H. Dorsett	(U.S.D.A. 1928)
1927	Shitoukhetsy, Manchuria	Washington, D.C.	I.V. Kosloff	(U.S.D.A. 1929)
1970	Maryland	New Jersey	W.C. Sharp	(U.S.D.A. 1981)
1979	United States	Mississippi	?	(U.S.D.A. 1982)
1980	Georgia	Texas	?	(U.S.D.A. 1983)
1983	Canada	North Dakota	?	(U.S.D.A. 1984)
1984	Maryland	Michigan	?	(U.S.D.A. 1985)

Braun (1961) only from Hamilton County, where it was "becoming abundant in pastures and woodlands." (As of October 1994 specimens have been collected in 34 Ohio counties [Trisel, pers. comm.]). In Greater Cincinnati the plant is now omnipresent, being by far the area's commonest shrub, native or alien. Efforts—in part thwarted by birds—are being made by various governmental agencies to eliminate the species from woodlands and other sites. The plant's establishment has been little short of phenomenal. The species is ubiquitous, and often abundant, on open slopes and in fencerows, pastures, prairies, thin woods, woodland borders, road rights-of-way, railroad yards, and waste places. When the junior author moved into his home in Alexandria (Campbell County, KY) in 1973, no Amur honeysuckle was on the property. Now hundreds of individuals are there.

We conducted a survey of selected botanical gardens and arboreta in the eastern United States and in eastern and western Canada. Although many botanists and arborists who responded noted that *L. maackii* was naturalized, the species was considered a problem weed only in the following localities: National Arboretum, DC; Morton Arboretum, IL; Butler University, IN; Bernheim Forest, KY; Matthei Botanical Gardens, MI; W.J. Beal Botanic Gardens, MI; Shaw Arboretum, MO; Morris Arboretum, PA; Core Arboretum, WV. The species may not be winter hardy at Edmonton and Montréal. Non-cultivated plants of Amur honeysuckle are currently known in at least 24 states of the eastern U.S. (Trisel and Gorchov 1994) and in Ontario (Pringle 1973).

The spread of Amur honeysuckle beyond the points of introduction is clearly facilitated by bird dispersal (Ingold and Craycraft 1983). Dirr (1990) noted that "birds deposit the seeds in old shrub borders, hedges, wasteland and before one knows it, Amur honeysuckle has taken over." Seed production is so prodigious, however, that most seeds simply fall to the soil. Such gravity dispersal, plus rainwash at least on slopes, is sufficient to allow seedling establishment at edges of existing colonies or individuals (Luken and Goessling 1995). Soil seedbanks as high as 1100 seeds/m^2 have been recorded (Luken and Mattimiro 1991).

Despite the published record of the plant's invasiveness, a U.S.D.A.-S.C.S. leaflet (Anonymous 1977) described Amur honeysuckle as a useful specimen plant for borders, hedges, and screens. Then followed the understatement that the species "may spread into old fields, fence rows and open woodland." Other sources (Anonymous 1980; Sharp 1970) asserted that the shrub has "no objectionable features." Amur honeysuckle is, unwisely, still recommended (Lorenz et al. 1989) and commercially available (e.g., Southmeadow Fruit Gardens 1994).

Not until the 1960s, after the shrub achieved some notoriety as a "weed" of concern in the U.S., did ecological studies of Amur honeysuckle begin. The data base on the species has been greatly augmented through research on population structure, productivity, interaction with herbivores, and community dynamics (Ingold and Craycraft 1983; Luken 1988; Luken and Goessling 1995; Williams et al. 1992). As yet, no definitive study has been undertaken to determine if invasion of Amur honeysuckle is directly linked to local changes in native floras.

Because of conservation goals calling for native species only, numerous prescriptions are now available for "control" of this species and for eliminating it from natural areas (Nyboer 1992). What is probably the nadir in the fall of Amur honeysuckle was reached in 1989 when the Illinois Department of Conservation adopted a policy mandating that no uses of the plant are acceptable in that state (Harty 1993).

In Europe

Even though *L. maackii* has been cultivated in Europe longer than in North America, we have seen no records of its naturalization or even of its weediness there. One possible explanation is that fruit production by the shrub in at least *western* Europe, especially in England, seems to be less predictable than it is in eastern North America. The original report of flowering of Amur honeysuckle in *eastern* Europe (Regel 1884) mentioned the fruit, but early *western* European accounts described flowers only—e.g., Belgium (Anonymous 1909), France (Mottet 1907), Germany (Purpus 1900; Schneider 1911), and Great Britain (Anonymous 1907a, 1907b, 1915).

An early report from Germany (Dippel 1889) noted the lack of fruit development. Not until 20 years after the species' introduction into Great Britain were the fruits described in British horticultural literature (e.g., Anonymous 1917). The fruiting habits of *L. maackii* in England were singled out for comment in two articles. The first cautioned that "no shrubby Honeysuckles can be depended on to fruit with the same constant profusion in our English climate as they do in the United States, where ... gardeners do not suffer from frosts after winter is over" (Thatcher 1922). The second mentioned that "as a fruiting shrub ... its merits are not so well known, but, apparently, in warm seasons and on certain soils it fruits abundantly and becomes a highly attractive plant in October" (Anonymous 1934). Another explanation may be the fact that *L. maackii* apparently is grown in Europe largely on estates or in botanical gardens where weediness is often simply not tolerated, any volunteer plants being quickly removed. Further, climatic differences between western Europe and eastern Asia/eastern North America may be such that potential for naturalization is suppressed.

HABITATS AND ASSOCIATED PLANTS

In Eastern Asia

In its Asiatic range, *L. maackii* occurs in "mixed forests" (North Korea; Kolbek and Kučera 1989); edges of montane deciduous forests, sometimes on calcareous rocks (Japan; Hara 1983; Iwatsuki et al. 1993); in oak- and elm-woodland (Amurland; Herder 1878; Ruprecht 1857); in xerophytic forests dominated by spinous-leaved oaks (northwestern Yunnan; Forrest 1915); in forests of *Abies delavayi*, *Picea yunnanensis* and other *Picea*, *Tsuga yunnanensis*, and species of *Acer*, *Prunus*, *Pyrus*, *Sorbus*, and *Tilia* (northwestern Yunnan; Forrest 1916); and forests of *Liriodendron chinense* (western China; Wilson 1913). In 1994 at Changbai Mountain Forest Research Station in northeastern China, the first author (JOL) found Amur honeysuckle growing exclusively in frequently disturbed floodplain forests with *Acer mono*, *Fraxinus mandschurica*, *Juglans mandshurica*, *Phellodendron amurense*, *Populus davidiana*, *Prunus padus*, *Syringa amurensis*, and *Ulmus propinqua*. In the lower elevation montane forest at Changbai, the species grew with *Larix princips*, *Quercus liaotungensis*, and *Tilia mandshurica*. According to Wang (1961) *L. maackii* was part of the undergrowth of shrubs in the "Montane-boreal Coniferous Forest of the Northeastern Province," which is characterized by *Abies holophylla*, *A. nephrolepis*, *Picea jezoensis*, *P. obovata*, and species of *Larix*, *Pinus*, and *Taxus*. Forrest (1915, 1916) and Wilson (1913) listed other woody associates in China: *Amelanchier asiatica*, *Berberis* sp., *Corylus* sp., *Crataegus cuneata*, *Deutzia* sp., *Diervilla* [*Weigela*] *japonica*, *Indigofera pendula*, *Ligustrum ionandrum*, *L. Henryi*, *L. ligustrina* forma *yunnanensis*, *Lonicera xerocalyx*, *Philadelphus* sp., *Rhamnus* sp., *Rosa sericea*, *Styrax hemsleyanus*, *Symplocos crataegoides*, *Viburnum tomentosum*, and *Wikstroemia* sp. Woeikoff (1941) remarked on the "enormous number" of species of *Lonicera*, including *L. maackii*, "in forests and on mountains of Manchuria."

In North America

As is the case with many successful introduced species, *L. maackii* thrives in communities with histories of human disturbance. Specifically, urban or exurban forests with histories of fragmentation, cattle grazing, or woodcutting are often heavily invaded. In such sites in northern Kentucky/southwestern Ohio *L. maackii* forms a dense understory and associates with *Acer saccharum*, *Celtis occidentalis*, *Fraxinus americana*, *Gleditsia triacanthos*, *Maclura pomifera*, *Prunus serotina*, *Quercus rubra*, *Robinia pseudoacacia*, and *Ulmus rubra* (Luken 1988, 1990; Williams et al. 1992; Yost et al. 1991). In large, closed canopy forests, *L. maackii* may be relegated to forest edges, suggesting moderate shade intolerance.

The plants are fully capable of thriving in full-sun environments. Productivity in open sites is higher than in forests (Luken 1988); open-grown plants also show strong resilience when cut repeatedly (Luken and Mattimiro 1991). Open sites heavily invaded by *L. maackii* may, after invasion, be converted to a scrub-type community. The understory in this scrub is often dominated by the grasses *Festuca arundinacea* and *Poa pratensis* and by introduced herbaceous species such as *Coronilla varia* and *Melilotus alba* (Luken and Thieret 1987; McClain and Anderson 1990).

AMUR HONEYSUCKLE IN FLORISTIC WORKS

Eastern Asia

Lonicera maackii is part of many publications on the flora of Japan, China, Korea, and far eastern Russia. The information available in these varies from mere mention in checklists to accounts with descriptions, ecological and morphological notes, and geographical data. Some works of the latter kind are, for Japan, those by Hara (1983), Iwatsuki et al. (1993), Kurata (1971), Nakai (1921b), and Ohwi (1965); for China, those by Hao (1934), Hsu and Wang (1984, 1988), Komarov (1907), and Noda (1971); for Korea, those by Kolbek and Kučera (1989), Lee (1989), and Nakai (1909, 1911, 1921a); and for Russia, those by Charkevicz (1987), Maximowicz (1878), Penkovsky (1901), Poyarkova (1958), and Vol'f' (1899). The earliest reports known to us from countries in the species' range are the following: Russia (Ruprecht 1857), China (Maximowicz 1878), Japan (Maximowicz 1878), and Korea (Palibin 1898).

North America

Documentation in North American floras of the plant's travels was surprisingly slow. Examples follow.

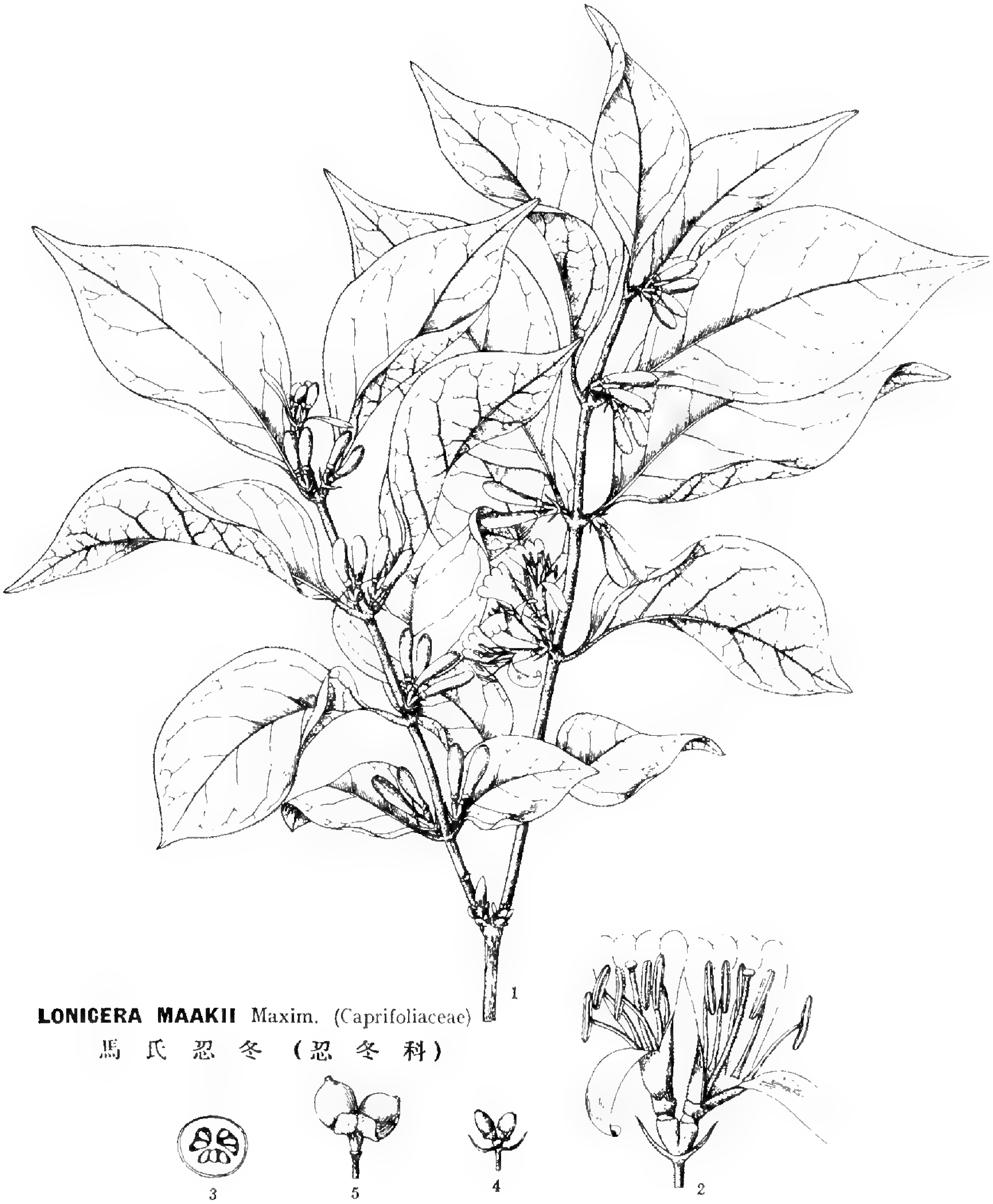

FIG. 3. Illustration of Amur honeysuckle (*Lonicera maackii*) from Hao (1934) in *Flore illustrée du nord de la Chine* (T.-n. Liou, ed.).

Although collected in Maryland as early as 1937, Amur honeysuckle is absent from *Gray's manual of botany* (Fernald 1950) and from *The new Britton and Brown illustrated flora of the northeastern United States and adjacent Canada* (Gleason 1952). Two decades later, in the Gleason and Cronquist (1963) *Manual*, it received passing mention—"it is becoming established in

Maryland"—but was not included in the key to species of *Lonicera*. By the 1991 edition of the *Manual* (Gleason and Cronquist 1991) it had been admitted and placed in the key as a full-fledged member of the flora: "escaped and becoming naturalized in our range, as in N.Y., Md., Ky., and Oh." (The species was not listed for New York just 5 years before [Mitchell 1986], even though herbarium records for that state indicate the presence of Amur honeysuckle there as early as 1954 [Trisel and Gorchov 1994]).

Amur honeysuckle was collected as early as 1966 in Virginia (Trisel and Gorchov 1994), but it is missing from the 1981 atlas of the Virginia flora (Harvill et al. 1981). In the 1992 edition (Harvill et al. 1992) it is listed from seven counties. The plant is "taking over people's back yards" in parts of Virginia (Luken, personal observation).

Some field guides, too, have been slow in recognizing the establishment of Amur honeysuckle in North America. For example, the plant is not to be seen in Petrides' field guide (Petrides 1986) to "all" trees, shrubs, and woody vines in the northeastern and central United States and adjacent Canada.

THE SPECIES

Morphology

Known also as bush honeysuckle, tree honeysuckle, Maack's honeysuckle, or even (through misinterpretation of the specific epithet), "Maacky's" honeysuckle (Darnell 1930), Amur honeysuckle is a robust, upright, multistemmed, deciduous shrub that can grow to 6 m tall, with stems to 15 cm in diameter near the base, and can attain a spread of 9 m (Doney 1947). The bark of the largest stems, longitudinally fissured, is dark gray to grayish brown. Long shoots can grow as much as 1.2 m in their first year and can bear some flowers. Short shoots develop from axils of long shoots; they flower freely. The branchlets are hollow. Dark green and lightly pubescent, the leaf blades average about 7 cm long; on fast-growing shoots they may reach 15 cm. Their acuminate apex is one of the species' distinguishing features. Distinctive, too, is the early leafing out of the species before that of associated deciduous-leaved plants and the persistence of the leaves in fall, sometimes into December (a few even into January) in central U.S.

The paired, axillary flowers (Fig. 3), produced in profusion especially on short shoots, are borne on peduncles 1.5 to 5 mm long (shorter than the subtending petioles); variation in peduncle length can be seen on a single branch. Five-lobed, the calyx is 2 to 3 mm long and eventually deciduous. Like those of some other honeysuckles, the white to pink corollas, 1.7 to 2.5 cm long, are two-lipped, the upper lip four-lobed, the lower lip entire. In age, the corollas become a dull yellow, a color change seen also in certain other species of *Lonicera*, e.g., *L. japonica*, *L. morrowii*, and *L. tatarica*.

Characteristics of the flowers make Amur honeysuckle a good bee plant. Unlike those of some other species of *Lonicera*, the "corolla tubes are short enough for honey bees to work successfully, and good nectar secretion takes place in cool, damp weather as well as under hot, dry conditions" (Clark 1984).

The twinned berries, admittedly one of the glories of the species, mature in fall. Ranging in diameter from 3.8 to 8.5 mm, they are glossy, translucent red (sometimes with a slight orange cast), and ± globose to somewhat ovoid or ellipsoid. To us they look much like red currants (*Ribes*). In mild seasons the fruits may persist, on leafless plants, until nearly Christmas in the Northern Kentucky/Cincinnati area.

The fruits of some honeysuckles have been reported to be toxic. In a study by Leveau et al. (1977) the fruits of eight species, including *L. maackii*, were found to "contain a small quantity of alkaloids, but saponosides seem to be responsible of [i.e., for] toxicity"; "immature fruits are more toxic than mature fruits" and "pericarps are much more toxic than seeds." Frohne and Pfänder (1984) suggested that, for problems to develop, about 30 fruits would have to be eaten, which is not likely to be done by people with functional taste buds—the fruits are exceedingly bitter.

A chromosome count of $2n = 18$ was published for *Lonicera maackii* var. *maackii* and for *L. maackii* var. *erubescens* (Janaki Ammal and Saunders 1953).

Horticultural Value

Its serious drawbacks in North America notwithstanding, Amur honeysuckle *is* a most handsome shrub, whether in flower or in fruit. It has been much extolled for horticultural purposes, as the following quotes attest. "Among all eastern Asiatic species [of *Lonicera*] *L. maackii* is the most beautiful" (Regel 1884). "There are few of the bush honeysuckles more beautiful than this variety" (Anonymous 1917). "... among the three best bush honeysuckles for the pleasure grounds and shrubbery borders" (Anonymous 1924). "... one of the most all-round beautiful members of an indispensable family" (Wilson 1929).

Its attractive foliage was singled out for special mention by some authors (e.g., Beezley 1939; Henry 1932; Purpus 1900). Alexander (1944) wrote that its "dark green foliage remains green until Christmas, thus rivalling some of the hollies in outdoor effect."

The fruiting habits of the plant have often been mentioned quite favorably: "Since it holds it fruit late into the winter it is a valuable addition to garden beauty when that beauty is limited" (Wilson 1925). "While nearly every other shrub is bare [*L. maackii*] stands out with its mantle of green studded with red berries strong and defiant" (Wilson 1925, 1928).

We assume that *L. maackii* has, by now, been widely distributed throughout the temperate horticultural world, even though we made no special effort to determine in what areas it is now grown. We did note, however, that it is cultivated in Italy (Cocker 1935), Japan (Kurata 1971), and New Zealand (Cook 1949). We have seen no published hints of the plant's weediness in any area other than North America.

Taxonomy

Authorship of the binomial *Lonicera maackii* has been controversial. Most authors cite Maximowicz as having made the combination *Lonicera maackii* in *Primitiae florae Amurensis* (Maximowicz 1859), but he did not validly publish such a new combination there. The binomial *Lonicera maackii* (Rupr.) Herder was validly published in 1864 (Herder 1864).

The first infraspecific taxon within *L. maackii* was described by Rehder (1903): *L. maackii* forma *podocarpa* Franchet ex Rehder. A plant of western and central China (Sargent 1913; Schneider 1911) introduced by Wilson in 1900 (Farrington 1931), it was said to differ from the typical form as follows: "Has the ovaries, together with the bractlets, on a short, stalk-like elongation raised above the bracts which gives the impression of a somewhat abnormal form, though it occurs in most Chinese specimens." Ten years later Rehder (1913) adopted varietal status for the taxon: *L. maackii* var. *podocarpa* (Franchet ex Rehder) Rehder, but in 1949 he returned to the status of forma (Rehder 1949a). Although a few authors have used the designation of forma (e.g., Anonymous 1929; Forrest 1916; Léveillé 1915-1916) most consider the taxon to be a variety (e.g., Bailey 1916; Bean 1914; Sargent 1913, 1922; Schneider 1911; Wilson 1913, 1917, 1925, 1928; Wyman 1962).

Variety *podocarpa* has been called "superior to the type" (Anonymous 1924), "especially fine" (Hadden 1925), and "a better flowerer" (Dirr 1990). Bonstedt (1932), in contrast, said of it that "it is not so beautiful as the species." According to Wyman (1962), "The chances are that [*L. maackii*] and its variety *podocarpa* are badly mixed in nurseries." Hsu and Wang (1988) wrote that the feature by means of which Rehder originally distinguished forma *podocarpa* shows continuous variation in the species and thus no evidence has been found to support recognition of the form. We, too, have noted that the feature is quite variable, even on a single individual, and so do not recognize this taxon.

A pink-flowered variant of *L. maackii*, described as forma *erubescens* by Rehder (1913), was said to have arisen from seeds collected by Wilson in China. The taxon is recognized as a form by some (e.g, Rehder 1949a; Sargent 1922) and as a variety by others (e.g., Alexander 1944; Bailey 1916; Hsu and Wang 1988; Royal Botanic Gardens, Kew 1934). We, however, do not recognize the variant at any rank because the corollas vary continuously from essentially pure white to a deep pink; all intergrades between these extremes can be found in a single population. Some of the pink individuals we have seen are an excellent match for the colored illustration of "var. *erubescens*" in *Addisonia* (Alexander 1944); others, however, are much more deeply pigmented.

According to Hara (1983), Japanese representatives of *L. maackii* "seem to differ slightly from the [East Siberian] plants ecophysiologically. When planted side by side in Tokyo, the East Siberian plants grow more vigorously bearing larger leaves with slightly impressed nerves, and flower and fruit much earlier, as compared with the Japanese plants." Earlier, Nakai (1938) had proposed a varietal name for Japanese plants but did not publish it validly. And most recently Iwatsuki et al. (1993) did not recognize any infraspecific taxa for the Japanese representatives of the species.

Accordingly, synonymy for Amur honeysuckle is as follows:

Lonicera maackii (Ruprecht) Herder, Bull. Soc. Imp. Nat. Moscou 37(1):204. 1864.

Xylosteum maackii Ruprecht, Bull. Cl. Phys.-Math. Acad. Imp. Sci. St.-Pétersbourg 15:369. 1857; *Caprifolium maackii* (Rupr.) Kuntze, Rev. Gen. Plant. 1:274. 1891; *L. maackii* forma *podocarpa* Franchet ex Rehder, Ann. Rept. Missouri Bot. Gard. 14:141. 1903; *L. maackii* var. *podocarpa* (Franchet ex Rehder) Rehder, Mitt. Deutsch. Dendrol. Ges. 1913:263. 1913; *L. maackii* forma *erubescens* Rehder, Mitt. Deutsch. Dendrol. Ges. 1913:263. 1913; *L. maackii* var. *erubescens* (Rehder) Rehder in Bailey, Standard Cycl. Hort. 4:1910. 1916.

CONCLUSION: FROM COMMENDATION TO CONDEMNATION

The ascent of Amur honeysuckle began when the species was introduced from eastern Asia to St. Petersburg, where it first flowered in Europe. Because of its attractive flowers and fruits, it was soon disseminated via diverse channels to other parts of Europe and to North America where, as a new introduction, it won great praise. In the New World its decline in favor began once its weedy, aggressive, and invasive nature came to the fore. Though still touted—and even sold—by some for conservation or wildlife purposes, the shrub has fallen from grace rather recently when various authors warned that it should not be planted and a U.S. state even proscribed its use.

The story of Amur honeysuckle recalls the stories of other Old World woody plants introduced into temperate eastern North America, only to become naturalized and often troublesome. Coming immediately to mind are *Ailanthus altissima*, *Celastrus orbiculata*, *Elaeagnus umbellata*, *Lonicera japonica*, *Rhamnus cathartica*, *Rosa multiflora*, and *Ulmus pumila*. One can but assume that the saga of introduction/naturalization, sometimes with unfortunate consequences, will be a continuing one.

AFTERWORD

We close our account of Amur honeysuckle with mention of the passing, some 6 decades ago, of E.H. "Chinese" Wilson, the man responsible for the "effective" introduction to Great Britain of the species—and of others that have found their way into western horticulture. On 15 October 1930 he and his wife were killed in an automobile accident near Boston (Tozer 1994). At the double funeral service, the caskets were covered in floral tributes representing some of Wilson's introductions (Briggs 1993). Among these tributes were fruiting branches of *Lonicera maackii*.

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BOOK NOTICES

COMMITTEE ON MANAGING GLOBAL GENETIC RESOURCES. 1993. **Managing Global Genetic Resources. Agricultural Crop Issues and Policies.** (ISBN 0-309-04430-8, hbk.). National Academy of Sciences Press, 2101 Constitution Avenue, N.W., Washington, D.C. 20418, (202) 334-3180. $49.95. 449 pp., 6 × 9.

"*Managing Global Genetic Resources. Agricultural Crop Issues and Policies* examines the structure that underlies efforts to preserve genetic material, including the worldwide network of genetic collections, the role of biotechnology, and a host of scientific, institutional, legal, economic, and political issues that surround management and use. The Executive Summary, with the committee's major recommendations; an Overview, which introduces the subject for those readers without a background in genetic conservation; and two parts. Part one addresses basic science issues and entails Chapters 1 to 10. Part two addresses policy issues and entails Chapters 11 to 15." The 15 chapters are: 1) Genetic Vulnerability and Crop Diversity; 2) Crop Diversity: Institutional Responses; 3) In Situ Conservation of Genetic Resources; 4) The Science of Collecting Genetic Resources; 5) The Science of Managing Genetic Resources; 6) Using Genetic Resources; 7) Biotechnology and Germplasm Conservation; 8) Documentation of Genetic Resources; 9) The Conservation of Genetic Stock Collections; 10) The Genetic Resources of Microorganisms; 11) Exchange of Genetic Resources: Quarantine; 12) Exchange of Genetic Resources: Proprietary Rights; 13) Genetic Resources: Assessing Economic Value, 140 Conflicts Over Ownership, Management, and Use; and 15) National and International Programs.

PRIMACK, RICHARD B., 1993. **Essentials of Conservation Biology.** (ISBN 0-87893-722-6, hbk.). Sinauer Associates, Inc., Sunderland, Massachusetts 01375, U.S.A. 564 pp.

This elegant text provides a well-organized and comprehensive summary of the primary issues as well as the biological and economic principles involved in the new discipline of conservation biology. The text opens with concise discussions of the origins of the discipline and definitions of key terms. Concluding chapters review the applications of conservation biology principles to problems of the effective management of habitat and remnant reserves as well as human dominated lands and degraded lands to be restored.

Essentials of Conservation Biology will be useful in undergraduate introductory courses. Abundant use is made of interesting worldwide case examples in the narratives as well as in side boxes. The frequent figures are clear and well-selected to illustrate the narrative. Lists of suggested readings are provided at the end of each chapter. Talented teachers of conservation biology, who usually represent a wide interdisciplinary background and deep personal commitment, will find this text an important foundation upon which to customize their courses. —*Lawrence D. Ford.*

A SYNOPSIS OF THE GENUS *CLUSIA* SECTIONS *CRIUVOPSIS* AND *BRACHYSTEMON* (CLUSIACEAE) IN NORTHERN SOUTH AMERICA

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ABSTRACT

The genus *Clusia* sections *Criuvopsis* and *Brachystemon* are revised, in preparation for a treatment of the Clusiaceae for *Flora of the Venezuelan Guayana* and *Flora de Colombia*. Amplified descriptions, keys to the species and lectotypifications are provided for each section. In *Clusia* section *Criuvopsis*, 3 species are recognized, of which one, *Clusia araracuarae*, is described as new, illustrated, and its phylogenetic relationships discussed. Amplified descriptions, illustrations and discussions of phylogenetic relationships are provided for *Clusia amazonica* and *C. martiana*. *Clusia oedematopoidea* is reduced to synonymy under *C. amazonica*, and *C. uleana* under *C.martiana*. In *Clusia* section *Brachystemon*, 3 taxa are recognized, of which one, *Clusia aymardii*, is described as new, illustrated, and its phylogenetic relationships are discussed. Amplified descriptions and discussions of phylogenetic relationships are provided for *Clusia spathulaefolia* and *C. penduliflora*.

RESUMEN

Como resultado de investigaciones para preparar un tratamiento taxonómico del género *Clusia* para *Flora of the Venezuelan Guayana* y *Flora de Colombia*, se presenta una revisión de las secciones *Criuvopsis* y *Brachystemon*. Se presentan descripciones actualizadas para las dos secciónes, claves para separar sus especies, y se lectotipifiquen.. Se reconoce tres especies en la sección *Criuvopsis*, entre las cuales, *C. araracuare*, se describe como especie nueva, se ilustra, y se discute su parentesco. Se provee descripciones ampliadas, ilustraciones y comentarios sobre relaciones filogenéticas para *Clusia amazonica*,y *C. martiana*. Se relega *C. oedematopoidea* a sinonímia bajo *C. amazonica* y, a *C. uleana* bajo *C. martiana*. In sección *Brachystemon*, se reconoce tres especies, entre las cuales, *C. aymardii* se describe como especie nueva, se ilustra, y se discute su parentesco. También, se provee descripciones ampliadas, y comentarios sobre relaciones filogenéticas para *C. spathulaefolia* y *C. penduliflora*.

INTRODUCTION

The genus *Clusia* Linnaeus contains over 250 species (with 336 names), distributed throughout the Neotropics, with two, *C. rosea* Jacquin, and *C. minor* Linnaeus, widely cultivated throughout the tropics. Despite taxo-

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nomic overdescription, it is estimated that there are at least an additional 40 as yet undescribed species in the Andes of Colombia, Ecuador, Peru and Bolivia, particularly in the premontane, montane (including ceja de selva), subpáramo, páramo and jalca habitats. The genus is easily recognized by its capsular, septicidally dehiscent fruits, with few to numerous stamens, and copious cream, yellow or white latex. Characters traditionally used to define the sections of the genus include the structure of the androecium in staminate flowers, and corresponding structure of the stigmas and staminodes of the pistillate. The last comprehensive revision was that of Vesque (1893), in which Engler's (1888) classification was simplified. The taxonomy of the group is difficult owing to its sexual lability, with staminate, pistillate, bisexual (Hammel 1986) and apomictic (Hammel 1986; Maguire 1976) individuals known. In addition, I have seen staminate flowers on reiterative (sensu Hallé et al. 1978) shoots of otherwise functionally pistillate plants in *Clusia pusilla* Steyermark and in *C. grandiflora* Splitgerber, in the Pakaraima Mountains of Guyana and on the Chimantá Massif complex of tepuis in the eastern portion of the state of Bolívar, Venezuela.

While preparing a diagnostic treatment of the genus for the *Flora of the Venezuelan Guayana* and a more comprehensive one for *Flora de Colombia*, sections *Criuvopsis* and *Brachystemon* were revised. These two sections form a natural group, closely related to section *Criuva* Bentham. Engler (1893) considered both sections *Criuvopsis* and *Brachystemon* to be subsections within subgenus *Criuva* sensu Bentham (1862). In fact, this study grew out of the difficulty in distinguishing young plants of *Clusia* (*Brachystemon*) *penduliflora* from *C.* (*Criuvopsis*) *martiana*. Because the formats of the floristic treatments in preparation do not allow for complete descriptions and synonymy, the present treatment is intended to provide data for the groups over their entire range, until a more comprehensive revision is prepared.

TAXONOMIC TREATMENT

Clusia L. section **Criuvopsis** Planchon and Triana, Ann. Sci. Nat., Ser. 4 13:322. 1860. Lectotype Species (here designated): *Clusia amazonica* Planchon and Triana, Ann. Sci. Nat., Ser. 4 13:358. 1860.

Clusia section *Criuva* Bentham and Hooker, subsection *Criuvopsis* (Planchon and Triana) Engler, Fl. Bras. 12(1):401. 1888. J. Vesque in A. DC and DC, Monogr. Phan. 8:77. 1893.

Clusia subgenus *Criuva* (Bentham and Hooker) Engler, section *Criuvopsis* (Planchon and Triana) Engler, Nat. Pflanzenfam. 3(6):225. 1895.

Glabrous lianas or hemiepiphytes; latex white to translucent. Leaves petiolate. Inflorescence a terminal panicle, the flowers cymose; secondary inflorescence bracts 2, coriaceous; bracteoles 4, decussate, coriaceous. Perianth spreading; sepals 4–5, chartaceous, opposite the petals; petals 5, contorted, very thickly carnose; androphore pentagonal, stamens numerous, the filaments short, flat, apically free, connate at the base, fleshy, often thickened at the base; anthers basifixed, muticous, equalling or slightly longer than the filaments, truncate to emarginate apically, dehiscent by longitudinal slits; pistillode absent, the central receptacle resiniferous or not. Pistillate inflorescence and flowers as in staminate, but staminodia 5, free, linear, with vestigial anthers; carpels 5, stigmas thin, elliptic to oblong, peltate; ovules horizontally ascending;. Fruit a capsule, ovoid to oblongoid, stigma and styles persistent.

Distribution.—Three species, distributed from Panama to Colombia, Venezuela, Ecuador, Peru, Bolivia and Amazonian Brazil.

Clusia section *Criuvopsis* appears to be most closely related to *C.* section *Brachystemon* by virtue of its short, thick filaments of the fertile stamens, sessile stigmas, and linear anthers deshiscent by longitudinal slits. However, section *Criuvopsis* may be easily distinguished from section *Brachystemon* by the flat filaments connate basally, and very thin inflorescence rachises.

KEY TO SPECIES OF *CLUSIA* SECTION *CRIUVOPSIS*

1. Leaf blades oblong, bullate; sepals 4; petals 5; anthers rounded to slightly emarginate apically and basally .... 1. *C. araracuarae*
1. Leaf blades obovate to elliptic, smooth; sepals 5, petals 5; anthers muticous.
    2. Leaf base obtuse to broadly rounded, leaves coriaceous, adaxial latex canals inconspicuous, adaxial venation and submarginal collecting vein prominent; liana. .... 2. *C. amazonica*
    2. Leaf base acute to cuneate, leaves subcoriaceous, adaxial latex canals highly conspicuous, adaxial venation inconspicuous, submarginal collecting vein barely discernible; scandent, epiphytic shrub, at times appearing lianous .... 3. *C. martiana*

1. **Clusia araracuarae** Pipoly, sp. nov. (Fig. 1)

Propter lamina coriacea ad bases obtusa vel late rotundata, nervos secundarios conspicuous necnon nervo submarginale conjunctos, *C. amazonicae* valde arcte affinis, sed ab ea laminis oblongis (non obovatis vel ellipticis), necnon bullatis (nec laevibus), sepalis 4 (non 5), tandem antheris ad apices basesque emarginatis vel rotundatis (non muticis), praeclare distat.

Scandent lianous shrub, to 23 m long, 4 cm diam. glabrous; branchlets tetragonal in cross section, squarrose, 3–5 mm diam., bark of apical portions rufous, appearing scaly, checking transversely, gray at maturity, rugose, latex white, copious. Leaves decussate; blades coriaceous, oblong, (8)13–18 cm long, (2.5–)3–3.5(–4) cm wide, apex abruptly acuminate to rostrate, base widely rounded to truncate, deeply bullate, nitid above at first, then pallid above and below at maturity, midrib deeply impressed above, prominently raised below, secondary veins 17–32 pairs, perpendicular to midrib, deeply impressed above, prominently raised below, united by a prominent

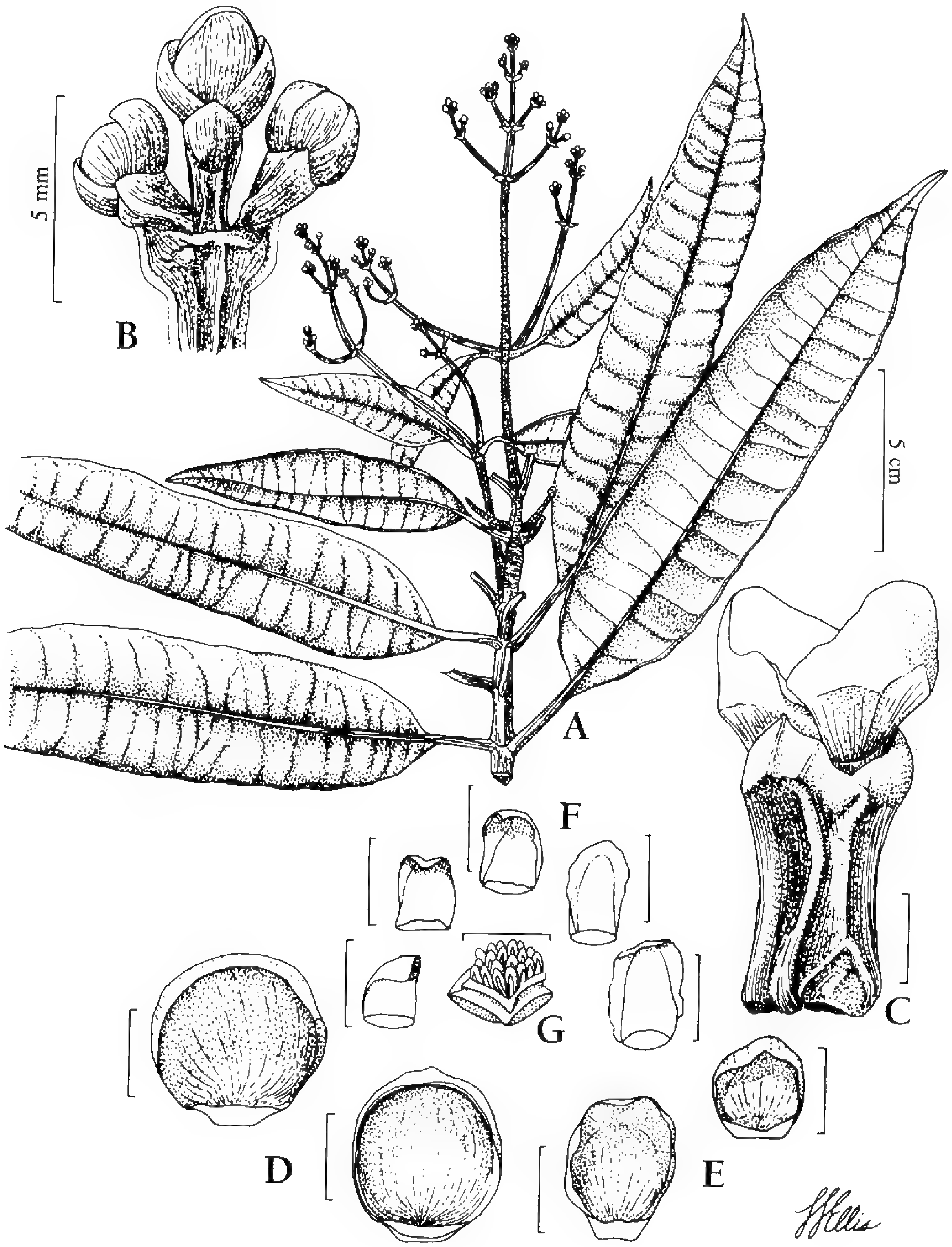

FIG. 1. *Clusia araracuarae* Pipoly. A. Habit, showing the oblong, bullate leaves. B. Closeup of cyme, showing callose keels of bracteoles. C. Quadrate pedicel. D. Outer sepals. E. Inner sepals. F. Petals. G. Androecium, showing pentagonal morphology and apically rounded anthers. A–G, drawn from holotype.

submarginal collecting vein, latex canals linear, conspicuous, margin revolute, entire; petioles deeply canaliculate, 2.5–2.8 mm long, glabrous. Staminate inflorescence terminal, erect, pyramidally paniculate, 7–9 cm long and 5–7 cm wide in bud, the branches cymose, flowers in 3's; peduncle 3.5–5 cm long, subtended by two reduced leaves similar to vegetative leaves but 3–5 cm long, 1.4–1.8 cm wide; secondary inflorescence bracts carnose, depressed-ovate, 1.3–1.6 mm long, 1.6–1.8 mm wide, apex rounded, medially carinate, the margin opaque, not scarious, entire; pedicel squarrose, 2.8–4.2 mm long; bracteoles four, 2 decussate pairs, carnose, depressed-ovate to suborbicular, apex obtuse, carinate medially, the keel callose, hyaline, the margin entire, glabrous, the outer 2–2.5 mm long, 2.3–2.6 mm wide, the inner 2.5–3 mm long and wide. Staminate flower buds cream; outer sepals 2, opposite, coriaceous, orbicular, 2.3–6 mm long and wide, apex very widely rounded, cucullate, hyaline except apically, the margin entire; inner sepals 2, decussate to the outer ones, coriaceous, as outer sepals but reddish, hyaline apically; petals 5, contorted, carnose, oblong, 0.8–1.1 mm long, 0.4–0.6 mm wide in bud; androphore convex, pentagonal as seen from above; stamens numerous, 0.9–1 mm high, the filaments flat, 0.6–0.8 mm long, the anthers linear, 0.1–0.2 mm long, emarginate or rounded apically and basally; pistillode absent, not resiniferous. Pistillate inflorescence unknown. Fruit unknown.

TYPE: COLOMBIA. AMAZONAS: Araracuara, along Río Caquetá, right bank, 3 km above Sumaeta, 0°36'S, 72°10'W, riparian floodplain, 200–300 m, 30 Sep 1990 (stam. fl bud), *E. Alvarez, A.C. Londoño, A. Rodríguez, & F. Moreno 116* (HOLOTYPE: COAH!; ISOTYPE: NY!).

Distribution.—Known only from the type.

Ecology and conservation status.—*Clusia araracuarae* occurs in Igapó vegetation (Prance 1979), forming mats in canopies of trees along black water river margins. The area in which this species occurs is subject to extreme disturbance owing to forest destruction, largely for firewood. Araracuara is a significant population center and busy port on the Río Caquetá, and therefore, this species should be considered threatened.

The long inflorescences, lianous habit, leaves with prominent secondary venation and submarginal collecting vein and obtuse to broadly rounded bases, indicate that *Clusia araracuarae* is most closely related to *Clusia amazonica*. However, the bullate leaf blades, fewer sepals, and anthers that are rounded to emarginate apically and basally clearly set *C. araracuarae* apart.

2. **Clusia amazonica** Planchon and Triana, Ann. Sci. Nat., Ser. 4 13:358. 1860. (Fig. 2). TYPE. BRAZIL. AMAZONAS: near Panure along the Rio Uaupes, Oct 1852–Jan 1853 (stam. fl), *R. Spruce 2878* (HOLOTYPE: P!; NY Neg. 5033; ISOTYPE: P!; NY Neg. 5034).

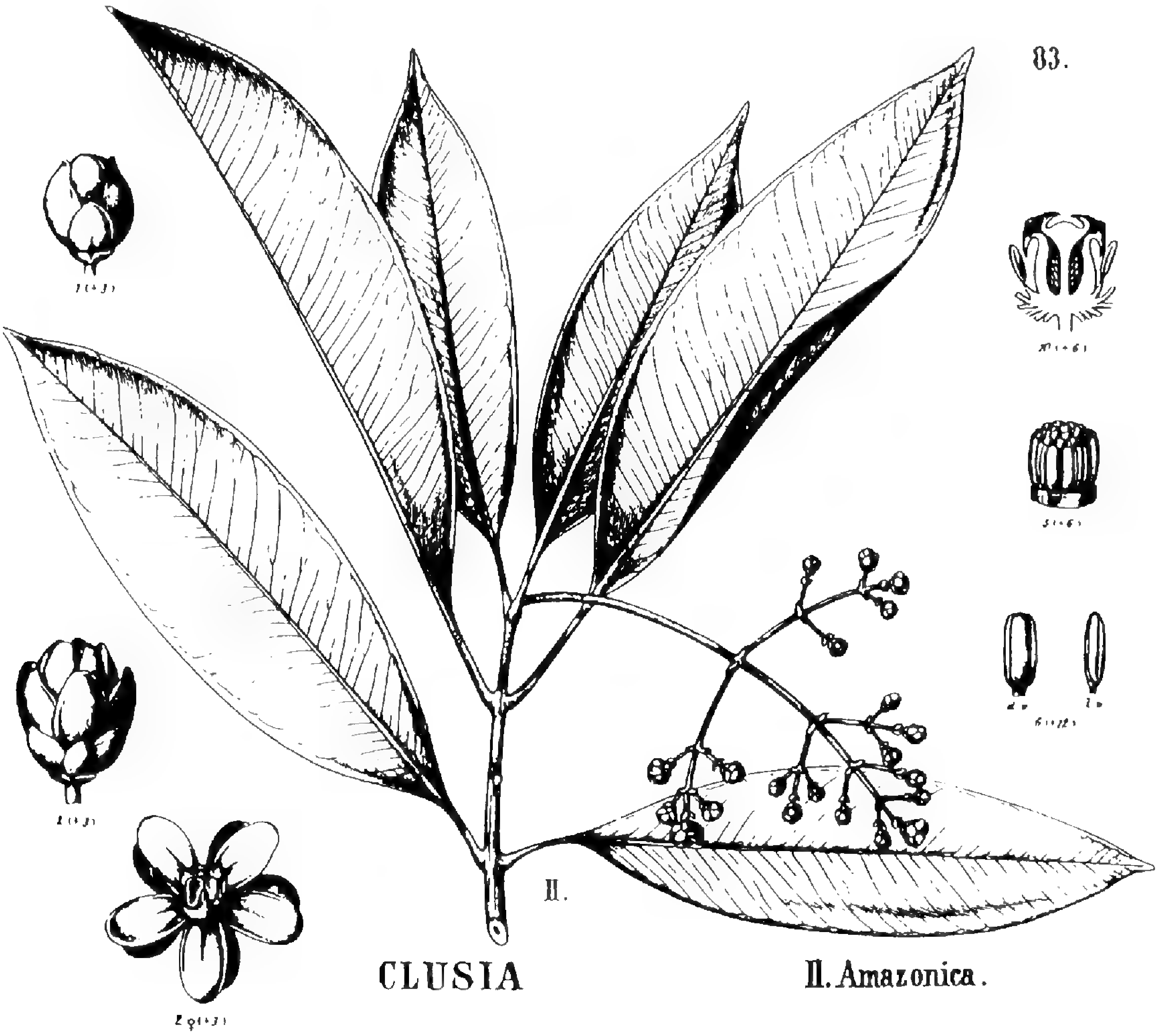

FIG. 2. *Clusia amazonica* Planchon et Triana. Habit (center); staminate bud, pistillate flower bud, pistillate flower, stamens in abaxial and lateral views, androecium, and longisection through pistillate flower (counterclockwise, from upper left). Adapted from Engler in Martius, *Flora Brasiliensis*, 12: Plate 83.

Clusia oedematopoidea Maguire, Phytologia 39:73. 1978. TYPE. PANAMA. PANAMA: *J. Duke 13557* (HOLOTYPE: NY; ISOTYPE: MO!).

Liana; branchlets tetragonal in cross section, squarrose, (2.5–)3–5.5(–7) mm diam., bark of apical portions rufous, appearing scaly, checking transversely and exfoliate, beige at maturity, rugose; latex white, copious. Leaves decussate; blades coriaceous, oblong, elliptic or rarely obovate, (8.0–)10.5–20.0(–26.0) cm long, (3.5–)4.0–4.6–10.5(–12.2) cm wide, apex broadly rounded, with an abruptly short-acuminate tip, the acumen 0.5–1 cm, base obtuse to broadly rounded, not decurrent on the petiole, smooth, sordid above, pallid below, latex canals varying in conspicuousness above, but never readily visible without maginification below, midrib prominently raised above and below, secondary veins numerous, prominently raised above, slightly raised below, united by a fine submarginal collecting vein, the margin subrevolute, entire, glabrous; petioles canaliculate, (2.1–)2.7–4.0 (–5.8) cm long. Inflorescence terminal, erect, pyramidally paniculate, (6–) 12–24 cm long, 6–10 cm wide at maturity, the flowers cymose, 3 per cyme; peduncle (2–)4–8(–11.5) cm long, subtended by normal leaves; secondary bracts coriaceous, very widely ovate, 1.5–2.5 mm long, 1.5–2 mm wide, apex obtuse to rounded, carinate, the margin hyaline, scarious, entire. Staminate inflorescence with tetragonal pedicels, 3–5 mm long; bracteoles 4, decussate, the outer 2 coriaceous, very widely ovate, 1.5–2.5 mm long, 1.5–2 mm wide, apex obtuse to rounded, carinate, the margin hyaline, scarious, entire, the inner 2 suborbicular to orbicular, 2.5–3 cm long and wide, apex rounded, flat, the margins entire, hyaline, scarious. Staminate flowers white; sepals 5, contorted, membranaceous, brittle, suborbicular to orbicular, 5–6 mm long and wide, apex broadly rounded, translucent, densely lineate, the margin hyaline, scarious; petals 5, contorted, carnose, somewhat cucullate, oblong, 3.5–4 mm long, 2.5–3 mm wide, apex obtuse to rounded, somewhat cucullate, densely lineate, the margin hyaline; androphore flat or slightly concave, pentagonal, the stamens numerous, free, 2.5–3.5(–3.7) mm long at maturity, the filaments short, flattened, ca. 1–1.2 mm long, the anthers linear, 1.5–2.5 mm long, 0.7–1 mm wide, apex truncate, base truncate, dehiscent by wide longitudinal slits, abruptly expanding at base to filament, the connective flat, darkened; pistillode obsolete, resin scanty. Pistillate inflorescence as in staminate but (1.5–)2–3(–5) mm long; outer bracteoles deltate, 1.8–2 mm long and wide; inner bracteoles oblate, 2.7–3.5 mm long, 3–3.7 mm wide. Pistillate flowers white, as in staminate but sepals orbicular, 6–7 mm long and wide; petals strongly cucullate, 6–6.5 mm long, 3.5–4 mm wide, staminodes 5, flat, 2.5–3.5 mm long, the filament ca. 1 mm long, abruptly tapering at apex, the anther linear, ca. 1.5–2.5 mm long, apex broadly rounded, not well-differentiated from apex of filament, the thecae not fully differentiated and devoid of pollen, the connective darkened; pistil 3–5 mm long, 4–6 mm wide; carpels 5; styles absent, stigmas thinly coriaceous, suborbicular, peltate, 1.5–2 mm long and wide, thickening with age, flat in early ontogeny, convex at maturity; ovules numerous. Fruit yellowish-cream, suffused with purple along the carpel sutures, oblongoid, 2–3.5 cm long, 1.5–2.5 cm diam.

Common name.—"Jubaga bakoko" (Mui language, Colombia)

Distribution.—From lowlands of central Panama southward along the Pacific coast of Colombia (Chocó Floristic Province), along and below the western slopes of the Andean Cordillera Occidental of Ecuador, eastward through the Amazon Basin of Colombia and Brazil, and south-southwestward through the Amazon Basin of Ecuador, Peru and Bolivia, 100–400 (–1,690) m elevation.

Ecology and conservation status.—*Clusia amazonica* is a riparian species, tolerant of moderate amounts of disturbance but not capable of surviving long periods of indundation. It usually occurs high enough up in the canopy to permit some of the foliage to remain above periodic floodwaters. It occurs in várzea, igapó, tahuampa and other periodically inundated habitats. Unlike *Clusia martiana*, *C. amazonica* spends its entire life as a liana, and does not form large mats over the canopies of the trees. It is only very locally common, but is not considered threatened.

Specimens examined. **COLOMBIA**. Amazonas: Río Caquetá River Basin, 00°50'S, 71°50'W, 20 Nov 1991 (ster.), *J. Duivenvoorden et al. 1259* (BRIT, COAH, COL, U); Mpio. Leticia, 03°47'S, 70°15'W, 100 m, 14 Apr 1991 (fr), *J. Pipoly 15398* (BRIT, COL, FMB, MO); Antioquia: Mpio. San Francisco, Corregimiento Aquitania, Finca La Ilusión, 1,200–1,500 m, 2 Apr 1992 (stam. fl; pist. fr- mixed coll.), *R. Fonnegra et al. 4129* (BRIT, COL, HUA, JAUM, MO). **VENEZUELA**. Amazonas: Depto. Atabapo, along Río Cunucunuma, near Culebra, 03°44'N, 65°44'W, 210 m, 15–16 Feb 1985 (stam. fl), *R. Liesner 17516* (MO, VEN), (fr), *R. Liesner 17535* (BRIT, MO, VEN); Salto Yureba, Caño Yureba, Bajo Ventuari, 04°03'N, 66°01'W, 120–150 m, 4 Nov 1981 (stam. fl bud), *F. Delascio & F. Guánchez 10841* (MO, NY, US, VEN), 350 m, 15–16 Mar 1985 (pist. fl, fr), *R. Liesner 18755* (MO, VEN); Depto. Atures, near Remo Camp, 04°34'N, 67°18'W, 180 m, Jun 1989 (fr), *E. Foldats & J. Velazco 9580* (MO, PORT, VEN); Depto. Casiquiare, 12 km SE of San Fernando de Atabapo, Sector "El Pozo," CVG Experiment Station, 03°50'N, 67°47'W, 110 m, 10–16 Feb 1988 (pist. fl), *G. Aymard et al. 6391* (MO, PORT, VEN); *G. Aymard et al. 6404* (MO, PORT, VEN); Depto. Río Negro, Cerro de la Neblina, vicinity of base camp along Río Mawarinuma, afluent of Río Baria, 00°50'N, 66°10'W, 110–130 m, 8–10 Jan 1984 (stam. fl bud), *J. Steyermark & J. Luteyn 129759* (F, MO, NY, US, VEN); Margins of Río Gavilán, between Raudal Gavilancito and Cerro Pelón, 05°37'N, 67°22'W, 80–120 m, 10–11 Feb 1992 (pist. fl), *G. Romero et al. 2373* (AMES, MO, VEN). **ECUADOR**. Esmeraldas: Ecological Reserve Cotocachi-Cayapas, Parroquia Luís Vargas Torres, Río Santiago, Pote Salt Marsh, 00°49'N, 78°45'W, 250 m, 23–27 Oct 1993 (fr), *M. Tirado et al. 539* (BRIT, QCNE, MO). Napo: Cantón Orellana, Parque Nacional Yasuní, "Maxus" road and oil pipeline, km 20, 00°33'S, 76°30'W, 250 m, 11–15 Aug 1993 (pist. fl bud), *M. Aulestia 306* (BRIT, MO, QCNE); Conoco oil well "Amo II," 00°52'S, 76°05'W, 230 m, 29–30 Mar 1988 (fr), *F. Covello 152* (BRIT, MO, QCNE); Cantón Tena, Jatun Sacha Biological Station, Río Napo, 8 km E of Misahuallí, 01°04'S, 77°36'W, 450 m, 20 Jan 1990 (fr), *C. Cerón 8386* (BRIT, MO, QCNE), 22–24 Feb 1988 (fr), *W. Palacios 2489* (BRIT, MO, QCNE), 400 m, 17–28 May 1989 (fr), *W. Palacios 4224* (BRIT, MO, QCNE), 17–28 May 1989 (fr), *W. Palacios 4307* (BRIT, MO, QCNE), 6 May 1990 (fr), *W. Palacios et al. 4954* (BRIT, MO, QCNE), 13 May 1990 (fr), *W. Palacios & E. Freire 5105* (BRIT, MO, QCNE). 14 May 1990 (fr), *W. Palacios & E. Freire 5145* (BRIT, MO, QCNE), Permanent Inventory along Río Chiguipino, 450 m, 22 May 1992 (fr), *E. Guidiño & J. Zuleta 1660* (BRIT, MO, QCNE). Pastaza: Cantón Pastaza, "Masaramu" oil well, of UNOCAL, 40 km NNW of Montalvo, 00°44'S, 76°52'W, 400 m, 1–16 May 1990 (fr), *E. Guidiño 362* (BRIT, MO, QCNE); PetroCanada road, Via Auca, 115 km S of Coca, 5 km S of Río Tigüino, 01°15'S, 76°55'W, 320 m, 26–31 Jan 1989 (fr), *D. Neill & F. Hurtado 8749* (BRIT, MO, QCNE), 1–6 Mar 1989 (ster.), *V. Zak 4119* (BRIT, MO, QCNE). Sucumbios: Cantón Gonzalo Pizarro, Campo Bermejo No. 6 Norte, 30 km NE of Lago Agrio, 00°14'N, 77°13'W, 1,050 m, 23 Mar 1990 (fr), *C. Cerón 9227* (BRIT, MO, QCNE). **PERU**. Loreto: Prov. Maynas; Allpahuayo, Institute of Amazonian Investigations (IIAP) Experimental

Station, 04°10'S, 73°30'W, 150–180 m, Permanent Inventory, Plot A, Subplot 10, Nov 1991 (stam. fl), *R. Vásquez & N. Jaramillo 14830* (AMAZ, BRIT, MO, USM), 27 May 1991 (ster.), *R. Vásquez & N. Jaramillo 16618* (AMAZ, BRIT, MO, USM); Dtto. Fernando Lores, Caserío Serafín, Quebrada Tamshiyacu, from Caserío Serafín to Caserío Constancia, 125–130 m, 10 May 1991 (fr), *C. Grández et al. 2606* (AMAZ, BRIT, MO, USM); Dtto. Iquitos, 1977 (stam. fl), *J. Revilla 3312* (AMAZ, BRIT, F, MO, USM); Casería Mishana, Río Nanay, right bank, 20 Dec 1976 (stam. fl), *J. Revilla 89* (AMAZ, F, MO, USM); Río Yarapa, 04°20'S, 73°30'W, 122 m, 20 Nov 1989 (stam. fl bud), *C. Grández & J. Tapullima 1466* (AMAZ, MO, USM). **BOLIVIA**. Beni: Prov. Ballivian, Carinavi-San Borja Hwy, E side of Serranía del Pilón Lajas, 15°13'S, 67°03'W, 850 m, 2 Nov 1989 (fr), *D. Smith & V. García 13865* (LPB, MO). La Paz: Prov. Nor Yungas, near Yolosa, at entrance to road to Chairo, 2 km from Chairo, 2,430 m, 5 Sep 1987 (pist. fl), *S. Beck 12969* (LPB, MO); Prov. Morillo, Valle de Zongo, along trail from end of road at the Cahua Power Plant, 1,660–1,690 m, 23 Nov 1980 (pist. fl), *T. Croat 51413* (LPB, MO), 16°05'S, 68°03'W, 1,400–1,600 m, 22 Apr 1982 (fr), *J. Solomon 7491* (LPB, MO). **BRAZIL**. Amazonas: Alto Rio Solimões, Mpio. de São Paulo de Olivença, plateau S of city, road to Bom Fim, 25 Nov 1986 (stam. fl), *C. Cid et al. 8552-A* (BRIT, IAN, INPA, MG, NY). Pará:Ilha do Marajó, Rio Mocões, 2 km upriver from Anajás, 00°57'S, 49°56'W, 13 Nov 1987 (fr), *S. Beck et al. 484* (BRIT, INPA, MG, NY), center of Iha Marajó, 27 Oct 1984 (stam. fl), *G. Sobel et al. 4829* (BRIT, INPA, MG, NY). Rondônia : 28 km from Vilhena on road to Colorado, 13°00'S, 60°00'W, 29 Oct 1979 (fr), *B. Nelson et al. 330* (BRIT, IAN, INPA, MG, NY).

Clusia amazonica is most closely related to *C. araracuarae,* but is readily distinguished by its smooth, obovate to elliptic leaf blades, muticous anthers, and inconspicuous latex canals. This species is apparently sympatric with *C. martiana*, but occurs in riparian forests above and away from the inundation zone. Forest inventory data indicate that *C. amazonica* is much more infrequent than *C. martiana*, and does not form large mats as the latter species does.

The type of *C. oedematopoidea* represents populations with smaller, less coriaceous leaves and smaller, more compact inflorescences than the Amazonian populations of *C. amazonica*. A collection from Antioquia, Colombia (*R. Fonnegra et al. 4129*) is identical to the type of *C. oedematopoidea.* Collections from Bolivia (*S. Beck 12969, T. Croat 51413, J. Solomon 7491*) resemble *C. martiana* in quantitative features of the leaves, but the prominent secondary veins and submarginal collecting vein, and, absence of significant numbers of latex canals visible on the adaxial leaf surface, clearly indicate they belong to *C. amazonica*.

3. **Clusia martiana** Engler, Fl. Bras. 12(1):411. 1888. (Fig. 3). TYPE: BRAZIL. AMAZONAS: Alto Amazonas, in forests of the Rio Japurá, Dec 1852 (stam. fl), *C. Martius 3033* (HOLOTYPE: M, n.v.).

Clusia uleana Engler, Bot. Jahrb. 58:Beibl. 130:1. 1923. Syn. Nov. TYPE: BRAZIL. AMAZONAS: near Fortaleza, along Rio Juruá, 6 Nov 1901 (pist. fl bud), *E. Ule 6006* (HOLOTYPE: B-destroyed, F Neg. 9205 !). A search for remaining duplicates of the type collection is underway and neo- or lectotypification is postponed until the whereabouts of duplicate collections is known, or if any are extant.

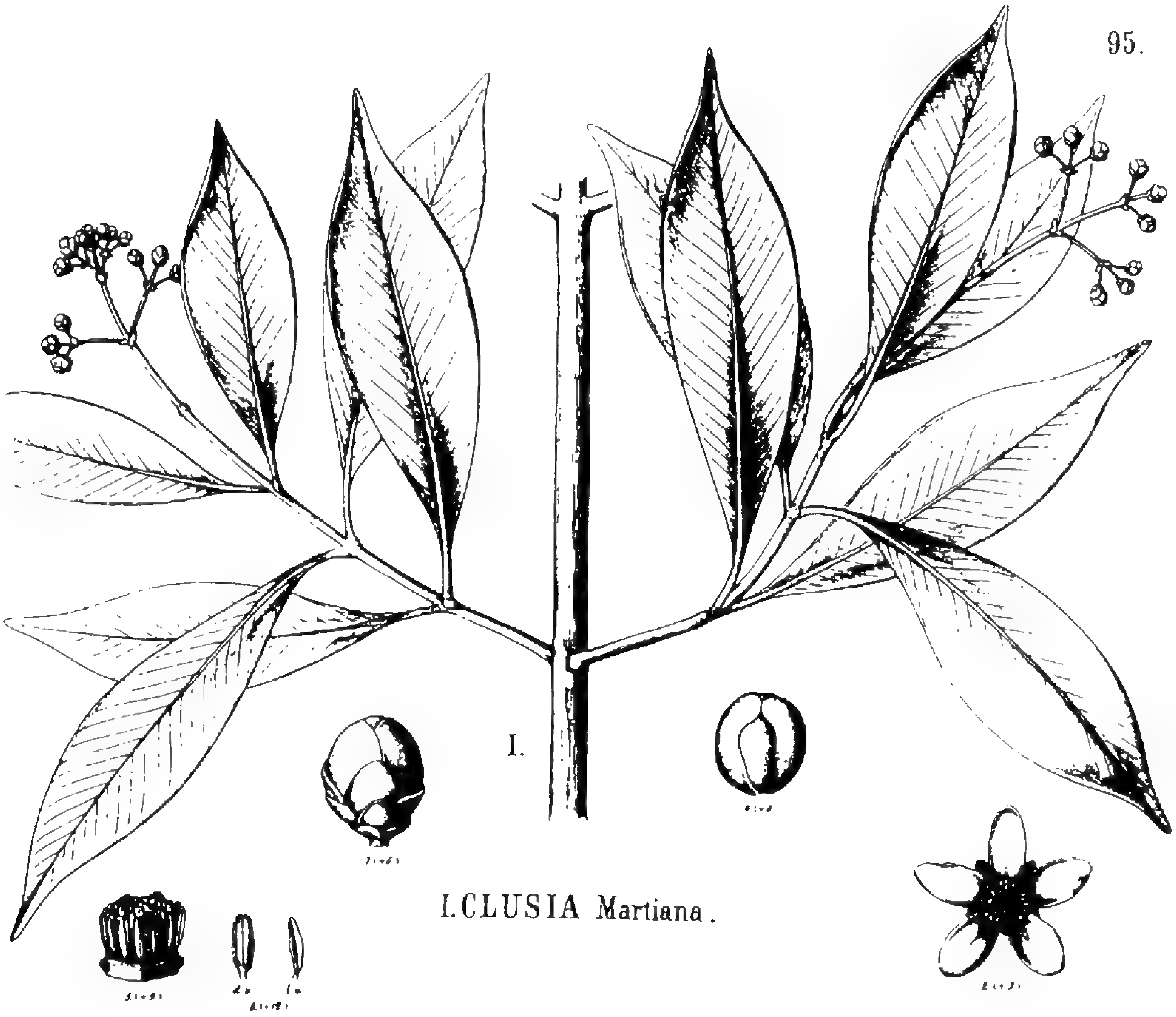

FIG. 3. *Clusia martiana* Engler. Habit (center); androecium, anthers in abaxial and lateral views, staminate flower bud, staminate flower bud with sepals and bracteoles removed, top view of staminate flower in anthesis (from left to right). Adapted from Engler in Martius, *Flora Brasiliensis*, 12:Plate 95.

Scandent epiphytic shrub, at times appearing lianous to 4 m tall; branchlets terete to somewhat tetragonal or pentagonal in cross section, at times squarrose, 2.5–3.5 mm diam., bark of apical portions rufous, scaly, checking transversely and exfoliate, rufous and glabrous at maturity, latex clear, moderate. Leaves decussate; blades subcoriaceous, obovate to oblanceolate, (6.5–)10–14.5 (–19)cm long, (2.3–)3.5–5.0(–6.5) cm wide, apex narrowly acute to abruptly acuminate, the acumen 0.3–1.5 cm long, base acute to cuneate, not decurrent on the petiole, smooth, glabrous above and below, sordid above, pallid below, latex canals dense and conspicuous above and below, midrib slightly raised above, prominently raised below, secondary veins numerous, smooth, inconspicuous above, slightly raised below, submarginal collecting vein barely discernible, the margin flat, entire, glabrous; petioles canaliculate, 1–1.5(–2) cm long, glabrous. Inflorescence terminal, pendent, pyramidally paniculate, 2–4 cm long, 3–5 cm wide at maturity, the flowers 3 per cyme; peduncle 0.8–1.5 cm long, subtended by normal leaves; secondary bracts coriaceous, oblate, 2.3–2.6 mm long, 3.5–4 mm wide, apex widely rounded, carinate, the margin somewhat hyaline, very narrowly scarious, entire, glabrous. Staminate inflorescence with tetragonal pedicels, the lateral 1.8–2.2, the terminal 2.5–3.5 mm long, glabrous; bracteoles 4, the outer 2 coriaceous, oblate, 2.3–2.6 mm long, 3.5–4 mm wide, apex widely rounded, carinate, the margin somewhat hyaline, very narrowly scarious, entire, glabrous, the inner 2 stiffly coriaceous, oblate, 2.5–3 mm long, 3.3–4.5 mm wide, apex broadly rounded, somewhat carinate, the margins entire, somewhat translucent, not scarious, glabrous. Staminate flowers white to yellow; sepals 5, contorted, membranaceous, very widely ovate, 5–7 mm long, 4–6 mm wide, apex broadly rounded, somewhat cucullate, densely lineate, the margin hyaline, scarious, glabrous; petals 5, contorted, carnose, oblong, 5.3–5.8 mm long, 1.8–2.2 mm wide, apex rounded, flat, obscurely lineate, the margin entire, opaque, not scarious, glabrous; androphore flat, pentagonal, the stamens numerous, free, 2.1–3.3 mm long at maturity, the filaments short, flat, anther 1–1.3 mm long, apex muticous, base truncate, dehiscent by longitudinal slits, the connective flat, truncate, darkened; pistillode absent. Pistillate flowers white, as in staminate but sepals orbicular, 3.5–4 mm long and wide; petals 4.5–5 mm long, 2.8–3.3 mm wide, apex obtuse to rounded; staminodes 5, 3–3.5 mm long, the filaments wide, 1 mm long, 2 mm wide, abruptly constricted apically to anthers, the anthers linear, ca. 1 mm long, 0.5 mm wide, apex muticous, base not distinguishable, with longitudinal slits, devoid of pollen, the connective darkened; pistil 4 mm long, 5 mm diam.; carpels 5; styles absent, stigmas thinly coriaceous, oblongoid, peltate, 1.8–2.2 mm long, 1–1.2 mm wide, flat in early ontogeny, convex at maturity; ovules numerous. Fruit greenish white with red hue in intercarpelary areas, ovoid, 2–3.5 cm long, 1.5–2.5 cm wide,

Distribution.—Amazon Basin of Colombia, Venezuela, Peru, Bolivia and Brazil, 100–450(–1,850) m elevation.

Ecology and conservation status.—*Clusia martiana* is a hemiepiphyte, growing along riverbanks, where it forms mats in and over the canopies of low trees, eventually killing them. This species can withstand extended periods submerged. I have seen the fruits floating on rivers, but it is doubtful that dispersion by fish is significant, because of the large numbers of small birds I have seen feeding from open capsules, on the red arillate seeds. It is commonly found on the margins of várzea, and "tahuampa" forests, which are on lateritic soils, but is also rarely found in sandy loams ("varillal") and very rarely found in riparian forests with some pockets of white sand. *Clusia martiana* is one of the few weedy species of *Clusia*.

Specimens examined: **COLOMBIA.** Amazonas: Mpio. Leticia, Parque Nacional Natural Amacayacu, Matamatá trail, 03°47'S, 70°15'W, 110–120 m, 28 Oct 1991 (ster.), *J. Pipoly 15610* (BRIT, COL, FMB, MO), near Quebrada Matamatá, 100 m, 11 Mar 1991 (fr), *A. Rudas et al. 1542* (BRIT, COL, FMB, MO), along Quebrada Bacaba, 100 m, 16 Apr 1992 (fr), *A. Rudas & A. Prieto 4286* (BRIT, COL, FMB, MO), along bank of Río Amacayacu, 100 m, 9 Apr 1991 (ster.), *J. Pipoly et al. 15133* (BRIT, COL, FMB, MO); Vereda Puerto Nariño, 03°45'S, 70°15'W, 100 m, 3 Aug 1989 (ster.), *R. Vásquez et al. 12510* (AMAZ, BRIT, COL, FMB, MO, USM). Antioquia: Mpio. Amalfí, 8–27 km NE of Almafí, en route from Vetilla to Fraguas, near Salazar and Marengo, 06°00'N, 75°04'W, 1,150–1,450 m, 7 Dec 1989 (pist. fl), *R. Callejas et al. 9114* (BRIT, COL, HUA); Mpio. Campamento, Vereda Llanadas, 6–12 km W of Campamento en route to Mina Las Brisas, 07°05'N, 75°20'W, 1,650–1,810 m, 7 Sep 1989 (pist. fl), *R. Callejas et al. 8266* (BRIT, COL, HUA). **VENEZUELA.** Amazonas: Isla Sebastián, Río Casiquiare above Chapezón, between Boca and Solano, 01°58'N, 67°03'W, 120 m, 31 Jan 1980 (pist. fl), *R. Liesner & H. Clark 8941* (MO, VEN); Depto. Atabapo, "Caño Iguapo, Alto Orinoco, 15 km SE of La Esmeralda, 03°00'N, 65°28'W, 150 m, 24 Feb 1990 (stam. fl), *G. Aymard & L Delgado 8227* (BRIT, PORT, VEN); Depto. Atures, Río Jénita floodplain, 7 km before Ocamo river mouth, 02°46'N, 64°54'W, 170 m, Feb 1990 (stam. fl), *A. Fernández 7318* (BRIT, PORT, VEN); Río Mayaca, 02°01'N, 65°07'W, 228 m, 6 Feb 1989 (stam. fl), *A. Henderson et al. 987* (BRIT, NY, VEN); Alto Orinoco, along riverside 2 hours above La Esmeralda, 26 Mar 1953 (stam. fl), *B. Maguire & J. Wurdack 34708* (MO, NY, VEN); Río Padamo, 10 km above mouth, 27 Mar 1953 (stam. fl), *B. Maguire & J. Wurdack 34718* (MO, NY, VEN); Depto. Casiquiare, near Capihuara, along Río Casiquiare, 5 Feb 1991 (pist. fl, fr), *M. Collela et al. 1829* (BRIT, NY, VEN); Isla Sebastián, along Río Casiquiare between Boca and Solano, 01°58'N, 67°03'W, 120 m, 31 Jan 1980 (pist. fl), *R. Liesner & H. Clark 8941* (MO, VEN). **PERU.** Cuzco: Dtto. Camantí, 8 km W of Quincemil, right margin of Río Manirí, toward the mouth of Río Araza, 13°17'S, 70°48'W, 720 m, 17 Jul 1990 (stam. fl), *M. Timaná & H. Astete 646* (BRIT, CUZ, MO, USM). Junín: Mazamari, 1,000 m, 13 Sep 1960 (pist. fl, fr), *F. Woytkowski 6019* (MO, US, USM). Loreto: Prov. Maynas, Buena Vista, Río Tahuayo, 04°15'S, 73°10'W, 140 m, 24 Jan 1981 (stam. fl), *R. Vásquez & N. Jaramillo 1229* (AMAZ, F, MO, USM); Explornapo Camp, Quebrada Sucusari, Río Napo, 03°15'S, 72°55'W, 130 m, 30 May 1991 (ster.), *A. Gentry et al. 74277* (AMAZ, BRIT, MO, USM), Explornapo Camp, 03°20'S, 72°55'W, 140 m, 18 Apr 1991 (fr), *R. Vásquez & N. Jaramillo 16141* (AMAZ, BRIT, MO, USM); Vicinity of Iquitos, 1977 (stam. fl), *J. Revilla 3254* (AMAZ, BRIT, F, MO, USM); Río Mamón, 6 Sep 1972 (stam. fl), *T. Croat 20028* (AMAZ, MO, USM); Santa María de Nanay, 10 km W of Casería Mishana, Reserva Cocha Yaramá, along Río Nanay, 03°55'S, 73°35'W, 130 m, 15 Mar 1991 (ster.), *J. Pipoly et al. 15031* (AMAZ, BRIT, MO, USM), (fr), *J. Pipoly et al. 15036* (AMAZ, BRIT, CUZ, MO, USM); Río Itaya, below San Juan de Muniches, ca. 40 min above Iquitos), 120 m, 19 Mar 1977 (fr), *A. Gentry et al. 18422* (AMAZ, F, MO, USM); Río Nanay, 6 turns above Iquitos, 28 Dec 1976 (pist. fl, fr), *J. Revilla 2098* (AMAZ, F, MO, TEX, USM); Río Nanay between Iquitos and Puerto Almendras, 13 Jul 1976 (stam. fl), *A. Gentry & J. Revilla 16710* (AMAZ, F, MO, USM); Dtto. Iquitos, Río Nanay, near Santa Clara, 19 Aug 1976 (stam. fl), *J. Revilla 1144* (AMAZ, F, MO, USM), 13 Nov 1976 (stam. fl), *J. Revilla 1899* (AMAZ, CUZ, F, HUT, MO, USM), 14 Nov 1976 (pist. fl bud), *J. Revilla 1817* (AMAZ, F, MO, USM); Río Nanay, near Santa Clara, ca. 10 km above Morona Cocha, 150 m, 12 Dec 1976 (stam. fl), *C. Davidson & J. Revilla 5415* (AMAZ, F, MO, USM); Nauta, Quebrada Saragosa, 04°29'S, 73°35'W, 200 m, 29 Mar 1987 (fr), *R. Vásquez & N. Arévalo 9048* (AMAZ, MO, USM); Río Yavarí, across river from Brazilian village of Pãomari, 23 Nov 1977 (stam. fl), *A. Gentry & J. Revilla 20814* (AMAZ, BRIT, CUZ, F, HUT, MO, TEX, USM); Along Río Blanco, above Tamshiyacu, 140 m, 17 Mar 1978 (fr), *C. Díaz et al. 215* (AMAZ, CUZ, F, MO, USM); Caserío Nina Rumi, along Río Nanay, 23 Feb 1976 (fr), *J. Revilla 199* (AMAZ, MO, USM); San Antonio, Río Pintuyacu, 03°40'S, 73°54'W, 160 m, 21 Apr 1986 (fr), *R. Vásquez et al. 7487* (AMAZ, CUZ, F, MO, USM); Quebrada Yanayacu, tributary of Río Manatí, 03°45'S, 72°55'W, 110 m, 25 Jan 1989 (pist. fl, fr), *R. Vásquez & N. Jaramillo 11573* (AMAZ, BRIT, MO, US). **BOLIVIA**. La Paz: Río Saturiapo, 14 km SW of Ixiamas, second ridgetop, 13°53'S, 68°15'W, 620–650 m, 2 Jun 1990 (bud), *A. Gentry & R. Foster 70864* (F, LPB, MO); Prov. Nor Yungas, 4.5 km below Yolosa, then 14 km W on road along Río Huarinilla, on abandonded road to Hacienda Sandillan, S side of river, 16°12'S, 67°50'W, 1,200–1,300 m, 24 Jan 1983 (fr), *J. Solomon 9391* (LPB, MO); Prov. Murillo, 1/2–3/4 by trail downriver from the Cahua Hydropower Plant, 16°05'S, 68°03'W, 1,400–1,600 m, 22 Apr 1982 (fr), *J. Solomon 7491* (LPB, MO); 44 km below Lago Zongo Dam, vicinity of Cahua hydroelectric plant, 16°03'S, 68°01'W, 1,200 m, 12–15 Sep 1983 (stam. fl), *J. Solomon 10829* (LPB, MO). **BRAZIL**. Roraima: SEMA Ecological Reserve, Ilha de Maracá, Parimiu, 03°20'N, 62°58'W, 24 May 1987 (fr), *W. Milliken & S. Bowles 276* (MO).

Clusia martiana is isolated within the section, but may be more closely related to *C. amazonica* than to *C. araracuarae*. It is readily separated from both of those species by the subcoriaceous leaves with acute to cuneate bases, the highly conspicuous, numerous linear latex canals, and barely discernible submarginal collecting vein. I have observed that *C. martiana* is an epiphytic shrub at first, then becomes lianous with age. *Clusia martiana* is most frequently confused with *C.* (section *Brachystemon*) *penduliflora* because they share the nearly the same habit, have relatively short inflorescences (compared to *C. amazonica*), and are partially sympatric. However, the oblongoid stigmas, flattened, longer filaments and subcoriaceous leaves of *C.* martiana easily distinguish it from *C. penduliflora* and *C. amazonica*.

The type of *Clusia uleana* represents those populations of *C. martiana* with short branches and inflorescences, and slightly larger flowers than those of the average population. However, it is otherwise identical to the majority of *C. martiana* populations. The type specimen was destroyed in Berlin, and no duplicate has been found in HBG or other herbaria thus far. However, the Field Museum of Natural History (F) photograph clearly shows the characteristic squarrose branchlet tips with horizontally checking and exfoliating bark, numerous, very highly conspicuous foliar linear latex canals, and obscure secondary venation, thus confirming its identity as *Clusia martiana*.

Clusia section **Brachystemon** (Engler) Pipoly, comb. nov. *Clusia* section *Criuva* subsection *Brachystemon* Engler in Martius, Fl. Bras. 12(1):412. 1888. LECTOTYPE SPECIES (here designated): *Clusia spathulaefolia* Engler in Martius, Fl. Bras. 12(1):412. 1888.

Clusia section *Criuva* subsection *Criuvopsis*, pro parte, Vesque, Monogr. Phan. 8:34. 1893.
Clusia subgenus *Criuva* Bentham section *Brachystemon* (Engler) Engler, Pflanzenfam. 3(6):225. 1893.

Free-standing trees or hemiepiphytes; latex white or cream. Leaves petiolate. Inflorescence a terminal panicle; branches cymose; secondary inflorescence bracts 2, carnose; bracteoles 4, decussate, carnose or coriaceous. Perianth erect, sepals 5–9, membranaceous or coriaceous, the outer 2 opposite, the others contorted; petals 4–5, contorted, chartaceous, coriaceous or thickly carnose; androphore pentagonal; stamens numerous, subsessile on free, short, terete or prismatic filaments; anthers linear, basifixed, muticous, much longer than the filaments, apically truncate or emarginate, dehiscent by longitudinal slits; pistillode absent or very reduced, the central receptacle resiniferous. Pistillate inflorescence and flowers as in staminate, but staminodia 5, free, the filament broad, abruptly tapering apically, anther linear, apex muticous; carpels 5; ovules horizontal; stigmas sessile, peltate, elliptic or narrowly triangular. Fruit a capsule, oblongoid or depressed-globose, stigmas persistent.

Distribution.—Three species in the Amazon Basin and adjacent Andes of Colombia, Venezuela, Ecuador, Peru, Bolivia and Brazil.

Clusia section *Brachystemon* is most closely related to section *Criuvopsis*, but is separated by the short, subterete or prismatic filaments of the anthers, and compact inflorescences with relatively thicker rachises. It is restricted to the Amazon Basin and adjacent Andes of South America, often along riverbanks. The three species of the section can be separated by the following key.

KEY TO SPECIES OF *CLUSIA* SECTION *BRACHYSTEMON*

1. Hemiepiphytes; leaf blade coriaceous, dull above and below, the apex broadly rounded to an abruptly acuminate tip; flowers on pedicels 3–10 mm long; stigmas elliptic; fruits smooth, not ribbed .... 1. *C. penduliflora*
1. Free-standing trees; leaf blade stiffly coriaceous to cartilaginous, nitid above, pallid below, the apex broadly rounded to truncate, without acuminate tip; flowers sessile to subsessile, the pedicels less than 1 mm long;stigmas cuneiform; fruits strongly ribbed.
    2. Leaf blades oblanceolate to obovate, the base attenuate, decurrent on the petiole, the margins revolute; petioles broadly marginate, 1–1.5(–2.2) cm long; branchlets 7–10 mm diam. .... 2. *C. spathulaefolia*
    2. Leaf blades oblong to elliptic, the base obtuse to broadly rounded, not decurrent on the petiole, the margins flat; petioles subterete, 3–4.5(–5) cm long; branchlets 10–22 mm diam. .... 3. *C. aymardii*

1. **Clusia penduliflora** Engler, Fl. Bras. 12(1):412. 1888. (Fig. 4). TYPE. BRAZIL. AMAZONAS: Near Panure along Rio Uaupes, Dec 1852 (stam. fl), *R. Spruce 2792* (HOLOTYPE: G, n.v.; ISOTYPE: P!).

Hemiepiphyte; branchlets quadrate to subterete, 3.5–5 mm diam., gla-

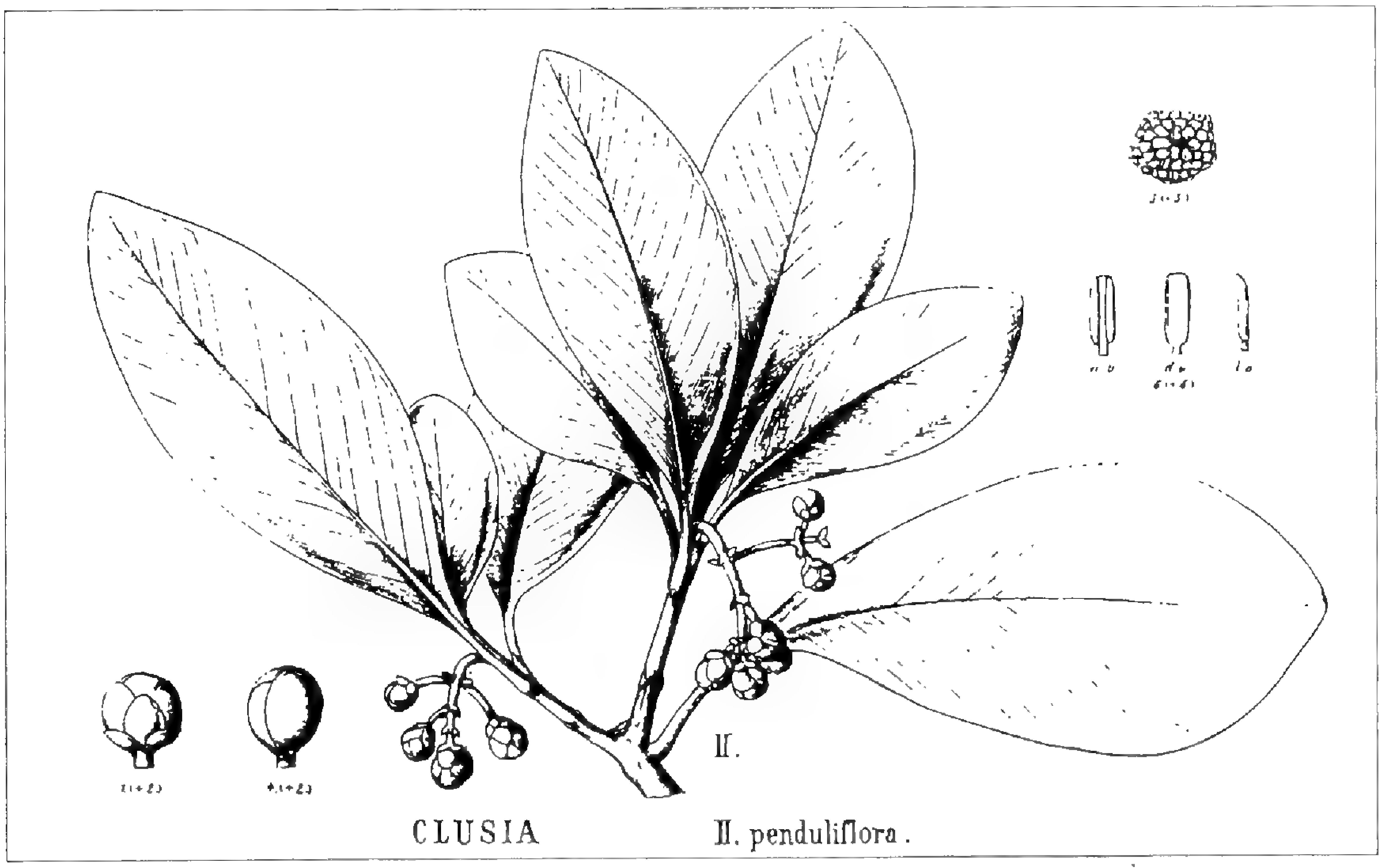

Fig. 4. *Clusia penduliflora* Engler. Habit (center); staminate flower bud, staminate flower bud with sepals and bracteoles removed (lower left, from left to right); top view of androecium (upper right); anthers in adaxial, abaxial and lateral views (right side, left to right). Adapted from Engler in Martius, *Flora Brasiliensis* 12:Plate 84.

brous, bark gray to grayish-brown, not transversely checked or exfoliating; glabrous; latex white to cream, scanty. Leaves decussate; leaf blades coriaceous, obovate to rarely elliptic, (8.8–)14–22.5 cm long, (3–)6.5–11.0 cm wide, apex broadly rounded to an abruptly acuminate tip, or rarely acute, base obtuse to acute, not decurrent on the petiole, dull above and below, at times with numerous, conspicuous latex canals, midrib raised above, prominently raised below, secondary veins inconspicuous, numerous, extending to the margin, without submarginal collecting vein, the margin flat, entire, glabrous; petioles canaliculate, 1.3–1.7(–2.3) cm long, glabrous. Inflorescence: terminal, pendent, pyramidal paniculate, 3–7(–8.5)cm long, 3–8 cm wide, the branches cymose, 3-flowered at inflorescence apex, 2–3 flowers per cyme below; peduncle (0.7–)1–2 cm long, subtended by normal leaves; secondary bracts carnose, depressed ovate, 2–3 cm long, 2.5–3.5 cm wide, apex rounded, carinate, the margin opaque, not scarious, entire, glabrous. Staminate inflorescence with tetragonal pedicels, 3–10 mm long, glabrous; bracteoles 4, decussate, carnose, the outer 2 suborbicular, 3–4 mm long, 3–3.5 mm wide, apex broadly rounded, medially carinate, the margins entire, opaque, not scarious, the inner 2 coriaceous, orbicular, 5–6 mm long and wide, apex broadly rounded, carinate, the margin entire, opaque, scarious. Staminate flowers greenish pink; sepals 7–9, the outer sepals 2, opposite, coriaceous, suborbicular to oblate, 5–6 mm long, 6–7 mm wide, apex very widely rounded, subcucullate, the margin entire, scarious, the inner sepals 5–7, contorted, membranaceous, brittle, very widely ovate, 6–7 mm long, 5–7 mm wide, translucent, apex rounded, venation prominent, the margin hyaline, scarious; petals 5, contorted, coriaceous, widely obovate, 5–7 mm long, 3–4 mm wide, apex truncate to very broadly rounded, linear latex canals numerous, prominent, the margin hyaline; androphore flat or slightly convex, the stamens numerous, free, 3.5–3.8 mm long, the filaments short, terete, ca. 1 mm long, the anthers linear, 2.5–3.5 mm long, ca. 0.5 mm wide, apex truncate, base truncate to broadly obtuse, dehiscent by longitudinal slits, the connective terete, darkened; pistillode subobsolete to obsolete, resiniferous. Pistillate inflorescence as in staminate but with outer bracteoles 2.5–3.5 mm long, 2.5–3.5 mm wide, inner 2 bracteoles suborbicular to oblate, 2–3.5 mm long, 2.5–4 mm wide pedicels subobsolete to 3 mm long. Pistillate flowers green, as in the staminate but sepals suborbicular, 3.5–5 mm long, 5–7 mm wide, the inner sepals suborbicular to very widely ovate, 5–8 mm long, 5–7 mm wide; petals prominently cucullate; staminodes 5, flat, 3.5–4 mm long, the filaments 2–2.5 mm long, 2–2.2 mm wide, abruptly tapering apically; anthers rectangular, 1–1.2 mm long, 0.5–0.6 mm wide, muticous apically, the connective darkened, the thecae not fully differentiated and devoid of pollen; pistil subglobose, 4–6 mm long and in diam.; carpels 5; styles absent; stigmas thinly coriaceous, elliptic, peltate, 1.5–2 mm long, 1–1.5 mm wide, persistent, flat in early ontogeny, convex at maturity; ovules numerous. Fruit green, oblongoid, 2–3.5 cm long, 1.3–2.5 cm diam.

Common names.—"Matapalo" (Napo-Ecuador).

Distribution.—Central and western Amazonia of Brazil, Colombia, Ecuador and Peru, 50–500(–1,800) m elevation. *Clusia penduliflora* is expected to occur in Amazonian Venezuela in forests on *terra firme*. Its apparent absence there is probably a collection artifact.

Ecology and conservation status.—*Clusia penduliflora* is a hemiepiphyte that grows in primary lowland moist, wet and rain forests, on alluvial terraces just above floodplains. It may be found in tree canopies in areas of high incident light near the transition zones with varzea forests.

Specimens examined. **COLOMBIA**. Chocó: Along Río San Juan, near Docordó, 0–100m, 04°15'N, 77°22'W, 29 Mar 1979 (stam. fl), *E. Forero et al. 4328* (COL, MO); road to Cabí, SW of Tutunendo, 100 m, 19 Jan 1979 (pist. fl), *A. Gentry & E. Rentería 24444* (COL, JAUM, MO). **ECUADOR**. Esmeraldas: Lita-San Lorenzo Road, ca. 30 km NW of Lita, 01°05'N, 78°40'W, 300–500 m, 12 May 1991 (fr), *A. Gentry et al. 70025* (BRIT, MO, QCNE). Morona-Santiago: Campamento La Playa, road construction camp 23 km SE of San Juan Bosco, 1,050 m, 28 Jan 1981 (stam. fl), *A. Gentry et al. 30932* (MO, SEL). Napo: Cantón Aguarico, Reserva Faunistica Cuyabeno, Laguna Zancudo Cocha (Iripari), 00°33'S, 75°32'W, 230 m, 28 Sep 1991 (pist. fl), *W. Palacios et al.. 7770* (MO, QCNE); Cantón Tena; Jatun Sacha Biological Station, Río Napo, 8 km below Misahuallí, 01°04'S, 77°36'W, 450 m, 17 Jan–6 Feb 1987 (pist. fl), *C. Cerón 614* (MO, QCNE), 17–28 May 1989 (fr), *W. Palacios 4274* (BRIT, MO, QCNE), 14 May 1990 (fr), *W. Palacios & E. Freire 5151* (MO, QCNE), 17–24 Feb 1988 (stam. fl), *C. Cerón 3622* (MO, QCNE), 24 Nov 1987 (pist. fl), *D. Neill & S. Manning 8013* (MO, QCNE); Parque Nacional Yasuní, "Daimi" Oil Well 2, 00°55'S, 76°11'W, 200 m, 26 May–8 Jun 1988 (fr), *C. Cerón & F. Hurtado 4084* (MO, QCNE); Limnocecha, NE of runway, Feb 1970 (stam. fl), *R. Mowbray 7026* (MO, SEL). Pastaza: Via Auca, 110 km S of Coca, 10 km from Río Tigüino, sector Cristal, 01°15'S, 76°55'W, 320 m, 7 Jan 1989 (pist. fl), *W. Palacios et al. 3433* (BRIT, MO, QCNE). Canton Pastaza, "Ramirez" Oil Well, 20 km S of Curaray, 01°32'S, 76°51'W, 300 m, 21–28 Feb 1990 (fr), *V. Zak et al. 5292* (BRIT, MO, QCNE). Pichincha: Cooperativa Santa Marta No. 2, along Río Verde, 2 km SW of Sto. Domingo de Los Colorados, 530 m, 5 Feb 1979 (pist. fl), *C. Dodson 7418* (MO, QCA, SEL). Sucumbios: Canton Gonzalo Pizarro, Campo Bermejo 6 N, 30 km NW of Lago Agrio, 00°14'N, 77°13'W, 1,050 m, 23 Mar 1990 (fr), *C. Cerón et al. 9120* (BRIT, MO, QCNE); Parroquia Reventador, PreCooperativa Garcia Moreno, 3rd line N of road, near Río Due, 00°03'N, 77°35'W, 1,800 m, 23 May 1990 (fr), *C. Cerón et al. 9841* (BRIT, MO, QCNE). **PERU.** Cuzco: Prov. Quispicanchis, Camantí, Manirí, along Río Manirí, trail to Quebrada Garrote, 13°71'S, 70°45'W, 720 m, 8 Sep 1990 (stam. fl), *M. Timaná 924* (AMAZ, BRIT, CUZ, F, MO, USM); hills around Río Araza between Pan de Azucar and Quince Mil Airport, 292 km from Cusco, 13°13'S, 70°45'W, 643 m, 10 Aug 1991 (stam. bud), *P. Nuñez 14081* (CUZ, HUT, MO, USM). Loreto: Prov. Maynas; forest behind Caseria Mishana, 150 m, 13 Nov 1977 (pist. fl), *A. Gentry et al. 20673* (AMAZ, MO, USM); Río Gueppi, tributary of Río Putumayo, Peru/Ecuador border, 200 m, 14 May 1978 (fr), *A. Gentry et al. 21842* (AMAZ, MO, USM); Dtto. Fernando Lores; Caserio Constancia (Quebrada Tamshiyacu), 04°08'S, 72°55'W, 120–130 m, 7 May 1991 (fr), *C. Grández et al. 2472* (AMAZ, BRIT, MO, USM); Dtto. Pevas; Caserio Colonia (Quebrada Sumón), tributary of Río Yahuasyacu, trail to Río Putumayo, 03°20'S, 71°50'W, 120–130 m, 30 Mar 1991 (fr), *Grández et al. 2334* (AMAZ, BRIT, MO, USM); San Antonio, Río Itaya, 04°10'S, 73°20'W, 13 Dec 1982 (stam. fl), *R. Vásquez & N. Jaramillo 3558* (AMAZ, MO, USM); Prov. Requena, Jenaro Herrera, Río Ucayali, 04°55'S, 73°45'W, 22 Feb 1987 (fr), *A. Gentry et al. 56361A* (AMAZ, MO, USM); Sapuena, Bagazan-Río Ucayali, 04°45'S, 73°38'W, 130 m, 14 Jan 1987 (pist. fl), *R. Vásquez & N. Jaramillo 8789* (AMAZ, MO, USM). **BRAZIL.** Amazonas: Dtto. Agropecuario, Reserva 1051 ("km 41") of the WWF/INPA MCS Project; 02°25'31" S, 59°45'50" W, 50–125 m, 20 Nov 1988 (stam. fl), *B. Boom et al. 8568* (BRIT, INPA, NY), 02°24'26"- 02°25'31"S, 59°43'40"- 59°45'50" W, 6 Dec 1988 (pist. fl), *B. Boom et al. 8764* (BRIT, INPA, NY), (stam. fl), *S. Mori et al. 20194* (BRIT, INPA, NY); Municipality of São Paulo de Olivença, near Palmares, 11 Sep–26 Oct 1936 (stam. fl), *B. A. Krukoff 8324* (MO, NY, US); Municipality Oriximiná, BR 163 to 7 km N of Cachoeira Porteira, near ES-7, 01°02'S, 57°02'W, 20 Aug 1986 (stam. fl), *C. A. Cid et al. 7929* (BRIT, MG, INPA, NY).

Clusia penduliflora is most closely related to *C. spathulaefolia*, but is readily separated by its hemiepiphytic habit, leaves with long petioles, cuneate bases, obscure secondary venation and conspicuous latex canals, and the relatively small, pendent inflorescences. This species is often confused with *Clusia martiana*, but may be readily separated in flower by its subsessile anthers. Vegetatively, *Clusia penduliflora* generally has larger leaves and an erect habit, but this character overlaps between the two species considerably. In fruit, *C. penduliflora* has an oblongoid fruit with elliptic stigmas, while *C. martiana* has ovoid fruits with oblongoid stigmas.

3. **Clusia spathulaefolia** Engler, Fl. Bras. 12(1):412. 1888. TYPE. BRAZIL. AMAZONAS: Alto Amazonas, along streams near Panuré, along Rio Uaupes, Dec 1852 (stam. fl), *R. Spruce 2782* (HOLOTYPE: B-destroyed, F Neg. 32279!; LECTOTYPE (here designated): P!).

Free-standing trees to 20 m tall, 35 cm DBH; branchlets 4-angled with narrow ridges approximately 2 mm tall, 7–10 mm diam., bark gray to grayish-brown, smooth, not transversely checked or exfoliating, glabrous; latex white, copious. Leaves decussate; leaf blades stiffly coriaceous to cartilaginous, oblanceolate to obovate, rarely elliptic, (12–)19–28 cm long, (3.5) 10(–16.8) cm wide, apex obtuse to broadly rounded, base attenuate and decurrent on the petiole, nitid above, dull below, latex canals inconspicuous, midrib raised but canaliculate above, prominently raised below, secondary veins numerous, raised above, slightly raised below, extending to a fine submarginal collecting vein, the margin revolute, entire, glabrous; petioles broadly marginate, 1–1.5(–2.2) cm long, glabrous. Inflorescence terminal, erect, pyramidal paniculate, 5–8(–10) cm long, 5–7(–10) cm wide, the branches cymose, the flowers solitary or 3 per cyme; peduncle 1–2.5(–5) cm long, subtended by normal leaves; secondary bracts carnose, widely ovate, 3–7 mm long, 4–6 mm wide, apex obtuse to rounded, carinate, the margin scarious, entire, glabrous. Staminate inflorescence with tetragonal pedicels, within each cyme, the pedicels of the lateral flowers 0.6–1 mm long, those of the terminal flower 3–5 mm long, glabrous; bracteoles 4, the outer 2 carnose, widely ovate, 3–7 mm long, 4–6 mm wide, apex obtuse to rounded, carinate to crested medially, the margin scarious, hyaline, entire, glabrous, the inner 2 coriaceous, orbicular to oblate, 4–4.5 mm long, 3–3.5 mm wide, apex broadly rounded, somewhat carinate, the margins scarious, hyaline, entire, glabrous. Staminate flowers white; sepals 7(–8), the outer sepals 2, opposite, chartaceous, brittle, orbicular, 5–7 mm long and wide, apex broadly rounded, cucullate, the margin entire; the inner ones 5, contorted, membranaceous, brittle, very widely ovate, 4–6 mm long, 3–5 mm wide, largely opaque, apex very broadly rounded to subtruncate, translucent latex canals dense, cucullate, the margin hyaline, entire, scarious; petals 5, thickly carnose, obovate-spathulate to oblong, 5–7 mm long, 2–2.5 mm wide, apex truncate, venation and latex canals prominent, medially thickened, the margin undulating, entire, translucent, glabrous; androphore flat or slightly concave, quadrangular, the stamens numerous, free, 2.5–3.3 mm long, the filaments prismatic, 0.5–0.8 mm long, the anthers linear, 2–2.5 mm long, 0.5 mm wide, apex truncate, base truncate, dehiscent by longitudinal slits, the connective prismatic, darkened; pistillode obsolete. Pistillate inflorescence as in staminate but with pedicels 2–3 mm long; outer bracteoles suborbicular, 3–3.5 mm long, 3–4 mm wide, the inner 2 4–5.5 mm long, 5–6 mm wide. Pistillate flowers white, as in the staminate but sepals suborbicular, 5–7 mm long, 3.5–5 mm wide; petals obovate-spathulate, 5–7 mm long, 2.5–3 mm wide, apex rounded, abruptly constricted toward base; staminodes 20, to 2 mm long, the filament flat, 0.3–0.5 mm long, anther linear, 1.3–1.5 mm long, 0.3–0.5 mm wide, not bearing pollen; pistil subglobose, 5–8 mm long, and in diam., narrowing toward the apex; carpels 5; the ovules numerous, the styles absent; stigmas sessile, cuneiform, convex, 2–3.5 mm long, 1.5–2 mm wide. Fruit pale green, tinged with pink in intercarpelary grooves, depressed-globose, 1.5–1.8(–2) cm long, 2.2–2.5(–2.8) cm diam.

Common names.—COLOMBIA: "Matapalo" (Spanish); "Detziva" (Miraña language); "Atbo-caja-jubaga-bacoco-moho" (Mui language); "Jubagagaimio" (Mui language- elders); "Jipeo" (Hui language). VENEZUELA: "Cupí banero hoja gruesa," "Cupí".

Distribution.—Endemic to the Guayana Crystalline Shield of Venezuela, Brazil, and Colombia, with a disjunct population in Peru, at 50–200 (–1,650) m elevation.

Ecology and conservation status.—*Clusia spathulaefolia* is a medium-sized, free-standing tree growing in gallery scrub forests ("Bana") and savannas ("campinarana" or "amazonian caatinga") along black water rivers, on deep white sands. These formations are near rivers but do not flood (Macedo & Prance 1978; Prance 1979; Prance & Schubart 1978).

Specimens examined. **COLOMBIA**. Caquetá: Araracuara, N side of the central portion of the airstrip; 27 Apr 1988 (ster.), *M. Sanchez et al. 131* (COAH, MO), Near the airport, 00°37'S, 72°24'W, 17 Oct 1990 (fl bud), *J. Duivenvoorden & A. Cleef 258* (BRIT, COAH, COL, U), 15 Nov 1991 (ster.), *J. Duivenvoorden 980* (BRIT, COAH, COL, U). Amazonas: Río Caquetá, right bank, 1.8 km above the mouth, Quinche, 2.7 km; 11 May 1988 (fr), *M. Sanchez et al. 341* (COAH, MO); Río Caquetá, left bank, 1 km above the W end of Mariñame Island, 3.5 km; 13 Jun 1988 (fr), *M. Sanchez et al. 744* (COAH, MO), Jun 1989 (ster.), *L. Urrego 578* (COAH, MEDEL, MO), Jul 1989 (ster.), *L. Urrego 721* (COAH, MEDEL, MO); Cuenca Río Caquetá, 00°50'S, 71°50'W, 22 Nov 1991 (stam. fl bud), *J. Duivenvoorden et al. 1361* (BRIT, COAH, COL, U); Quebrada el Tigre, 8 km N of mouth, 2 km, 20 Sep 1988 (immature bud), *M. Sanchez et al. 1347* (COAH, MO). Vaupés: Amazon Basin, Río Negro, San Felipe de Vaupés, 200 m, 13–25 Nov 1952 (ster.), *H. Humbert 27511* (COL, P). **VENEZUELA**. Amazonas: Depto. Atabapo, SE bank of middle portion Caño Yagua at Cucurital de Yagua, 03°36'N, 66°34'W, 120 m, 8 May 1979 (pist. fl, fr), *G. Davidse et al. 17404* (MO, US, VEN); below Salto Los Monos, on tributary of headwaters of Río Iguapo, 03°35'N, 65°23'W, 1500–1650 m, 12 Mar 1985 (fr), *R. Liesner 18601* (MO, VEN); third slope, on Río Atacavi, 03°12'N, 67°24'W, 100 m, Nov 1989 (fr), *J.*

Velazco 1126 (BRIT, PORT, VEN); Depto. Atabapo/Casiquiare, El Almidón, Río Atacavi, slope 2, 03°04'N, 67°06'W, 80 m, Nov 1989 (stam. fl bud), *J. Velazco 870* (BRIT, PORT, VEN). Depto. Atures, Second camp 110 km above Río Guayapo, 04°18'N, 67°28'W, 120 m, May 1989 (fr), *E. Foldats & J. Velazco 9318* (BRIT, NY, MO, PORT); Depto. Casiquiare, Caño San Miguel, sector "Las Tinajas," 02°39'N, 66°45'W, 160 m, 25 Apr 1991 (fr), *G. Aymard 9232* (BRIT, PORT, VEN); Depto. Río Negro, Bona, 10 km NE of San Carlos de Río Negro, ca. 20 km S of confluence of Río Negro & Brazo Casiquiare, 01°56'N, 67°03'W, 119 m, 21 Dec 1978 (pist. fl), *H. Clark & P. Maquirino 6907* (BRIT, MO, VEN), 6 May 1979 (pist. fl, fr), *H. Clark 7172* (MO, VEN), 2 Mar 1979 (pist. fl, fr), *H. Clark 7053* (MO, VEN), 7 Apr 1979 (pist. fl, fr), *R. Liesner 6302* (MO, VEN), 16 Apr 1979 (pist. fl, fr), *R. Liesner 6692* (MO, VEN), 25 Jan 1985 (stam. fl), *B. Boom et al. 5361* (GH, NY, US, VEN); Alto Río Negro, Yapacana Savanna, 16 Mar 1953 (pist. fl), *B. Maguire & J. Wurdack 34547* (MO, NY, US, VEN), (stam. fl), *B. Maguire & J. Wurdack 34574* (F, MO, NY, US, VEN), *B. Maguire & J. Wurdack 34575* (F, MO, NY, US, VEN); Sierra de Unturán, 01°33'N, 65°12'W, 1,150 m, 3 Feb 1989 (stam. fl), *A. Henderson 941* (BRIT, NY, VEN); Cerro de la Neblina base camp, Río Mawarinuma, 00°50'N, 66°10'W, 140 m, 8 Feb 1995 (pist. fl), *B. Boom & A. Weitzman 5698* (BRIT, F, GH, MO, NY, US, VEN). **PERU.** Loreto: Campamento Petrolero San Jacinto, Río Tigre, 02°15'S, 75°50'W, 200 m, 16 Sep 1979 (pist. fl, fr), *C. Díaz & N. Jaramillo 1463* (AMAZ, F, MO, USM). **BRAZIL.** Amazonas: Munícipio Pres. Figueredo, Rioi Uatumã, Igarapé Catitu, right margin, 01°- 02°S, 59°-60°W, 29 Mar 1986 (fr), *C. Cid et al. 7014* (BRIT, INPA, MG, NY); Km 130, Manaus-Caracaraí Rd., 1 Dec 1974 (stam. fl), *A. Gentry 12960* (INPA, MO); Munícipio São Gabriel do Cachoeira, Ilha Tamanduá, at mouth of Rio Uaupés (Rio Caiari), 2 km above Cumunidade Jowavira, near Ilha de Flores, .30 Dec 1989 (fr), *B. Nelson et al. 1719* (BRIT, MG, INPA, NY); Rio Negro, near mouth of Rio Xié, opposite São Marcelino, 00°55'N, 67°15'W, 21 Oct 1987 (fr), *D. Stevenson et al.779* (BRIT, INPA, MG, NY). Pará: Município de Itaituba, Serra do Cachimbo, Base Aérea, 5 km behind the Cachimbo Airport, along bank of Rio Formiga, 27 Apr 1983 (fr), *M. N. Silva et al. 136* (BRIT, INPA, MG, NY).

Clusia spathulaefolia is most closely related to *C. aymardii*, the two having free-standing, terrestrial habit, stiffly coriaceous to cartilaginous and nitid leaf blades with rounded to truncate apices, the subsessile to sessile flowers, cuneiform stigmas and strongly ribbed fruits in common. *Clusia spathulaefolia,* along with *Clusia pusilla* Steyermark, and several species of Myrsinaceae, most notably *Cybianthus spicatus* (H.B.K.) Agostini, and *C. fulvopulverulentus* (Mez) Agostini subsp. *magnoliifolius* (Mez) Pipoly, all grown on Serra do Cachimbo, suggesting that it may be a tepui satellite not previously listed in Maguire's (1979) treatise on the phytogeography of the Guayana Highland.

3. **Clusia aymardii** Pipoly, sp. nov. (Fig. 5)

Ob habitu arboreum, folia rigido-coriacea vel cartilaginosa, supra nitida subter pallidaque, ad apicem late rotundata vel truncata, flores sessiles vel subsessiles, pedicelos usque 1 mm longos necnon stigmatibus cuneiformibus denique fructus praeclare costatus *C. spathulaefoliae* valde arcte affinis, sed ab ea laminis oblongis vel ellipticis (nec oblanceolatis vel obovatis), ad basem obtusis vel late rotundatis (nec attenuatis), secus marginis planis (nec revolutis), petiolis subteretibus (non marginatis) 3–5 (nec 1.5–2.2) cm longis, et ramulis 10–22 (non 7–10) mm in diametris facile cognoscitur.

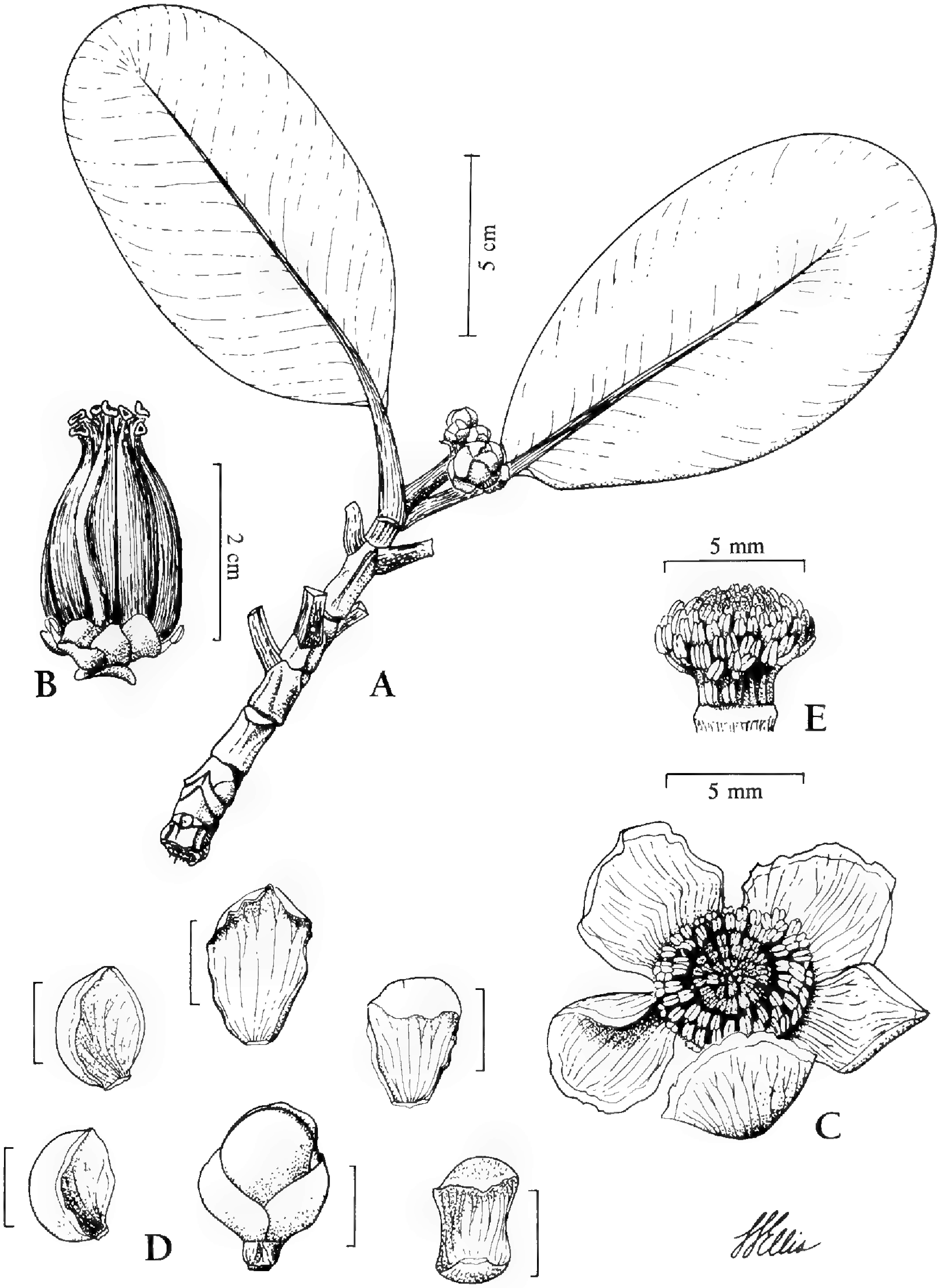

FIG. 5. *Clusia aymardii* Pipoly. A. Habit, showing cartilaginous leaves with broadly rounded bases and subterete petioles, erect inflorescence and sessile flowers. B. Fruit, showing costae. C. Staminate flower at anthesis, showing numerous stamens and somewhat clawed petals with hyaline, scarious margins. D. Staminate flower bud, showing sepals (on left), and petals (above and on right). E. Androecium, showing emarginate anthers. A, C–E, drawn from type; B, drawn from *G. Aymard 5918*. All unmarked scale bars represent 5 mm.

Glabrous, free-standing tree to 3 m tall; latex white, branchlets terete, 10–15(–22) mm diam., longitudinally ridged when dry. Leaves cartilaginous, the blades oblong elliptic, (10–)12–18 cm long, (5–)7–11 cm wide, apex very widely rounded to truncate, base obtuse to widely rounded and slightly inequilateral, nitid above, pallid below, costa raised above and below, secondary veins numerous, inconspicuous, latex canals, narrow, veinlike, margin entire, opaque; petiole subterete, (3–)3.5–4(–5) cm long, longitudinally ridged. Inflorescence erect, glomerate, (4–)8–12-flowered, peduncle essentially terete, 1–2 cm long; floral bracts 4, decussate, cartilaginous, oblate to depressed-ovate, (5–)8–10 mm long, 10–13 mm wide, apex obtuse, base subauriculate, carinate medially, margin scarious; pedicels obsolete. Staminate flower with latex canals not obvious in any perianth part; outer sepals 2, opposite, coriaceous, depressed-ovate, 7.7–8.4 mm long, 9.8–11.4 mm, wide, apex truncate, margin scarious, entire, inner sepals 5, contorted, coriaceous, obovate-spathulate, 9–12 mm long, 7.7–9.8 mm wide, apex broadly rounded, margin scarious, entire; petals 5, spirally arranged, chartaceous, 13.5–17.2 mm long, white, somewhat clawed; limb widely obovate, 7–8.4 mm long, 9.1–10.8 mm wide, apex truncate, base cuneate, with numerous longitudinal linear resin canals, the margin entire, undulate, hyaline, scarious, the claw 6.5–9.8 mm long, 3.6–4.2 mm wide; stamens numerous, 2.5–2.9 mm long, free; filaments prismatic, 1.5–1.8 mm long; anthers muticous, developmentally adnate to abaxial stamen surface, 0.8–1.1 mm long, distally highly recurved, emarginate at apex and base. Pistillode absent. Pistillate flower (in bud) like staminate but .sepals 7, the outer 2, decussate, oblate, 5 mm long, 8–10 mm wide, the inner 5, spiral, same shape, size and texture as in staminate flower; staminodes chartaceous, resiniferous, numerous, in one whorl, at times several connate in phalanges, anantherous, 6–8 mm long, 2–3 mm wide, apex muticous; pistil oblongoid, 5 mm long, 4 mm diam., styles absent, stigmas cuneiform, ca. 1.5 mm long, 1 mm wide. Fruit a 7-carpelled capsule, oblongoid, crimson, 3 cm long, 1.5 cm diam., strongly ribbed, the stigmas sessile, cuneiform, flat, persistent.

TYPE. VENEZUELA. BOLÍVAR: summit of Cerro Guaiquinima, falls at Río Szczerbanari (Río Carapó), 1–2 km upriver from Szczerbanari Falls, 05°44'04" N, 63°41'08" W, central part of mountain, 750 m, 20–25 Jan 1977 (stam. fl), *J. Steyermark & G. C. K. & E. Dunsterville 113157* (HOLOTYPE: VEN!; ISOTYPES: F!, MO!, NY, US).

PARATYPES. VENEZUELA. BOLÍVAR: Dtto. Heres, Cerro Guaiquinima, Camp 2, 05° N, 63°00'W, 1,200 m, 7 Feb 1990 (stam. fl), *B. Boom 9430* (BRIT, NY, VEN); central base of Guaiquinima-Tepuí, scrub forests along Quebrada Martínez, 85 km S of La Paragua, 06°04'N, 63°22'W, 500 m, 11 May 1987 (fr), *G. Aymard 5918* (PORT); Mpio. Raul Leoni, Cerro Guaiquinima, ca. 15 km NE of Río Paragua, 05°43'N, 63°35'W, 800 m, Nov 1988 (pist. fl bud), *Y. Fernández 275* (BRIT, PORT, VEN).

Distribution.—Endemic to Cerro Guaiquinima, state of Bolívar, Venezuela, at 750–1,200 m elevation.

Ecology and conservation status.—*Clusia aymardii* occurs only in scrub forests on the slopes and summit of Cerro Guaiquinima, and as an endemic, may be considered threatened.

Clusia aymardii is most closely related to *C. spathulaefolia*, but is easily recognized by the oblong to elliptic leaf blades with obtuse to broadly rounded bases and flat margins, the subterete, longer petioles, and thicker branchlets. While Cerro Guaiquinima is known to be poor in terms of numbers of endemic species (Pipoly 1992), *C. aymardii* is a remarkably distinct species.

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BOOK REVIEW

GRAHAM, LINDA E. 1993. **Origin of Land Plants.** (ISBN 0-471-61527-7, hbk.) John Wiley and Sons, New York. $89.00. 287 pp. 189 figures.

Linda Graham's entire career had been devoted to research on the origin of embryophytes from algal progenitors. In the *Origin of Land Plants*, she summarizes and synthesizes not only her own outstanding research, but the history of the debate, the pertinent research by other workers, and further unresolved issues. Although anyone would be tempted to bias such a synthesis in favor of one's own favorite hypothesis, she had provided a balanced, almost detached, review of the questions of embryophyte origins.

The first three chapters provide background to the problem of embryophyte origin, including early Paleozoic environments, current research methods being applied, and the consensus that the Charophyceae are the closest algal relatives of land plants. The next three chapters examine the Charophyceae in detail and compare them to land plants. Three more chapters follow with in-depth discussions on the evolution of significant features such as the cytoskeleton, cytokinesis, origin of embryos' sporophytes, nutrient transfer regions, control or meiosis, phytochrome systems, and phenolic biosynthetic pathways. The final chapter recapitulates the ideas presented in the previous chapters.

The book is clearly aimed at advanced undergrads, graduate students and professional botanists. In the final chapter Dr. Graham reveals her hopes that the book (or least that chapter) will be used by authors of introductory texts to update the often mistaken view students have of plant evolution. Certainly I found the book, especially chapters 3, 7, and 10, to be of great help in preparing lectures for an introductory botanical survey course at Southern Methodist University.

The book is a welcomed addition to the modern botanical literature, and I recommend it for every botany professor and college library.—*Roger W. Sanders.*

SUBTRIBAL CLASSIFICATION OF THE NEW WORLD ERAGROSTIDEAE (POACEAE: CHLORIDOIDEAE)

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ABSTRACT

A subtribal classification system for 38 genera of Eragrostideae that occur in the New World is presented. Seven recognized subtribes include: Eleusininae, Eragrostidinae, Monanthochloinae, Muhlenbergiinae, Munroinae, Sporobolinae, and Uniolinae. A comparative discussion outlining the recent classification history is included. Diagnostic fully comparative descriptions are given for each subtribe and a new subtribe, Munroinae, is validated.

RESUMEN

Se presenta un sistema de clasificación tribal de 38 géneros de Eragrostideae que viven en el Nuevo Mundo. Las siete subtribus reconocidas son: Eleusininae, Eragrostidinae, Monanthochloinae, Muhlenbergiinae, Munroinae, Sporobolinae, y Uniolinae. Se incluye una discusión comparativa que esboza la historia de la clasificación reciente. Se ofrece una descripción diagnóstica comparativa completa de cada subtribu y se valida una nueva subtribu, Munroinae.

INTRODUCTION

The tribe Eragrostideae in the subfamily Chloridoideae includes approximately 80 genera and 1000 species or about one-tenth of all grasses. These

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taxa are primarily distributed in the subtropical to tropical regions in arid climates with centers of distribution in the savannahs of southern Africa and north central Mexico. In the New World or Western Hemisphere, we recognize 38 genera and about 427 species with the highest concentration in north central Mexico and southwestern United States.

Within the Eragrostideae there is considerable variation in morphology, anatomy, and cytology (Peterson 1988, 1989; Peterson & Annable 1990, 1991, 1992; Peterson et al. 1989, 1993, 1996; Peterson & Herrera 1995; Valdes-Reyna & Hatch 1991). It is difficult, if not impossible to select diagnostic characteristics that exclusively delimit the Eragrostideae from other tribes in the Chloridoideae. However, the tribe commonly has paniculate inflorescences (occasionally racemose), laterally compressed or terete (rarely dorsiventral) spikelets, lemmas 3-nerved (occasionally 1 or more than 3-nerved), and disarticulation typically above the glumes (Peterson et al. 1996).

In *Flora Capensis*, Stapf (1898) first used the tribal name Eragrosteae (= Eragrostideae) where he recognized four genera: *Desmostachya* (Hook. f) Stapf, *Diplachne* P. Beauv. (= *Leptochloa*), *Eragrostis*, and *Pogonarthria* Stapf. Pilger (1956) increased the number of taxa in the Eragrostideae to include 53 genera in six subtribes. Five out of the six Eragrostideae subtribes (Eragrostinae, Lycurinae, Muhlenbergiinae, Scleropogoninae, and Sporobolinae) used by Pilger contain indigenous New World genera.

Relationships among these genera have been problematic and agrostologists have attempted to sort out a classification that reflects common ancestry. The primary objective of the present study is to present a comprehensive, fully comparative classification system for the 38 native and introduced New World genera of the Eragrostideae. In addition to presenting our new classification, we include a review of the major classifications used in the last half century. A proposed classification recognizing seven subtribes is given to elucidate probable phylogentic relationships among the New World genera.

METHODS

A discussion is presented for those classification treatments that were considered important for the New World genera of the Eragrostideae and these include: Hitchcock and Chase (1951), Pilger (1954, 1956), Gould and Shaw (1983), Clayton and Renvoize (1986), and Watson and Dallwitz (1992). An outline of these classifications is presented in Table 1. Associated with Table 1 is a discussion on the characters used by the authors to delimit the categories. This information was extracted from their keys and descriptions. Within each classification outline we primarily included only those categories pertinent to the New World genera. Recognition of subtribes was based on a synthesis of data from relevant systematic disciplines and includes morphological, anatomical, cytological, ecological, and molecular characteristics. In addition, this classification reflects our knowledge gained from experience studying these taxa in the laboratory and field.

The DELTA system (Dallwitz 1980; Dallwitz et al. 1993) was used in the selection of characters and production of diagnostic comparative descriptions of the seven recognized subtribes. Initially, a list of 90 characters was constructed to account for variation at the generic level for the Eragrostideae. A full range and adequate number of herbarium specimens were analyzed and data were recorded for the 38 recognized New World genera. A comprehensive taxonomic account for these genera is forthcoming (Peterson et al. 1996). INTKEY was used to combine data for the genera of a subtribe. For example, the DELTA format data of the Monanthochloinae was produced through INTKEY by combining the data for the members, specifically *Allolepis, Distichlis, Jouvea, Monanthochloë, Reederochloa,* and *Swallenia*. This combined DELTA format data was converted to the natural language description presented here. Selection of the 21 characters presented in these descriptions was based on their diagnostic value and on the value of the character in distinguishing among the subtribes. Additional methods concerning the application of the DELTA programs can be found in Webster (1988, 1992a, 1992b).

HISTORICAL CLASSIFICATION

It is important to present a discussion of the relevant classifications of this group. Included here in chronological order are discussions of the treatments by Hitchcock and Chase (1951), Pilger (1954, 1965), Gould and Shaw (1983), Clayton and Renvoize (1986), and Watson and Dallwitz (1992). Important characteristics used to distinguish among their catagories are outlined together with the placement of our 38 New World genera.

The Eragrostideae are treated by Hitchcock and Chase (1951) in three tribes: Agrostideae, Chlorideae, and Festuceae (Table 1). Their Agrostideae (*Blepharoneuron*, *Calamovilfa*, *Crypsis*, *Lycurus*, *Muhlenbergia*, *Sporobolus*) is based on the presence of perfect, 1-flowered spikelets, and paniculate inflorescences. Although the number of florets per spikelet is a very diagnostic generic characteristic, its use to determine tribal and sufamily relationships has proven fallacious. Therefore, members of their Agrostideae have been subsequently re-aligned to other tribes in the Poaceae. Their Chlorideae included six genera (*Dactyloctenium*, *Eleusine*, *Leptochloa*, *Munroa*, *Trichoneura*, *Tripogon*) are characterized as having 1-to several-flowered spikelets in two rows along one side of a continuous rachis. The inflorescence consists of spikes or spike-like racemes, either solitary, digitate, or racemosely arranged along the main axis. The Festuceae as interpreted by Hitchcock and Chase

(1951) includes the following genera: *Blepharidachne*, *Distichlis*, *Eragrostis*, *Eragrostis* (in part, *Neeragrostis*), *Monanthochloë*, *Redfieldia*, *Scleropogon*, *Ectosperma* (=*Swallenia*), *Neyraudia*, *Tridens* (in part, *Dasyochloa*, *Erioneuron*), *Triplasis*, *Uniola*, *Vaseyochloa*. Nine genera (*Allolepis*, *Bealia*, *Chaboissaea*, *Gouinia*, *Jouvea*, *Neesiochloa*, *Pereilema*, *Sohnsia*, *Steirachne*, *Reederochloa*, *Tetrachne*) were not treated by Hitchcock and Chase (1951) since they do not occur in the United States.

A progressive classification of the grass family was given by Pilger (1954, 1956) who placed our 38 genera into five different tribes in two different subfamilies (Table 1). It is worthy to note that he states exceptions to most if not all characters used to define his categories. The following characteristics were used to differentiate the Eragrosteae from the other five tribes in subfamily Eragrostoideae: spikelets in loose or contracted panicles (often compounded in racemes or spikes); branches spirally inserted; glumes usually shorter than the lemma; upper floret in many-flowered spikelets often sterile; lemma usually 1 or 3-nerved, membranous to leathery; lemma apex entire, crenate, toothed or lobed, if aristate, the awn arising from the midnerve; lemma nerves often hairy; stamens 2–3; fruits usually loosely surrounded by the palea (often becoming free); pericarp thin (often loosening and leaving the seeds naked); hilum small and basal; base chromosome number 8 or 10.

Pilger's Eragrosteae included six subtribes (Eragrostinae, Scleropogoninae, Lycurinae, Garnotiinae, Sporobolinae, and Muhlenbergiinae). The Eragrostinae (including *Blepharidachne*, *Dactyloctenium*, *Eleusine*, *Eragrostis*, *Leptochloa*, *Munroa*, *Neesiochloa*, *Neyraudia*, *Redfieldia*, *Steirachne*, *Trichoneura*, *Tridens*, *Triplasis*, *Tripogon*) was separated by multi-flowered spikelets with perfect florets. The Scleropogoninae with only *Scleropogon* was characterized by unisexual spikelets with the female spikelets long aristate. Pilger's Lycurinae (including *Lycurus*) was characterized by glumes finely aristate and single-flowered spikelets. The Sporobolinae which includes *Blepharoneuron*, *Crypsis*, and *Sporobolus*, was differentiated by single-flowered spikelets, thin glumes, aristate lemmas, and rounded fruits. The Muhlenbergiinae (including *Muhlenbergia*) was separated by glumes shorter than the lemma, single-flowered spikelets, and narrow cylindrical caryopses. Pilger's final tribe that includes New World genera, the Jouveeae (*Jouvea*), was characterized by dimorphic, unisexual spikelets, with or without a rachilla extension (in female spikelets), 1-flowered female spikelets, rudimentary glumes, inflorescence a spike with few spikelets, and a thick, grooved rachis.

Pilger (1954) placed eight of our genera in the subfamily Festucoideae in three tribes (Festuceae, Aveneae, Arundineae, see Table 1). The Festuceae was separated by paniculate inflorescences, spikelets 1 to many-flowered, glumes shorter than the florets, and lemmas 3 to 5-nerved. His treatment included six of our 38 genera in three subtribes: Monanthochloinae, Festucinae, and Melicinae. The Monanthochloinae (including *Monanthochloë*) was characterized by spikelets without "outer" glumes, unisexual spikelets (dioecious or monecious), and short stiff leaves. The Festucinae (including *Distichlis*, *Uniola*, *Tetrachne*) was defined by spikelets with two outer glumes, lemmas 5 to several-nerved (rarely 3-nerved), and the lemma apex entire or bidentate. The Melicinae (including *Ectosperma* and *Vaseyochloa*) was distinguished by a several to many-nerved lemma, a paniculate inflorescence, and lemmas blunt and rounded on the back. *Calamovilfa* was placed in the Aveneae, a tribe characterized by disarticulation above the glumes, relatively long glumes, and mostly 5-nerved lemmas. The Arundineae (including *Gouinia*) was described as mostly tall reed-like in habit, rachilla or lemma hairy, outer glume shorter or equalling the spikelet length, 3 or 5-nerved lemmas, and lemmas with a straight or twisted awn. New World genera not treated by Pilger included *Allolepis*, *Reederochloa*, and *Sohnsia*.

The classification presented in Gould and Shaw (1983) represents a significant advance over that given by Hitchcock and Chase (1951). This advancement was the result of Gould's (1968, 1983) synthesis of the advancements from 1950 to 1983 (eg. Stebbins & Crampton 1961) in agrostology, specifically in the areas of anatomy, cytology, ecology, and morphology. Gould and Shaw (1983) divided the Chloridoideae into eight tribes, whereas Hitchcock and Chase only include four tribes with chloridoid genera (Agrostideae, Chlorideae, Festuceae, Zoysieae).

Five tribes recognized by Gould and Shaw (1983) do not include genera that we place in the Eragrostideae. Each of these five possess diagnostic characters that separate them from the genera of the Eragrostideae. A key to the tribes is not given by Gould and Shaw; however, diagnostic characters can be extracted from the brief descriptions associated with each tribe. The Pappophoreae is best distinguished by the presence of lemmas with 9 or mores nerves and awns. Secondary characters include a paniculate inflorescence with 3 to several florets per spikelet, ligule a line of hairs, and point of disarticulation close to the glumes. The Chlorideae is distinguished by an inflorescence of "a unilateral spike or of few to several unilateral spicate primary branches." Secondary diagnostic characters are spikelets with a single fertile floret and one or more reduced florets, 3-nerved lemmas, and ligule a line of hairs. The Orcuttieae is distinguished by the absence of a ligule and the undifferentiated leaf blade and sheath. Additional characters include persistent spikelets, 5-nerved lemmas, and paniculate inflorescences with several-flowered spikelets. Gould and Shaw define the Aristideae by 1-flowered spikelets, disarticulation above the glumes, and lemmas with an awn column usually bearing 3 awns. In addition they give many anatomical characters, such as: dumbbell-shaped silica cells, two parenchyma sheaths, and elongate chlorenchyma cells. The last tribe lacking genera we place in the Eragrostideae, Zoysieae, is differentiated by a ligule as a line of hairs, inflorescence a contracted raceme of 1-flowered spikelets, and disarticulation at the base of the spikelet.

As Table 1 indicates, Gould and Shaw (1983) place our New World Eragrostideae genera in three tribes (Aeluropodeae, Eragrosteae, Unioleae), with some not treated. The Unioleae, including only *Uniola* in the U. S., was distinguished by disarticulation below the glumes, ligule a line of hairs, large paniculate inflorescences, and several to many-flowered spikelets that have the lowermost and uppermost florets sterile. Additional anatomical characters include a leaf epidermis with club-shaped bicellular microhairs and square or saddle-shaped silica cells. Their concept of the Aeluropodeae included four of our New World genera (*Allolepis*, *Distichlis*, *Monanthochloë*, *Swallenia*). Their tribe was differentiated by the presence of a stoloniferous or rhizomatous habit, usually occurring in saline habitats, short pungent leaf blades, and inflorescences a contracted panicle or raceme, usually unisexual. Excluding those genera not treated by Gould and Shaw, the remaining 22 New World genera were lumped into the Eragrosteae. This tribe is poorly defined with numerous exceptions to all characters used to recognize the group. However, important characters include a 3-nerved lemma, 1-several flowered spikelets, a paniculate inflorescence with some rebranching of the primary branches, and disarticulation mostly above the glumes. New World genera not treated by Gould and Shaw (1983) include *Bealia*, *Chaboissaea*, *Gouinia*, *Jouvea*, *Neesiochloa*, *Neyraudia*, *Pereilema*, *Reederochloa*, *Sohnsia*, *Steirachne*, and *Tetrachne*. All of which occur in regions south of the United States.

Clayton and Renvoize (1986) separate the Chloridoideae into five tribes (Pappophoreae, Orcuttieae, Eragrostideae, Leptureae, and Cynodonteae) and nine subtribes; with five subtribes in the Eragrostideae and four subtribes in the Cynodonteae. Our New World genera of the Eragrostideae are all placed in their concept of the Eragrostideae. The Pappophoreae includes five genera and is distinguished by a many-nerved, lobed, and awned lemma, a narrow paniculate inflorescence, spikelets with several florets (commonly with the lower 2 or more florets bisexual), and disarticulation above the glumes. The Orcuttieae is delimited on leaves that are scarcely differentiated into a blade and sheath, absence of a ligule, viscid and aromatic leaf blades, lemmas with 13–15 nerves, and absence of lodicules. The Leptureae, consisting of *Lepturus*, is separated from other members of the subfamily by having a single cylindrical bilateral raceme with the spikelets alike, borne edgeways on and embedded in hollows in the fragile rachis. There do not appear to be any New World chloridoids that are morphologically similar

TABLE 1. Tribal classifications of the Chloridoideae.

Hitchcock & Chase (1951)

Subfamily Festucoideae

1. Agrostideae = *Blepharoneuron*, *Calamovilfa*, *Crypsis*, *Lycurus*, *Muhlenbergia*, *Sporobolus*
2. Aveneae
3. Bambuseae
4. Chlorideae = *Dactyloctenium*, *Eleusine*, *Leptochloa*, *Munroa*, *Trichoneura*, *Tripogon*
5. Festuceae = *Blepharidachne*, *Distichlis*, *Eragrostis* (including *Neeragrostis*), *Monanthochloë*, *Redfieldia*, *Scleropogon*, *Ectosperma* (= *Swallenia*), *Neyraudia*, *Tridens* (in part, *Dasyochloa*, *Erioneuron*), *Triplasis*, *Uniola*, *Vaseyochloa*
6. Hordeae
7. Oryzeae
8. Phalarideae
9. Zizanieae
10. Zoysieae

Not Treated = *Allolepis*, *Bealia*, *Chaboissaea*, *Gouinia*, *Jouvea*, *Neesiochloa*, *Pereilema*, *Sohnsia*, *Steirachne*, *Reederochloa*, *Tetrachne*

Pilger (1954, 1956)

Subfamily Eragrostoideae

1. Eragrosteae
    - a. Eragrostinae = *Blepharidachne*, *Dactyloctenium*, *Eleusine*, *Eragrostis* (including *Neeragrostis*), *Leptochloa*, *Munroa*, *Neesiochloa*, *Neyraudia*, *Redfieldia*, *Steirachne*, *Trichoneura*, *Tridens* (includes *Dasyochloa* and *Erioneuron*), *Triplasis*, *Tripogon*
    - b. Scleropogoninae = *Scleropogon*
    - c. Lycurinae = *Lycurus*, *Pereilema*
    - d. Garnotiinae
    - e. Sporobolinae = *Blepharoneuron*, *Crypsis*, *Epicampes* (= *Muhlenbergia* in part), *Sporobolus*
    - f. Muhlenbergiinae = *Muhlenbergia* (including *Bealia* and *Chaboissaea*)
2. Phaenospermeae
3. Chlorideae
    - a. Lepturinae
    - b. Chloridinae
4. Aristideae
5. Lappagineae
6. Jouveeae = *Jouvea*

Subfamily Festucoideae

1. Festuceae
    - a. Monanthochloinae = *Monanthochloë*
    - b. Festucinae = *Distichlis*, *Uniola*, *Tetrachne*
    - c. Melicinae = *Ectosperma* (= *Swallenia*), *Vaseyochloa*
2. Aveneae = *Calamovilfa*
3. Arundineae = *Gouinia*

Not Treated = *Allolepis*, *Reederochloa*, *Sohnsia*

Gould & Shaw (1983)

1. Eragrosteae = *Blepharidachne*, *Blepharoneuron*, *Calamovilfa*, *Crypsis*, *Dactyloctenium*, *Eleusine*, *Eragrostis*, *Erioneuron* (including *Dasyochloa*), *Leptochloa*, *Lycurus*, *Muhlenbergia*, *Munroa*, *Neeragrostis*, *Redfieldia*, *Scleropogon*, *Sporobolus*, *Trichoneura*, *Tridens*, *Triplasis*, *Tripogon*, *Vaseyochloa*
2. Aeluropodeae = *Allolepis*, *Distichlis*, *Monanthochloë*, *Swallenia*
3. Unioleae = *Uniola*

TABLE 1. *(Continued)*

4. Pappophoreae
5. Chlorideae
6. Orcuttieae
7. Aristideae
8. Zoysieae

Not Treated = *Bealia*, *Chaboissaea*, *Gouinia*, *Jouvea*, *Neesiochloa*, *Neyraudia*, *Pereilema*, *Reederochloa*, *Sohnsia*, *Steirachne*, *Tetrachne*

Clayton & Renvoize (1986)

1. Pappophoreae
2. Orcuttieae
3. Eragrostideae
   - b. Scleropogoninae = *Scleropogon*
   - a. Triodiinae
   - b. Uniolinae = *Tetrachne*, *Uniola*
   - c. Monanthochloinae = *Allolepis*, *Distichlis*, *Jouvea*, *Monanthochloë*, *Reederochloa*, *Swallenia*
   - d. Eleusininae = *Blepharidachne*, *Blepharoneuron*, *Dactyloctenium*, *Eleusine*, *Eragrostis* (including *Neeragrostis*), *Erioneuron* (including *Dasyochloa*), *Gouinia*, *Leptochloa*, *Munroa*, *Neesiochloa*, *Neyraudia*, *Redfieldia*, *Scleropogon*, *Sohnsia*, *Steirachne*, *Trichoneura*, *Tridens*, *Triplasis*, *Tripogon*, *Vaseyochloa*
   - e. Sporobolinae = *Calamovilfa*, *Crypsis*, *Lycurus*, *Muhlenbergia* (including *Bealia* and *Chaboissaea*), *Pereilema*, *Sporobolus*
4. Lepturеae
5. Cynodonteae
   - a. Pommereullinae
   - b. Chloridinae
   - c. Boutelouinae
   - d. Zoysiinae

Watson & Dallwitz (1992)

1. Triodieae
2. Pappophoreae
3. Orcuttieae
4. Chlorideae = *Allolepis*, *Bealia*, *Blepharidachne*, *Blepharoneuron*, *Calamovilfa*, *Chaboissaea*, *Crypsis*, *Dactyloctenium*, *Dasyochloa*, *Distichlis*, *Eleusine*, *Eragrostis*, *Erioneuron*, *Gouinia*, *Jouvea*, *Leptochloa*, *Lycurus*, *Monanthochloë*, *Muhlenbergia*, *Munroa*, *Neeragrostis*, *Neesiochloa*, *Neyraudia*, *Pereilema*, *Redfieldia*, *Reederochloa*, *Scleropogon*, *Sohnsia*, *Sporobolus*, *Steirachne*, *Swallenia*, *Tetrachne*, *Trichoneura*, *Tridens*, *Triplasis*, *Tripogon*, *Uniola*, *Vaseyochloa*

to *Lepturus*. Clayton and Renvoize (1986) characterize the Cynodonteae, which includes the subtribes Chloridinae and Boutelouinae, as having tough unilateral racemes (these single digitate or scattered along the axis), spikelets with one fertile floret (with or without additional staminate or sterile florets), 1–3(–5)-nerved glumes, nerveless or 3-nerved lemmas, and fruit occasionally with a free pericarp. Some genera of the Chloridinae are morphologically similar to members of our Eragrostideae. Specific examples include: *Eustachys*, *Chloris*, and *Cynodon* with 2-many digitate racemes;

Microchloa with a single raceme bearing spikelets on a semiterete rachis; and *Schedonnardus* with several racemes on a single axis bearing distant appressed spikelets on a three-angled rachis.

As indicated in Table 1, Clayton and Renvoize (1986) separate the Eragrostideae into five subtribes (Triodiinae, Uniolinae, Monanthochloinae, Eleusininae, and Sporobolinae). The Triodiinae includes only Australian genera and is best distinguished by highly xeromorphic pungent and needle-like leaf blades and disarticulation below each floret. The leaves have greatly reduced chlorenchyma tissue that occurs as narrow tracts along the stomatal grooves. The Uniolinae included the New World genera *Tetrachne* and *Uniola* and is diagnosed by the presence of several to many fertile florets, disarticulation below the glumes, and glumes shorter than the strongly keeled lemmas. Clayton and Renvoize's third subtribe the Monanthochloinae includes the New World genera *Allolepis*, *Distichlis*, *Jouvea*, *Monanthochloë*, *Reederochloa*, and *Swallenia*. Significant diagnostic characters of this group include are distichous often pungent leaf blades, spikelets with several to many perfect florets, disarticulation usually below each floret, and lemmas 5–13-nerved and thick textured. The Sporobolinae included six New World genera (*Calamovilfa*, *Crypsis*, *Lycurus*, *Muhlenbergia*, *Pereilema*, *Sporobolus*). Their concept of *Muhlenbergia* included *Bealia* and *Chaboissaea*. Important characters for this subtribe included inflorescence a panicle, spikelets 1-flowered, the rachilla not extending above the floret, and lemma 1–3-nerved, usually membranous. Clayton and Renvoize's (1986) Eleusininae includes 20 New World genera: *Blepharidachne*, *Blepharoneuron*, *Dactyloctenium*, *Eleusine*, *Eragrostis* (including *Neeragrostis*), *Erioneuron* (including *Dasyochloa*), *Gouinia*, *Leptochloa*, *Munroa*, *Neesiochloa*, *Neyraudia*, *Redfieldia*, *Scleropogon*, *Sohnsia*, *Steirachne*, *Trichoneura*, *Tridens*, *Triplasis*, *Tripogon*, *Vaseyochloa*. Important characters in this diverse subtribe include: spikelets with 2-many fertile florets, lemmas 3-nerved, and an inflorescence more often a raceme but sometimes a panicle.

Watson and Dallwitz (1992) recognized four tribes within subfamily Chloridoideae. These include the Triodieae, Pappophoreae, Orcuttieae, and Chlorideae. The distinguishing characters among these tribes are not clearly defined in their database nor hardcopy publication. However, in the interactive database, genera of the Orcuttieae can be separated from the Chlorideae by not having leaves that are clearly differentiated into a sheath and blade. Genera of the Pappophoreae can be characterized by lemmas with 7-many nerves and 7-many lobes, disarticulation above the glumes, paniculate inflorescences, and relatively long glumes. New World Troidieae (including only *Triodia*) can be differentiated from other chloridoids by indurate lemmas and hard, needle-like leaf blades. All of our New World

Eragrostideae are grouped by Watson and Dallwitz (1992) in the Chlorideae without recognition of subtribal categories.

PROPOSED CLASSIFICATION

Based primarily on morphological characteristics, we have attempted to place the genera of Eragrostideae into natural groups. We have included the naturalized genera along with the autochthonous genera, even though many of the remaining genera in each of the subtribes may be centered in other continents. By using results from our phenetic analysis (Peterson et al. 1996) and review of the literature, especially on data from chloroplast DNA restriction site comparisons (Duvall et al. 1994), the New World Eragrostideae is appropriately divided into seven subtribes: Eleusininae, Eragrostidinae, Monanthochloinae, Muhlenbergiinae, Munroinae, Sporobolinae, and Uniolinae (see Table 2).

Dactyloctenium and *Eleusine* are the New World representatives of the Eleusininae. An inflorescence with digitate primary branches is the diagnostic characteristic for this subtribe. Additional significant characters that define the Eleusininae include the presence of a free pericarp and a membranous ligule. The Eleusininae obviously has arisen in the Old World tropics, quite possibly in East Africa where species diversity of *Dactyloctenium* and *Eleusine* is greatest. The few species represented in the New World of these two genera suggest migration from the Old World has occurred recently.

The Eragrostidinae is, at best, an unnatural grouping of convenience, since the relationships among these 15 genera is poorly understood (Table 2). However, based on the full range of characters used here, these genera are presently excluded from our other subtribes. More than one floret per spikelet, fruit with an adnate pericarp, and base chromosome number of 10, 20 or 30 distinguishes the Eragrostidinae from the Eleusininae, Munroinae, Sporobolinae, and the Uniolinae. Important characters that can be used to separate the Eragrostidinae from most of the Monanthochloinae and Muhlenbergiinae include leaf arrangement (distichous in Monanthochloinae), sexuality (dioecious in Monanthochloinae, except *Swallenia*), lemma texture (relatively thick in Monanthochloinae), and number of lemmatal nerves (3-nerved in Muhlenbergiinae). No characters exclusively distinguish the Eragrostidinae from the Muhlenbergiinae. Eventually, as new data becomes available we suspect that many of these 15 taxa will be aligned within other current subtribes or placed within new, smaller monophyletic assemblages.

The Uniolinae is a curious small subtribe that includes only four genera worldwide (Clayton & Renvoize 1986), three distributed in Africa and *Uniola* centered along the subtropical and tropical coastal regions of North

Table 2. The subtribal classification of the New World Eragrostideae.

Eleusininae Dumort., Anal. Fam. 63. 1829. Type: *Eleusine*

Genera:
Dactyloctenium
Eleusine

Eragrostidinae Presl, Rel. Haenk., 1:273. 1830. Type: *Eragrostis*

Genera:
Eragrostis
Gouinia
Leptochloa
Neeragrostis
Neesiochloa
Neyraudia
Redfieldia
Scleropogon
Sohnsia
Steirachne
Trichoneura
Tridens
Triplasis
Tripogon
Vaseyochloa

Monanthochloinae Potztal, Willdenowia 5:472. 1969. Type: *Monanthochloë*

Genera:
Allolepis
Distichlis
Jouvea
Monanthochloë
Reederochloa
Swallenia

Muhlenbergiinae Pilger, Nat. Pfl. Fam. ed.2, 14d:168. 1956. Type: *Muhlenbergia*

Genera:
Bealia
Blepharoneuron
Chaboissaea
Lycurus
Muhlenbergia
Pereilema

Munroinae Parodi ex P. M. Peterson, Gram. Bonar. ed. 4:28. 1946, nom nud. Type: *Munroa*

Genera:
Blepharidachne
Dasyochloa
Erioneuron
Munroa

Sporobolinae Benth., J. Linn. Soc., Bot. 19:30. 1881. Type: *Sporobolus*

Genera:
Calamovilfa
Crypsis
Sporobolus

Uniolinae Clayton, Kew Bull. 37:417. 1982. Type: *Uniola*

Genera:
Tetrachne
Uniola

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and Central America. Presence of 5–20 florets per spikelet, fruit with a free pericarp, and ligule a line of hairs are characters, when used in combination, that serve to distinguish the Uniolinae from the other subtribes. Characters of secondary significance include: a 3–9-nerved lemma, primary inflorescence branches racemose or paniculate, and lemma entire at the apex. The Uniolinae shows some affinities with the Eleusininae, since both subtribes contain species with free pericarps, laterally flattened spikelets, and spikelets that are two-ranked along primary inflorescence branches.

Calamovilfa, *Crypsis*, and *Sporobolus* are the New World members of the Sporobolinae, which is exclusively defined by the presence of a 1-nerved lemma. Secondary diagnostic characters include one floret per spikelet and a line of hairs for a ligule. The Sporobolinae are closely linked to the Eleusininae and Uniolinae, as all three subtribes possess fruits with free pericarps. Our analysis does not indicate a close affinity between the Muhlenbergiinae and the Sporobolinae even though both have a one-flowered spikelet. Origin of the Sporobolinae probably lies in Africa or the Eastern Mediterranean where species diversity is greatest.

Allolepis, *Distichlis*, *Jouvea*, *Monanthochloë*, *Reederochloa*, and *Swallenia* are the New World members of the Monathochloinae (Table 2). For most taxa, the presence of distichous leaf arrangement, thick textured lemmas, and the dioecious habit distinguishes this subtribe. Secondary diagnostic characters include florets 2–25 per spikelet, fruit with an adnate pericarp, and lemmas entire at the apex. Numerous morphological and anatomical adoptions, i.e., distinctly distichous leaf arrangement and bicellular microhairs with enlarged bases, are found in some members of this subtribe. These adaptations are in direct response to the environment, since most of the species occur in saline habitats. Based on our phenetic analyses and those by Soderstrom and Decker (1963, 1964, 1965), the Monanthochloinae seems to be a good monophyletic unit. The Monanthochloinae is primarily New World in distribution, only *Aeluropus* Trin. is restricted to the Mediterranean, northern China, Ethiopia, and Sri Lanka.

The distribution of the Muhlenbergiinae is almost entirely New World, only approximately eight of the 160 species of *Muhlenbergia* are known to occur in southern Asia. The six genera of the Muhlenbergiinae (*Bealia*, *Blepharoneuron*, *Chaboissaea*, *Lycurus*, *Muhlenbergia*, *Pereilema*) are characterized by 1–3 florets per spikelet, 3-nerved lemmas, true caryopses, and a base chromosome number of 8 or 10. These characters do not adequately distinguish the Muhlenbergiinae from the Munroinae. However, the Munroinae always has 2–12 florets per spikelet and the lemma apex is usually emarginate to cleft, whereas, the Muhlenbergiinae usually has a single floret per spikelet and the lemma apex is mostly entire. Evidence from molecular data supports this subtribe as being monophyletic (Duvall et al. 1994).

The Munroinae, originally named by Parodi, is formally described below. At present, this subtribe consists exclusively of the following New World genera: *Blepharidachne*, *Dasyochloa*, *Erioneuron*, and *Munroa*. Diagnostic characteristics of the subtribe include lemmas with emarginate to cleft apices and a base chromosome number of $x = 7$ or 8. Molecular studies support the conclusion that the Munroinae evolved from a common ancestor (Duvall et al. 1994).

Munroinae Parodi ex P. M. Peterson, subtribus nov. Parodi, Gram. Bonar. ed. 4:28. 1946, nom nud.

Vaginae ciliatae; spiculae 2–20 flosculis; lemmata 3-nervia, villosa, aristata, emarginata vel lobata; stamina 1–3 flava; chromosomata: x = 7 vel 8.

TYPUS: *Munroa* Torr.

DESCRIPTIONS FOR RECOGNIZED SUBTRIBES

Eleusininae

Plants hermaphroditic. Ligule a membrane or a ciliate membrane. Leaf blades linear. Primary branches of the inflorescence digitate. Spikelets 4–6 mm long; laterally compressed. First glume 1-nerved. Second glume shorter than lower lemma; 1–3(–5)-nerved. Rachilla pronounced between the florets. Florets 3–15 per spikelet. Sterile florets present. Lemma entire; awned, mucronate, or unawned; glabrous; 3–5-nerved; membranous. Palea membranous. Lodicules truncate or acuminate. Fruit with a free pericarp. Base chromosome number, x = 9, 10, or 12.

Genera Included: *Dactyloctenium* Willd., and *Eleusine* Gaertn.

Eragrostidinae

Plants hermaphroditic, dioecious, or monoecious. Ligule a membrane, a ciliate membrane, or a line of hairs. Leaf blades filiform, linear, or triangular. Primary branches of the inflorescence not digitate. Spikelets 1–40 mm long; laterally compressed or terete. First glume 1–5-nerved. Second glume shorter than or about the same length as the lower lemma; 1–9-nerved. Rachilla pronounced between the florets. Florets 2–60 per spikelet. Sterile florets present (occ. absent in *Eragrostis*). Lemma entire, emarginate, lobed, or cleft; awned, mucronate, or unawned; glabrous or hairy; 3–9-nerved; hyaline, membranous, chartaceous, coriaceous, or indurate. Palea hyaline, membranous, or chartaceous. Lodicules truncate, rounded, or acuminate. Fruit with an adnate pericarp. Base chromosome number, x = 10, 20, or 30.

Genera Included: *Eragrostis* Wolf, *Gouinia* Benth., *Leptochloa* P. Beauv., *Neeragrostis* Bush, *Neesiochloa* Pilger, *Neyraudia* Hook. f., *Redfieldia* Vasey, *Scleropogon* Phil., *Sohnsia* Airy-Shaw, *Steirachne* Ekman, *Trichoneura* Anderss., *Tridens* Roem. & Schult., *Triplasis* P. Beauv., *Tripogon* Roem. & Schult., and *Vaseyochloa* Hitchc.

Monanthochloinae

Plants hermaphroditic or dioecious. Ligule a membrane, a ciliate membrane, or a line of hairs. Leaf blades linear. Primary branches of the inflorescence not digitate. Spikelets 5–30 mm long; laterally compressed or terete. First glume 0–8-nerved. Second glume shorter than or about the same length as the lower lemma; 1–11-nerved. Rachilla pronounced or not pronounced between the florets. Florets 2–25 per spikelet. Sterile florets present. Lemma entire; unawned; glabrous or hairy; 3–13-nerved; chartaceous, or coriaceous, or indurate. Palea membranous, chartaceous, coriaceous, or indurate. Lodicules truncate or cuneate. Fruit with an adnate pericarp. Base chromosome number, x = 10, 19, or 20.

Genera Included: *Allolepis* Soderstr. & Deck., *Distichlis* Raf., *Jouvea* Fourn., *Monanthochloë* Engelm., *Reederochloa*, and *Swallenia* Soderstr. & Deck.

Muhlenbergiinae

Plants hermaphroditic or andromonecious. Ligule a membrane or a ciliate membrane. Leaf blades filiform or linear. Primary branches of the inflorescence not digitate. Spikelets 0.5–8 mm long; laterally compressed, terete, or dorsiventrally compressed. First glume 1–3-nerved. Second glume shorter than, about the same length as, or longer than lower lemma; 1–4-nerved. Rachilla pronounced or not pronounced between the florets. Florets 1–3 per spikelet. Sterile florets present or absent. Lemma entire, emarginate, or lobed; awned, mucronate, or unawned; glabrous or hairy; 3-nerved; hyaline, membranous, or chartaceous. Palea hyaline, membranous, or chartaceous. Lodicules truncate. Fruit with an adnate pericarp. Base chromosome number, x = 8, or 10. Genera Included: *Bealia* Scribn., *Blepharoneuron* Nash, *Chaboissaea* Fourn., *Lycurus* Kunth, *Muhlenbergia* Schribn., and *Pereilema* Presl.

Munroinae

Plants hermaphroditic, monoecious, or gynomonoecious. Ligule a ciliate membrane, a line of hairs, or absent. Leaf blades linear, or triangular. Primary branches of the inflorescence not digitate. Spikelets 5–12 mm long; laterally compressed. First glume 1-nerved. Second glume shorter than lower lemma, about the same length as the lower lemma, or longer than lower lemma; 1-nerved. Rachilla pronounced between the florets. Florets 2–12 per spikelet. Sterile florets present. Lemma emarginate, lobed, or cleft; awned; hairy; 3-nerved; membranous, or coriaceous. Palea membranous. Lodicules truncate, or cuneate. Fruit with an adnate pericarp. Base chromosome number, x = 7, or 8.

Genera Included: *Blepharidachne* Hack., *Dasyochloa* Rydb., *Erioneuron* Nash, and *Munroa* Torr.

Sporobolinae

Plants hermaphroditic. Ligule a line of hairs. Leaf blades filiform, or linear. Primary branches of the inflorescence not digitate. Spikelets 1–10 mm long; laterally compressed or terete. First glume nerveless or 1-nerved. Second glume about the same length as the lower lemma; 1-nerved. Rachilla not pronounced between the florets. Florets 1 per spikelet. Sterile florets absent. Lemma entire; unawned; glabrous or hairy; 1-nerved; hyaline, membranous, or chartaceous. Palea hyaline, membranous, or chartaceous. Lodicules truncate. Fruit with a free pericarp. Base chromosome number, x = 8, 9, or 10.

Genera Included: *Calamovilfa* (A. Gray) Scribn., *Crypsis* Ait., and *Sporobolus* R. Br.

Uniolinae

Plants hermaphroditic. Ligule a line of hairs. Leaf blades linear. Primary branches of the inflorescence not digitate. Spikelets 3–30 mm long laterally compressed. First glume 1–5-nerved. Second glume shorter than lower lemma; 1–5-nerved. Rachilla pronounced between the florets. Florets 5–20 per spikelet. Sterile florets present. Lemma entire; unawned; glabrous; 3–9-nerved; membranous or coriaceous. Palea membranous or chartaceous. Lodicules truncate. Fruit with a free pericarp. Base chromosome number, x = 10.

Genera Included: *Tetrachne* Nees and *Uniola* L.

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Appreciation is extended to Joseph H. Kirkbride for providing an English translation of Pilger's (1956) treatment of the Eragrostoideae. Stephan L. Hatch, David W. Hall, and Harold E. Robinson are thanked for reviewing the manuscript on short notice.

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MARSILEA MINUTA (MARSILEACEAE): NEW TO FLORIDA AND NORTH AMERICA

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ABSTRACT

Marsilea minuta L. (Marsileaceae), discovered in a streetside ditch in Escambia County, Florida, is here reported as newly introduced for Florida and North America. A probable explanation of its introduction via waterfowl and its potential as a weed are considered.

ABSTRACT

Se cita *Marsilea minuta* L. (Marsileaceae), descubierta en una cuneta del borde de la carretera en el Condado de Escambia, Florida, como reciente neófito para Florida y Norte América. Se discute una explicación probable de su introducción mediante las corrientes de agua y su potencial como mala hierba.

An obviously spontaneous population of the primarily tropical water-clover fern *Marsilea minuta* L. has been found growing in a streetside ditch at the northwest corner of Lownde Avenue and Grundy Street in a residential subdivision on the southwest side of the Pensacola area in Escambia County, Florida. At the time of discovery it was realized that the nearest documented sites for *Marsilea* in Florida were many kilometers to the east and south in the peninsula (Ward and Hall 1976; Johnson 1986) and in Apalachicola (Anderson 1986) for the species *M. vestita* Hook. & Grev. and westward in Mobile, Alabama, for *M. macropoda* Engelm. ex A. Braun in Kunze (Burkhalter 1989). It was also realized that *Marsilea* in the Pensacola area constituted a new county record and a new species of vascular plant for the entire western Florida panhandle (Clewell 1980; Wilhelm 1984). Only the genus of the water-clover fern, namely *Marsilea*—a taxonomically difficult group—was recognized at the time of discovery, so a sporocarp-bearing specimen (*Burkhalter 13220*) collected 3 May 1992 was sent to David M. Johnson of Ohio Wesleyan University for determination. Dr. Johnson identified it as *Marsilea minuta* L. (Johnson 1986). Duplicates of that specimen were deposited at UWFP (Fig. 1). Additional fertile specimens (*Burkhalter 13304*) collected at the discovery site 19 June 1992 were subsequently deposited at UWFP, FSU, FLAS, USF, and NY. According to the information provided by Dr. Johnson (pers. comm. 27 August 1992)

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Marsilea minuta is hereby reported as new to Florida and North America (also see Flora N. Amer. Ed. Comm. 1993, p. 333).

At the discovery site *M. minuta* is the dominant vascular species in the described 60-cm-deep ditch for a distance of approximately 30 m northward from the stated intersection. Associated species in this section of the ditch include *Hypericum mutilum, Ludwigia decurrens, Hydrocotyle umbellata, Mikania scandens, Lipocarpha maculata, Juncus elliottii, Paspalum urvillei, Panicum repens, Sacciolepis striata, Thelypteris palustris,* and *Osmunda regalis.* The substrate is composed of black muddy silt mixed with tan sand, and standing or running water is almost constantly present. To the south of the intersection the ditch is very shallow and grades into adjacent residential lawns. There only a few scattered individuals of *M. minuta* occur over a distance of approximately 20 m in association with *Lilaeopsis attenuata, Cardamine pensylvanica*, and lawn grasses. This section of the ditch is subjected to periodic mowing. Less than 250 m southward the ditch drains into Bayou Grande, a large lagoonlike extension off the western side of Pensacola Bay. A detailed search of all ditches and other low moist habitats in the general geographic area has revealed that *M. minuta* occurs only in the ditch where it was discovered. An interview with Andrew L. Lucas, who resides across the street from the *Marsilea*-containing ditch, has provided information which leads me to conclude that the *M. minuta* colony is not very old and perhaps became established less than five years prior to its discovery.

Marsilea minuta is primarily tropical in its eastern hemisphere distribution (Johnson 1986). There it occurs as a common and widespread weed in Africa and India. In the western hemisphere, where it is introduced, it has heretofore been known only from the islands of Trinidad and Tobago and from the state of Pernambuco in eastern Brazil (Mickel 1985; Johnson 1986). The New World colonies occur at low elevations near the coast in freshwater or occasionally brackish habitats (Trinidad and Tobago) or in seasonal ponds (Brazil).

The question of how *M. minuta* became introduced into the Pensacola area deserves consideration. Johnson (1986) has reviewed the literature concerning long-distance dispersal of *Marsilea* sporocarps in the digestive tracts of migratory aquatic birds; and this mode of transport for certain species of *Marsilea*, particularly via various ducks (genus *Anas*, and possibly also *Aix*), is an established fact and a not uncommon occurrence. Dennis and Webb (1981) have commented on similar long-distance dispersal of *Pilularia* sporocarps by waterfowl. It thus seems apparent that the most probable mode of introduction of *M. minuta* into the Pensacola area is long-distance sporocarp transport via waterfowl from South America. This is particularly likely in view of the proximity of the discovery site to a waterfront area (Bayou Grande) visited by migratory waterfowl and the fact that a number of

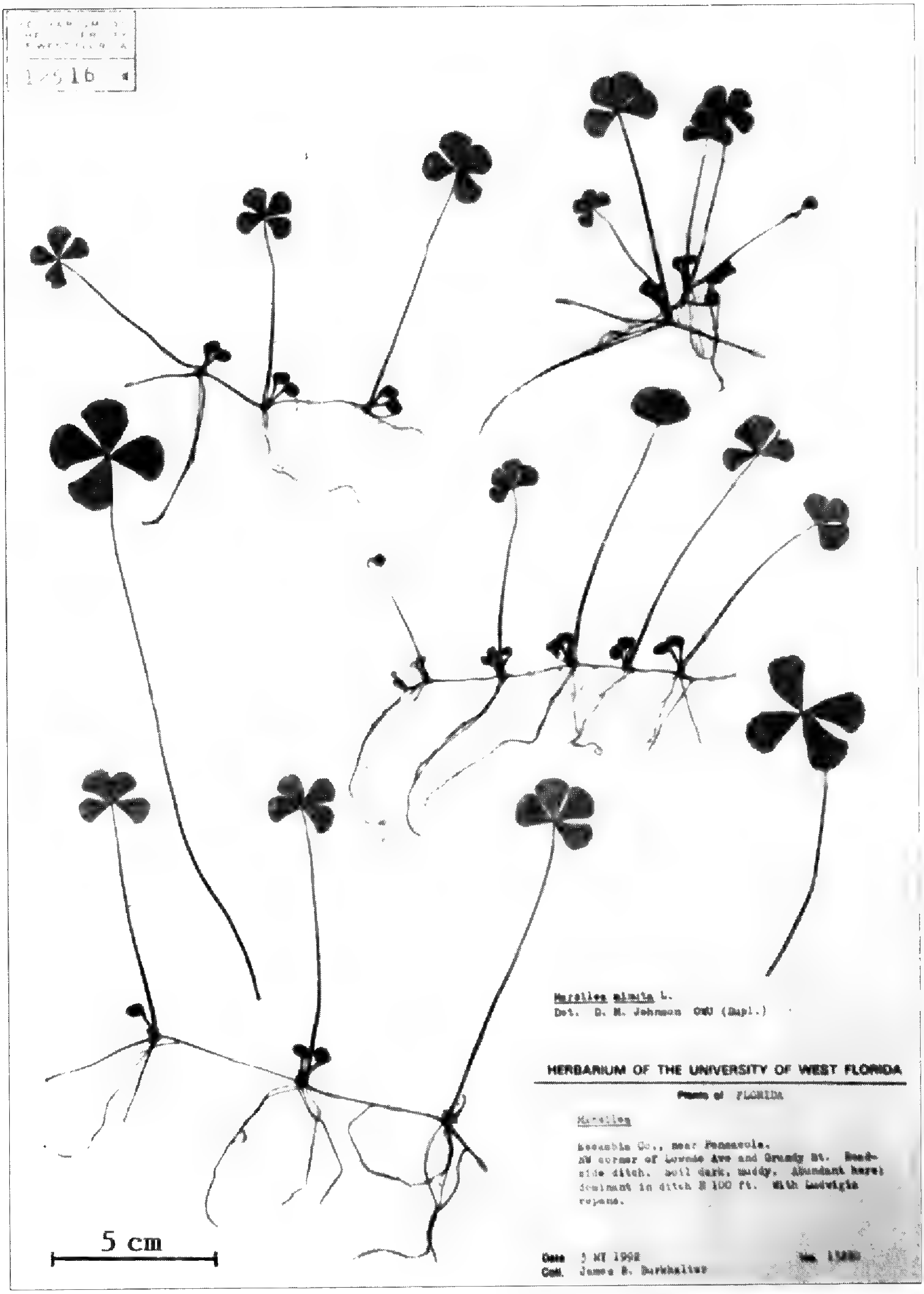

FIG. 1. Herbarium specimen of *Marsilea minuta* L. (*Burkhalter 13220*, UWFP).

migratory waterfowl species with suitable dietary habits (including species of *Anas* and *Porphyrula*) use flyways which pass over Pensacola and the known sites for *M. minuta* in Brazil, Trinidad, and Tobago (cf. Pough 1951, Weston 1965; Kale & Maehr 1990; Ffrench 1991). Of course, one bird transporting one sporocarp is all that would have been required to initiate the subject colony of *M. minuta* near Pensacola.

More than two years of observations have revealed that *Marsilea minuta* is evergreen in the Pensacola area and that it easily withstood two days of near- and below-freezing temperatures on 12–13 March 1993 and another unusually cold period on 17–18 January 1994. These facts, together with the documented invasive and weedy tendencies of this fern in other areas (Johnson 1986), lead to the conclusion that *M. minuta* indeed has the potential to become a weed of some importance throughout the southeastern United States. Suitable habitats for possible invasion by *M. minuta* include roadside ditches, sunny edges of freshwater and brackish marshes and swamp forests, and other similar low moist sites. Based on the luxuriant growth of *M. minuta* in the ditch at the discovery site, there is some concern that it would grow as vigorously if it became introduced into other similar sites. Fortunately, as of this writing, this interesting invader from South America is apparently restricted to the single streetside ditch where it was discovered.

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I am grateful to Dr. David M. Johnson for specific identification of the *Marsilea minuta* specimens cited in this paper. I also thank local ornithologists C. W. Milmore and Robert and Lucy Duncan for sharing their expertise and information concerning possible avian vectors.

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BOOK REVIEW

STUESSY, TOD F. 1994. **Case Studies in Plant Taxonomy: Exercises in Applied Pattern Recognition.** (ISBN 0-231-07611-8, pbk.) Columbia University Press, New York. $25.00. 171 pp., 59 figures, 38 tables.

As an experienced instructor of plant systematics at both the introductory and advanced levels, Tod Stuessy has both perceived and sought to fill the gaps in instructional materials. He has been using case studies in his own graduate course for several years. Now he has edited the class exercises in a handy volume to be available for other instructors to use. It will serve as a valuable teaching resource for any one training young systematists or for self-instruction.

It is designed to be used in conjunction with a comprehensive text, such as Stuessy's, *Plant Taxonomy: The Systematic Evaluation of Comparative Data,* or with an instructor's free-standing lectures. However, his inclusion in the first three chapters of some basic concepts of systematics, taxonomy, classification, taxonomic hierarchy, genera, species, infraspecific categories, and the range of taxonomic data, allows the book to be used somewhat independently. Although I found these chapters to be redundant with introductory texts, they do not detract from the overall usefulness of the book. The first two chapters, in particular, give us insight into Stuessy's perspective on these concepts.

The remaining introductory chapter is a guided example of discerning taxonomic patterns. Insightfully, Stuessy directs students to pay attention to "(1) correlations of character states among taxa; and (2) discontinuities in character states between taxa." I was disappointed that he did not stress statistical analysis of characters to discern discontinuities in these examples. However, that problem is corrected in the actual case studies, which are rich in bar diagrams, character polygons, and scatter diagrams.

The majority of the book consists of 10 case studies representing original journal articles. The taxonomic problem, method, data sets, journal reference and a brief discussion of the possible solutions are provided, but the original authors conclusions are not. The student is expected to reach his or her own conclusion from the pattern perceived in the data. Comparisons among students and to the original paper are encouraged. The case studies progress from simpler to more complex and from data sets of morphology/geography to those also incorporating macromolecular data.

Overall, I think that Stuessy is successful in providing a set of exercises that give the advanced student experience with interpreting taxonomic patterns. Especially in light of the short time left for botanical exploration, increasing the rate at which students can achieve the skills to become practicing systematists makes this book is a welcomed addition to our training resources.—*Roger W. Sanders.*

TAXONOMY OF THE NATIVE NORTH AMERICAN SPECIES OF *SACCHARUM* (POACEAE: ANDROPOGONEAE)

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ABSTRACT

Saccharum L. consists of about 40 species concentrated in the tropics and subtropics of the world. Five species and one variety are recognized in this revision of the native North American taxa. Recognized taxa include *S. alopecuroideum* (L.) Nutt., *S. baldwinii* Spreng., *S. brevibarbe* (Michx.) Pers. var. *brevibarbe*, *S. brevibarbe* (Michx.) Pers. var. *contortum* (Nutt.) R. Webster, *S. coarctatum* (Fern.) R. Webster, *S. giganteum* (Walt.) Pers. A review of the relevant taxonomic history of the taxa is presented. A comprehensive set of morphological, geographical, and nomenclatural data was collected. A discussion is given on the range and distribution of the 234 characters applied in the taxonomic analysis. The DELTA computer system was used for the analysis and production of a key to the species and comparative species descriptions. Given for each taxon is a representative set of specimen citations and a discussion of diagnostic characters and biological relationships among the recognized species.

RESUMEN

Saccharum L. está formado por cerca de 40 especies concentradas en las zonas tropicales y subtropicales del mundo. En esta revisión de los taxa nativos de Norteamérica se reconocen cinco especies y una variedad. Los taxa reconocidos son: *S. alopecuroideum* (L.) Nutt., *S. baldwinii* Spreng., *S. brevibarbe* (Michx.) Pers. var. *contortum* (Nutt.) R. Webster, *S. coarctatum* (Fern.) R. Webster y *S. giganteum* (Walt.) Pers. Se presenta una revisión de la historia taxonómica de los taxa. Se coleció un conjunto extenso de datos morfológicos, geográficos y nomenclaturales. Se hace una disucsión del rango y distribución de los 234 caracteres utilizados en el análisis taxonómico. Se empleó el sistema DELTA para el análisis, la elaboración de la clave de especies y para las descripciones comparativas de las especies. De cada taxon se da un conjunto representativo de citas y se hace una discusión de los caracteres diagnósticos y de las relaciones biológicas entre las especies que se reconocen.

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INTRODUCTION

North American floristic authors traditionally treated the native species of *Saccharum* L. under *Erianthus* Michx., which was established in Flora Boreali Americana (Michaux 1803). Hitchcock (1951) recognized both genera and separated them on the traditional character of presence or absence of the upper lemma awn. That is, *Saccharum* species possess an awned upper lemma, whereas *Erianthus* species lack the awn. For the grasses of South Africa, Chippendall (1955) treated only the introduced species, *S. officinarum* L., but described the genus as awnless or rarely awned. Bor (1960) used the same character in his treatment of Asian grasses to differentiate the genera; however, he listed *Erianthus* species under both genera. South American writers (Burkart et al. 1969; Rosengurtt et al. 1970; Smith et al. 1982) separated the genera on the same character. Bor's (1970) "Gramineae" in *Flora Iranica* recognized only *Saccharum* and submerged *Erianthus* as a section differentiated on the absence of an awn. Taxonomists associated with the sugarcane breeding programs (Dutt & Roa 1950) consistently placed the species in separate genera. In *Grasses of the Soviet Union*, Tsvelev's (1976) separated the genera on presence of an awn and length of the callus hairs. Hsu's (1978) treatment of Taiwanian grasses separated *Erianthus* and *Saccharum* on whether culms are solid, reduction of the upper lemma, and presence of an awn. Finally, Clayton and Renvoize (1986) concluded that placing the awned and unawned species into separate genera was artificial and recognized only *Saccharum*. In the absence of conclusive taxonomic evidence to the contrary, it seems appropriate at the present time to follow the concepts of Clayton and Renvoize (1986), Bor (1970), and Renvoize (1984) and treat *Erianthus* as a synonym of *Saccharum*.

Saccharum consists of about 40 species which mostly occur in the tropics and subtropics of the world. The center of diversity is tropical Asia, with approximately 25 native species occur. There is apparently only one native species in Africa and no species are known to be native to Australia. Four to 10 species occur in North America north of Mexico, excluding the Caribbean and 3 to 7 species are native to South America and Mesoamerica. The taxonomic relationships among the native taxa of *Saccharum* have not been carefully studied nor well-defined. The objective of the present study is to define this relationship for the North American taxa. The introduced species [*S. spontaneum* L., *S. officinarum* L., and *S. ravennae* (L.) P. Beauv.] are not treated here.

This study was based on field studies and loaned specimens from BM, BR, BRI, BRIT, C, CANB, F, GH, ISC, K, L, MICH, MO, NY, PH, and US. The DELTA system (Dallwitz 1980; Dallwitz et al. 1993) was used to gather, analyze, and present the taxonomic data. These procedures are discussed in previous studies by Webster (1988, 1992) but require a brief statement here. Initially, a list of characters and associated states was constructed to account for taxonomically significant variation within the complex. Classical methods of specimen analysis were used for the recognition of the taxa. Specimens of a recognized taxon were used to record the full range of data for each of the 285 characters. This data together with the authors concepts of species and character reliability were incorporated into the DELTA programs (CONFOR, KEY, & INTKEY) for the production of the identification key and descriptions.

TAXONOMIC HISTORY

The objective of this section is to provide a chronological explanation of the taxomonic development of the group, which begins with Linnaeus's Species Plantarum (1753) where *Saccharum* L. and two species, *Andropogon alopecuroides* L. and *Andropogon divaricatus* L., were named. Thirty-five years later Walter (1788) named the taxon *Anthoxanthum giganteum* and created a taxonommic problem which persists today. Andre Michaux (1803) in Flora Boreali-Americana defined *Erianthus* Michx. and two species, *E. brevibarbis* Michx. and *E. saccharoides* Michx. Persoon (1805) transferred *E. brevibarbis* and *A. giganteum*, to *Saccharum*; conversely, Muhlenberg (1813) transferred *A. giganteum* to *Erianthus*. Even at this relatively early date there were differences in opinion concerning the relationship between *Erianthus* and *Saccharum*. Elliott's *Sketch of the Botany of South Carolina and Georgia* (1816) contains two new species, *E. contortus* and *E. strictus*, and transfers the epithet *Andropogon alopecuroides* to *Erianthus*. His work was soon followed by Nuttall (1818), who placed *E. strictus*, *E. contortus*, and *E. alopecuroides* in *Saccharum*. Sprengel (1815) made the new combination, *S. strictum* (Host.) Spreng., for an Old World species, making Nuttall's combination [*S. strictum* (Baldw.) Nutt.] illegitimate. Sprengel (1825) provided the name, *S. baldwinii*, for this taxon. Chapman (1860) treated *Andropogon brevibarbis* and *E. contortus* as varieties of *E. alopecuroides*. Between 1895 and 1900 Nash named four new species and one variety of *Erianthus* (*E. smallii*, *E. compactus*, *E. laxus*, *E. tracyi*, and *E. alopecuroides* var. *hirsutis*). Fernald (1943) concluded that the name *brevibarbis* had been misapplied and named a new species and two varieties (*E. coarctatus* , *E. coarctatus* var. *elliottianus*, and *E. saccharoides* var. *compactus*).

As with many species complexes of flowering plants the most useful taxonomic information is contained in the regional floristic treatments. The earliest significant treatment is Mohr (1901), who recognized five species (*E. alopecuroides*, *E. saccharoides*, *E. brevibarbis*, *E. strictus*, and *E. smallii*), but does not give a key. In that work, *E. giganteum* and *E. saccharoides* are nomenclaturally confused, the concept of *E. brevibarbis* is incorrect, as is the relationship between *E. smallii* and *E. contortus*. Nash's (1903, 1913) treatments in Small's manual follows these concepts and recognizes his four new species. Albert Hitchcock contributed the Gramineae for the 1933 3rd edition of Small's manual, where five species (*E. brevibarbis*, *E. contortus*, *E. divaricatus*, *E. saccharoides*, and *E. strictus*) were recognized. Nash's taxa were placed in synonomy. Most of the morphological and nomenclatural confusion occurring in Mohr (1901) was duplicated in Hitchcock's (1933) treatment. Hitchcock (1935) presented a similar morphological treatment but uses the name *E. alopecuroides* in place of *E. divaricatus*, and *E. giganteus* in place of *E. saccharoides*. Fernald (1950) treatment incorporated his clarification (Fernald 1943) of *E. brevibarbis* and recognized six species and one variety (*E. giganteus* var. *compactus*). Hitchcock (1951) followed Fernald's concepts and recognized the same taxa. Mukherjee (1958) presented a worldwide revision of *Erianthus* and recognized eight North American species; however, his conclusions were not based on a detailed study of New World material or collections. Radford et al. (1964) recognized five species and apparently discounted or did not appreciate Fernald's contributions. Their treatment is similar to Hitchcock (1935). Strausb Augh and Core (1970) in their flora of West Virginia included one species (*E. alopercuroides*). Correll and Johnston (1970) follow the concepts presented in Mukherjee (1958), and provide a key to four species, which does not account for the known morphological variation within the complex. Long and Lakela (1971) recognizes only one species, *E. giganteus*, as occurring in tropical Florida. A recent explanation of the nomenclature of *E. giganteus* is given in Gandi and Dutton (1993). Gould (1975) followed Hitchcock's (1951) morphological concepts, and reported five species from Texas, and included a key to the species. Allen (1975) uses Mukherjee (1958) as a reference and reports five species for Louisiana. The most complete morphological data for these species is given in Godfrey and Wooten (1979), where five species are listed; however, their species concepts appear identical to Hitchcock (1935).

CHARACTER VARIATION

The purpose of this section is to define characters used in this study and to discuss the range in variation found among the taxa as compared to all grasses. Of the 234 characters considered in this study, 63 apply to vegetative structures, 49 describe the inflorescence, 103 describe spikelet parts, and 19 apply to topics other than morphology (eg. geography and ecology). Characters common to all taxa are applicable at the generic level.

All taxa are hermaphroditic, in that, no sexual differences exist among the spikelets of a plant. This is an exclusively perennial complex, lacking stolons, but with distinctly compacted rhizomes which produces a knotty crown. Rhizomes are relatively short, except in *S. alopecuroideum*, and soon become erect to produce a new flowering culm. Leaves of the rhizomes are glabrous and striate. Flowering culms are not lignified, not caespitose, erect, never root at the lower nodes, and typically vary from 0.8 to 2.5 meters in height. The shortest species is *S. baldwinii* and the tallest *S. giganteum*, however, height overlaps exist for these taxa. Each flowering culm is unbranched, terminates in a solitary inflorescence, and consists of 4–8 nodes. Culm nodes are not swollen and may be glabrous as in *S. baldwinii* or long pilose as in *S. alopecuroideum*. Internodes are glabrous, smooth, and hollow at maturity; however, immature internodes may be solid to spongy. Glaucous internodes occasionally occur in *S. alopecuroideum*, otherwise viscid or glaucous internodes do not occur in this complex. A basal cluster of leaves is not present, as all leaves originate from flowering culm nodes.

Pronounced leaf auricles are not present; however, minute sheath auricles, measuring 0.3–1.0 mm long, are present in *S. baldwinii* and *S. coarctatum*. Leaf sheaths are smooth, closed, rounded on the back, do not overlap, and the length has no diagnostic value. Sheaths are typically glabrous but are hairy in some immature specimens of *S. giganteum*. The apex of the sheath is ciliate in *S. alopecuroideum* and *S. giganteum*, but otherwise undifferentiated. The ligule is a rounded, ciliate membrane, measuring 1–6 (usually 2–3) mm long, and cannot be relied on to differentiate among the taxa. However, *Saccharum giganteum* is the only taxon with a differentiated collar with long pilose hairs. Leaf blades are linear, flat, lax, flexuous, and spreading in all taxa. Shorter and narrower blades are found in *S. baldwinii* and *S. giganteum*; however, range overlaps exist for all taxa and these characters have little or no diagnostic value. Surface of leaf blades are adaxially and abaxially smooth in all taxa and the margins are smooth or minutely scabrous. At maturity, *S. giganteum* is the only species which may possess hairy (pilose) leaf blades. Margins of the blades are flat and not thickened; however, the midvein of the blade is pronounced or swollen in all taxa. Significant variation was not found in shape of the acuminate apex and truncate base. Morphology of the prophyllum was not included.

The peduncle (stalk of the inflorescence) is typically elongate, but relatively short in *S. baldwinii* and *S. coarctatum*. It is hairy, especially at the apex, in *S. alopecuroideum* and *S. giganteum*, but otherwise glabrous and undifferentiated. The inflorescence is a terminal, fully exserted panicle varying from linear, oblong, to lanceolate. Inflorescence shape is determined by the amount and length of hairs associated with the callus. In *S. baldwinii*, the callus hairs are essentially absent and the inflorescence is narrow and linear; whereas, in *S. alopecuroideum* and *S. giganteum* the hairs are long, spread at maturity, and the inflorescence is oblong to lanceolate. *Saccharum brevibarbe* and *S. coarctatum* are intermediate between these forms. The lowermost inflorescence node is differentiated only in the sense that it is hairy in some taxa. The main axis of the inflorescence is present and relatively stout. There are no taxonomically significant differences among the taxa based on length of the main axis. The amount of hairs on the main axis varies from densely hairy to essentially glabrous, and is positively correlated with the amount of hairs associated with the callus. Primary branches of the inflorescence potentially originate at all points on the main axis (that is, quaquaversal and not secund or distichous), have appressed secondary branches with distichous spikelets, and are not whorled. The primary branches are best described as appressed; however, presence of dense inflorescence hairs produces some spreading and at anthesis the branches spread and produce a slightly open inflorescence. Number of primary branches is difficult to determine, but varies from 8–30, and was not given high taxonomic significance in this study. Primary branches are straight, smooth, and glabrous or hairy. Hairiness of the branches tends to occur in lines and is correlated with the amount of hairs on the main axis. Length of the branches varies between 2–18 cm with the rachis internode slightly longer than the pedicel, but shorter than the spikelets.

Pedicels are straight, not distinctly grooved, smooth, truncate, and glabrous or hairy. Hairiness of the pedicels is positively correlated with the amount of hairs associated with the callus and main axis. Disarticulation is identical for all taxa with distinct points at branch internodes and at the base of the pedicelled spikelet. Morphological differences associated with the callus hairs are taxonomically significant in this complex. Other than the presence of hairs, the callus is undifferentiated. The hairs are completely absent or sparse in *S. baldwinii* and dense and long in *S. alopecuroideum* and *S. giganteum*. Other taxa are intermediate between these extremes. Color of the hairs is diagnostically important. Silvery hairs are characteristic of *S. alopecuroideum*, whereas the hairs of the remaining taxa vary from white to brown. The single most reliable character for distinguishing among the taxa is the length of the callus hairs relative to spikelet length. They are relatively short in *S. baldwinii*, long in *S. alopecuroideum* and *S. giganteum* (but of different color), and intermediate in *S. brevibarbe* and *S. coarctatum*.

Cleistogamous spikelets were not observed in the taxa; however, certain South American taxa are characterized by this feature. Spikelets are paired, abaxial, slightly overlapping, not embedded in the rachis, evenly distributed on the rachis, and either heteromorphic or homomorphic. Here, heteromorphism is a result of differences in the amount of hairs. Except for *S. baldwinii*, it is typical for the glumes of the sessile spikelet to be glabrous or not as densely hairy as the pedicellate spikelet. The sessile and pedicellate spikelets are otherwise identical. Spikelet color has minor diagnostic importance and cannot be used with confidence to distinguish among the taxa. *Saccharum baldwinii* and *S. coarctatum* are dark brown in color, whereas the other taxa are best described as straw-colored. Spikelets are dorsiventrally compressed, lanceolate, and attenuate at the base. Frequently the second glume is slightly keeled. Spikelet length and width are of minor diagnostic value. The smallest spikelets are associated with species characterized by long callus hairs. These species may rely on wind dispersal of seeds, whereas species with larger spikelets and shorter hairs may depend more on dispersal by water. For example, *S. baldwinii* has relatively short hairs or completely lacks hairs and grows in shaded stream bottoms closely associated with moving water; whereas, *S. alopecuroideum* with long hairs and relatively smaller spikelets inhabits open areas not necessarily associated with water.

The first glume is 5 nerved, encircles the spikelet base, and equals spikelet length, spikelet shape, and length of the second glume. It is cartilaginous in texture and slightly denser than the second glume. The surface is smooth, except in *S. baldwinii* where it is scabrous. The degree of hairiness of the first glume is correlated with the amount of hairs associated with the callus. In *S. alopecuroideum* and *S. giganteum* the first glume is hairy, whereas in *S. baldwinii* it is glabrous. Apex of the first glume is acuminate and muticous for all taxa; however, commonly the apex is minutely knotched or emarginate. The rachilla is not pronounced in the complex. The second glume is 3 or 5 nerved, essentially smooth, not ciliate, equals spikelet length and shape, acuminate, and muticous. The lower floret consists of a well-developed lemma, with the palea and other structures missing. The lower lemma is glabrous, hyaline, lanceolate, smooth, not keeled, acuminate, and muticous. It usually lacks distinct nerves in *S. alopecuroideum*, *S. brevibarbe*, and *S. giganteum*, whereas, in *S. baldwinii* and *S. coarctatum* the lower lemma is 2–3-nerved. Rarely, in these latter species the central nerve extends into a pronounced awn. Length of the lower lemma ranges from 3–8 mm and is of minor diagnostic value, as is the relative length to the upper lemma. The upper lemma is lanceolate, hyaline, smooth, glabrous, acuminate, awned, and commonly purple at maturity. Differences exist among the taxa on length of the upper lemma, however, these differences are correlated with overall spikelet length. Number of nerves on the upper lemma ranges from 1–3. *Saccharum alopecuroideum* and *S. giganteum* are 1-nerved, whereas the others are distinctly 3-nerved. In those taxa with a straight awn the upper lemma apex is entire, whereas taxa with a coiled awn have a bifid apex. The bifid apex produces lateral lobes which measure approximately 2 mm long.

Morphology of the callus and upper lemma awn are taxonomically the most significant and reliable characters for the complex. This awn is minutely scabrous and glabrous. Length is variable and is of limited taxonomic value. The awn may be basally flat or terete, spiraled or not, and straight or geniculate. These three characters are all interrelated. That is, a flattened awn results in spiraling and spiraling frequently produces geniculation. A germination flap is not pronounced in the complex. The palea of the upper floret is hyaline, well-developed, and about 1/2 the length of the upper lemma. It is ovate, smooth, and acute or cleft at the apex. Lodicules are pronounced and measure about 1 mm in length. The taxonomic value of this structure lies in whether the nerves extend into hair-like projections, which is best illustrated in mature specimens of *S. coarctatum*. Taxa of the complex have 2 stamens, whereas the introduced species, *S. ravennae*, a native of southern Europe, is characterized by 3. Anthers are red to purple, about 1.7 mm long, and lack taxonomic significance. The caryopsis has a punctiform hilum and the length is correlated with spikelet length. The embryo measures about 1/2 the length of the caryopsis. Base chromosome number for the complex is 10. Cytology of the complex is the topic of a separate study (Burner & Webster 1994). Plants flower mostly from June to November, grow in helophytic to mesophytic conditions, and are locally common throughout the southeastern United States.

KEY TO THE SPECIES

1. Awn of upper lemma basally spiraled 2
    2. Callus hairs equal to or shorter than the spikelet; callus hairs white to brown; callus hairs less than 7 mm long; main axis sparsely hairy .... *S. brevibarbe*
    2. Callus hairs longer than the spikelet; callus hairs silvery; callus hairs more than 7 mm long; main axis densely hairy .... *S. alopecuroideum*
1. Awn of upper lemma not basally spiraled 3
    3. Callus hairs longer than the spikelet; lemma of upper floret 1-nerved; lowermost inflorescence node densely hairy .... *S. giganteum*
    3. Callus hairs equal to or shorter than the spikelet; lemma of upper floret 3-nerved; lowermost inflorescence node not densely hairy 4
        4. Callus hairs absent or up to 2 mm long; primary branches glabrous; inflorescence 10–25 mm wide .... *S. baldwinii*
        4. Callus hairs more than 2 mm long; primary branches hairy; inflorescence more than 25 mm wide 5
            5. Awn of upper lemma basally flattened; lemma of lower floret not distinctly nerved; upper lemma 0.9–1.0 times the length of the lower lemma; leaves sheaths without distinct auricles .... *S. brevibarbe*
            5. Awn of upper lemma basally terete; lemma of lower floret typically 3-nerved; upper lemma 0.7–0.8 times the length of the lower lemma; leaves with minute sheath auricles .... *S. coarctatum*

TAXONOMIC TREATMENT

Saccharum alopecuroideum (L.) Nutt., Gen. Pl. 1:60. 1818. *Andropogon alopecuroides* L., Sp. Pl. 1045. 1753. *Erianthus alopecuroides* (L.) Elliott, Sketch Bot. S. Carolina 1:38. 1816. TYPE: VIRGINIA, *Clayton 601* (HOLOTYPE: LINN 1211.9, photograph seen). Fig. 1.

Andropogon divaricatus L., Sp. Pl. 1045. 1753. *Erianthus divaricatus* (L.) Hitchc., Contr. U.S. Natl. Herb. 12:125. 1908. TYPE: VIRGINIA, *Clayton 70* (HOLOTYPE: LINN, not viewed).

Erianthus tracyi Nash, Bull. Torrey Bot. Club 24:37. 1897. TYPE: MISSISSIPPI, Starkville, *Tracy s.n.* (HOLOTYPE: NY!; ISOTYPE: US!).

Erianthus alopecuroides (L.) Elliott var. *hirsutus* Nash in Small, Fl. SE U.S. 55. 1903. TYPE: FLORIDA, *Chapman s.n.* (HOLOTYPE: NY!).

Rhizomes with elongate internodes. Flowering culms 10–25 dm tall. Nodes hairy (occ. glabrous at maturity; the hairs usually 7–12 mm long). Internodes solid; occasionally glaucous. Leaves without auricles. Sheaths apically ciliate. Ligule 1–3 mm long. Collar not differentiated; glabrous. Leaf blades 30–60 cm long; 14–28 mm wide; glabrous at maturity. Peduncle 40–60 cm long; hairy (pilose below the inflorescence). Inflorescence oblong to lanceolate; 3–10 cm wide. Lowermost inflorescence node hairy. Main axis 15–34 cm long; densely pilose. Primary branches appressed to the main axis; 3–12 cm long; hairy; ciliate. Rachis internode 3–5 mm long; 0.3 mm wide; hairy. Pedicels 2.5–4 mm long; hairy. Callus hairy; with silvery hairs (frequently tinged in purple). Callus hairs 9–14 mm long; longer than the spikelet. Spikelets heteromorphic; straw-colored; 6–7 mm long; 1.1–1.4 mm wide. First glume 5-nerved; smooth. Second glume 3 or 5-nerved. Lemma of lower floret 4.8–5.6 mm long nerveless or 1-nerved. Upper floret 0.6–0.8 times the length of the lower floret. Lemma or of upper floret 4–4.6 mm long; 1-nerved; bifid. Lateral lobes of upper lemma 1.8–2.2 mm long (ciliate). Awn of upper lemma 14–20 mm long; basally flattened; basally spiraled. Lodicules with nerves not extending into hair-like projections (occ. with a few short hairs).

Saccharum alopecuroideum occurs occasionally over a wide area of the southeastern United States, but is evidently rare or non-existent on the sandy coastal plain. Its western geographic limit is eastern Texas and Oklahoma, whereas the northern limit is southern Missouri, Illinois, Indiana to New Jersey. In addition, there is a paucity of specimens from southern Florida and the higher elevations of the Appalachians. It is common to find *S. alopecuroideum* associated with *S. giganteum;* however, *S. giganteum* occupies low moist areas and *S. alopecuroideum* exists on the dry clay upper slopes.

Vegetatively, *S. alopecuroideum* is differentiated from the other species by the presence of pronounced elongate rhizomes up to three inches long. The rhizomes of other members of this complex are short with few nodes and immediately produce an erect flowering culm. Additional diagnostic vegetative characters include the presence of long, white and pilose hairs on the culm nodes and base of the leaf blades. This hair type also occurs at the peduncle apex, main axis, and callus. Presence of silvery callus hairs exceeding spikelet length and a twisted geniculate upper lemma awn differ-

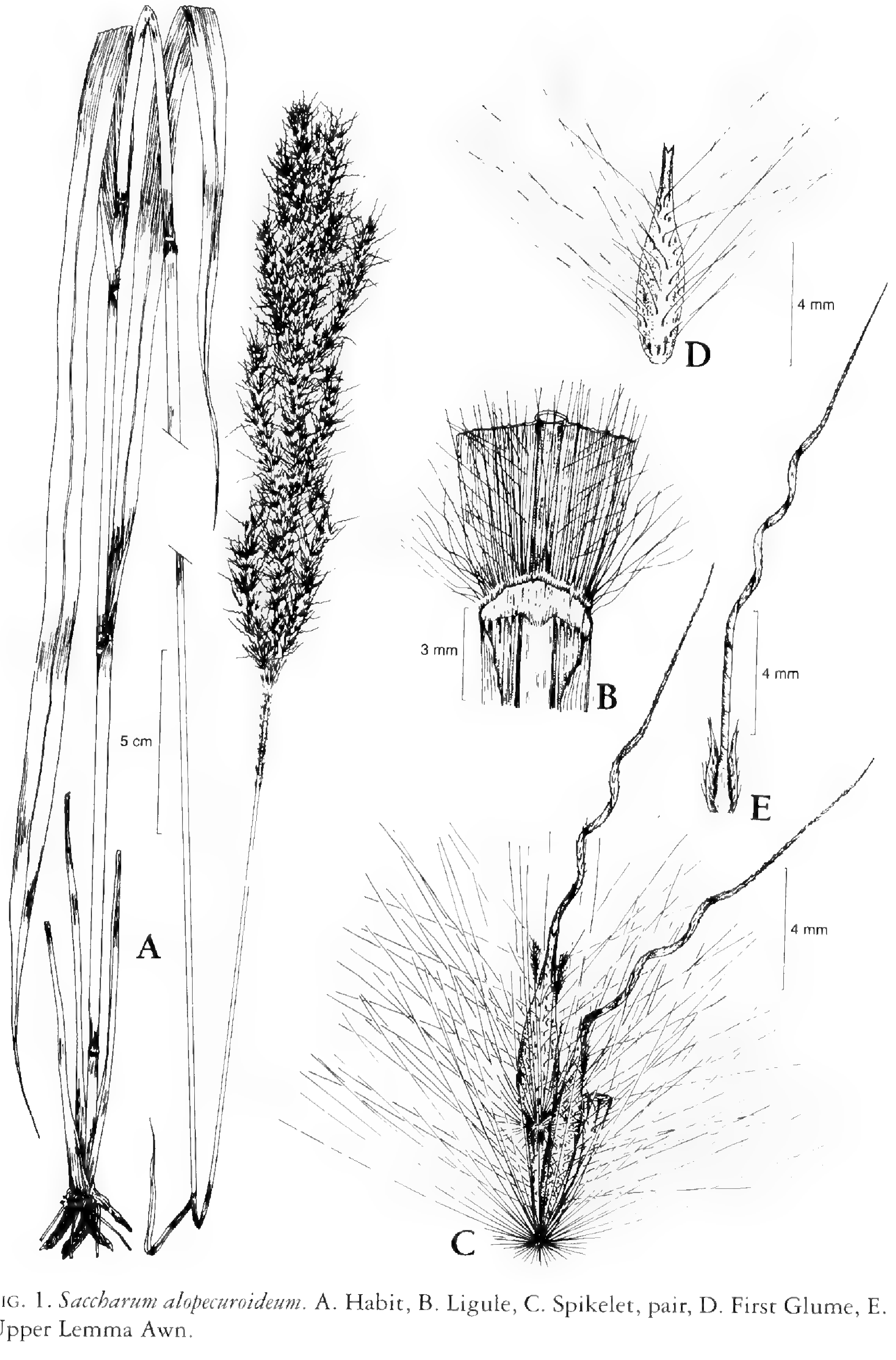

FIG. 1. *Saccharum alopecuroideum.* A. Habit, B. Ligule, C. Spikelet, pair, D. First Glume, E. Upper Lemma Awn.

entiates this species from others of the group. *Saccharum alopecuroideum* is most similar to *S. giganteum*, but easily distinguished on the presence of the spiraled upper lemma awn. Specimens with intermediate characteristics are rarely encountered.

Representative specimens examined. **ALABAMA:** Cherokee Co.: 2 mi N Leesburg, 14 Sep 1968, *Kral 33376* (BRIT, C). Lawrence Co.: 8.8 mi S Meulten, 23 Sep 1970, *Kral s.n.* (MO). Lee Co.: 14 Oct 1897, *Earle & Baker s.n.* (MO). Auburn, 25 Sep 1897, *Earle & Baker s.n.* (MICH). Marengo Co.: 3.5 mi N Dixon's Mill on US 43, 7 Oct 1967, *Kral 29585* (BRIT). Shelby Co.: 1 mi E of Harpersville by U.S. 231, 1 Oct 1971, *Kral 44615* (NY). Winston Co.: border of fields, 13 Sep 1897, *Eggert s.n.* (GH, MO). **ARKANSAS:** Carroll Co.: Eureka Springs, 24 Sep 1913, *Palmer 4470* (MO). Hot Springs Co.: P.O. Malvern, *Demaree 34477* (GH). Izard Co.: 3 mi S of Brandenburg, 24 Sep 1963, *Robinson 2147* (NY). Jefferson Co.: P.O. Pine Bluff, 1 Oct 1942, *Demaree 24038* (NY). Lawrence Co.: U.S. 62 between Imboden & Ravenden, 10 Apr 1963, *Robinson 2324* (NY). Miller Co.: Texarkana, 17 Oct 1894, *Letterman s.n.* (BM). Yell Co.: around Mt. Nebo, 30 Aug 1939, *Demaree 20545a* (MO, NY). **FLORIDA:** Leon Co.: near Tallahassee, *Berr s.n.* (NY). **GEORGIA:** Fulton Co.: College Park, Ga., 10 Oct 1963, *Schallert 573* (C). Walker Co.: Lula Falls at Lookout Mt., 28 Aug 1883 (NY). **ILLINOIS:** Jackson Co.: 14 Sep 1878, *French s.n.* (F). 2.6 mi S of Gorham, 26 Sep 1956, *Thieret 2760* (F). Saline Co.: 2 mi NW of Herod, 7 Oct 1949, *Fuller 14927* (F). **INDIANA:** Crawford Co.: 4 1/2 mi SE of Taswell, 1 Sep 1938, *Tryon, Jr. 4194* (BRIT). **KENTUCKY:** Rowan Co.: Rt. 1274 S of Clearfield, 16 Sep 1987, *Cusick & Hammer 27056* (NY). Warren Co.: Green River, Young's Ferry, 10 Sep 1892, *Price s.n.* (MO). **MISSISSIPPI:** Jackson Co.: Ocean Springs, Miss., 17 Oct 1898, *Tracy 4761* (F, MICH, NY). **MISSOURI:** Barry Co.: T22, R27W, NW 1/4 Sec. 35, 8 Sep 1979, *Hornberger 842* (MO). Butler Co.: near Rombauer, 2 Sep 1938, *Steyermark 6414* (F, MO). Carter Co.: Clubhouse, 11 Sep 1897, *Trelease s.n.* (MO). Christian Co.: 21 Sep 1905, *Bush 3337* (GH, MO, NY). Douglas Co.: T25N, R13W, Sect. 9, 27 Oct 1982, *DeLozier 781* (MO). Dunklin Co.: Campbell Mo., 14 Sep 1893, *Bush s.n.* (MO); throughout SE Mo., 24 Nov 1892, *Bush s.n.* (MO). Ozark Co.: near Tecumsen, 8 Oct 1927, *Palmer 32942* (GH). Ripley Co.: Little Black River between Greenville ford and Pennington ford, 1 Sep 1946, *Steyermark 63964* (F). Shannon Co.: 3 mi SW of Midridge, T30N, R3W, Sect. 10, 27 Sep 1936, *Steyermark 20155* (MO). **NEW JERSEY:** Hudson Co.: near the Hudson river at the base of the Palisades, 8 Nov 1936, *Beals s.n.* (GH, PH); Palisades at Coytesville, 3 Sep 1916, *Wiegmann 1709* (GH). **NORTH CAROLINA:** Catawba Co.: 5 mi ESE of US 64–70, on Startown Rd., 14 Sep 1978, *Solomon 3956* (MO). Forsyth Co.: 14 Sep 1941, *Schallert s.n.* (NY). Macon Co.: 5 mi S of Franklin, 22 Aug 1936, *Correll 6678* (GH). Moore Co.: 7.8 mi E of Carthage, 24 Oct 1936, *Correll 7001* (MICH). Orange Co.: 3 mi E of Hillsboro, 29 Sep 1939, *Blomquist 10945* (NY, PH). Robeson Co.: 4.5 mi SSW of St. Pauls along Co. 1765, 10 Oct 1964, *Britt 3064* (C, GH, MICH, NY). Rowan Co.: S bank of Yadkin River, E of U.S. 29 bridge, 11 Oct 1956, *Horton 522* (NY). Stokes Co.: 3 mi SW of King, *Radford 41268* (MICH); Cascades, 22 Aug 1938, *Blomquist 10,423* (F); 2.2 mi N of Moores Springs, 2 Oct 1958, *Radford 41382* (BRIT). Yadkin Co.: 6 mi E of Yadkinville, highway 421, 6 Sep 1937, *Blomquist & Anderson 9870* (GH). **OKLAHOMA:** Pushmataha Co.: 1 mi N and 1/2 W of Honobia, 9 Aug 1948, *Waterfall 8532* (GH). **SOUTH CAROLINA:** Anderson Co.: Anderson, 24 Sep 1919, *Davis s.n.* (MO). Greenwood Co.: Greenwood, 22 Oct 1913, *E.B.B. 3310* (PH). Lexington Co.: US. 378, 4 mi W of Lexington, 5 Oct 1957, *Radford 29876* (GH). Orangeburg Co.: Eutawville, 9 Sep 1939, *Godfrey 8198* (F, GH, MO, NY, PH). **TENNESSEE:** Anderson Co.: 30 Sep 1934, *Jennison 3336* (PH).

Blount Co.: 4 mi N of Tallahassee alongside U.S. 129, 17 Sep 1964, *Thomas 33216* (BRIT). Campbell Co.: near Norris Lake basin, 30 Sep 1934, *Underwood 1378* (NY). Carroll Co.: 2 mi SE of Hollow Rock Jc., 27 Aug 1922, *Svenson 452* (GH). Cocke Co.: between Paint Rock and Del Rio, 12 Sep 1897, *Kearney, Jr. 939* (MO). Grainger Co.: Thorn Hill, 31 Aug 1847, *Moldenke 19347* (NY, PH). Knox Co.: Cherokee Bluffs, Knoxville, 18 Sep 1928, *Anderson 1098* (GH); top of hill at Mr. Beane place out beyond U.T. farm, 7 Oct 1937, (MO). Macon Co.: few mi E of Beech Bottom, 14 Oct 1968, *Rogers 42914* (NY). Montgomery Co.: Adams, Sep 1927, *Rhoades s.n.* (GH). **TEXAS:** Gregg Co.: summer of 1941, *York s.n.* (GH). Rusk Co.: 6.5 mi NW of Tatum, 14 Oct 1962, *Correll 26303*. **VIRGINIA:** Albemarle Co.: 7 mi SE of the Monticello mansion, *Wieboldt M–675* (PH). Brunswick Co.: Rattlesnake Creek, at old Clippers Mill, S.W. of Triplett, 13 Sep 1944, *Fernald & Lewis 14690* (GH, PH). Dickenson Co.: 28 Aug 1942, *Carr 1070* (GH).

Saccharum baldwinii Spreng., Syst. Veg. 1:282. 1825. *Saccharum strictum* (Baldw.) Nutt., Gen. Pl. 1:60. 1818, non Sprengel (1815). *Erianthus strictus* Baldw., in Elliott, Sketch Bot. S. Carolina 1:39. 1816. TYPE: GEORGIA. Savannah, *Baldwin s.n.* (HOLOTYPE: PH!). Fig. 2.

Pollinia dura Trin., Acad. St. Petersb. Mem. VI. Sci. Nat. 2:91. 1836. *Andropogon durus* (Trin.) Steud., Nom. Bot. ed. 2. 1:91. 1840. TYPE: CAROLINA (not located).

Rhizomes with compacted nodes. Flowering culms 9–18 dm tall. Nodes glabrous or minutely pubescent (white hairs ca. 0.5 mm long). Internodes spongy or hollow; neither viscid nor glaucous. Leaves with sheath auricles. Auricles 0.5–1 mm long. Sheaths not ciliate. Ligule 1–3 mm long. Collar not differentiated; glabrous. Leaf blades 18–60 cm long; 5–12 mm wide; glabrous on the upper surface. Peduncle 30–40 cm long; glabrous. Inflorescence linear; 10–25 mm wide. Lowermost inflorescence node smooth. Main axis 10–35 cm long; glabrous or sparsely hairy. Primary branches appressed to the main axis; 6–18 cm long; glabrous; the margins glabrous. Rachis internode 3–5 mm long; 0.3–0.4 mm wide; glabrous. Pedicels 3–5 mm long; glabrous. Callus glabrous or hairy. Callus hairs straw-colored; 0–2 mm long; shorter than the spikelet. Spikelets brown; 7–10 mm long; 1.1–1.5 mm wide. First glume 5-nerved; scabrous. Second glume 3-nerved. Lemma of lower floret 6–8 mm long; 2-nerved. Upper floret 0.9–1 times the length of the lower floret. Lemma of upper floret 5.5–8 mm long; 3-nerved; entire. Awn of upper lemma 17–24 mm long; basally terete; not basally spiraled. Lodicules with nerves extending into hair-like projections.

Nuttall (1818) was evidently unaware of Sprengel's (1815) earlier name in *Saccharum*. Since North American authors consistently placed this taxon in *Erianthus*, a nomenclatural conflict has not existed. Acceptance of *Saccharum*, in the present study, necessitates the use of Sprengel's (1825) combination.

Saccharum baldwinii occurs throughout the southeastern United States, but is rare or completely absent from higher elevations of the Appalachians. Its western geographic limit is eastern Texas and Arkansas, and the north-

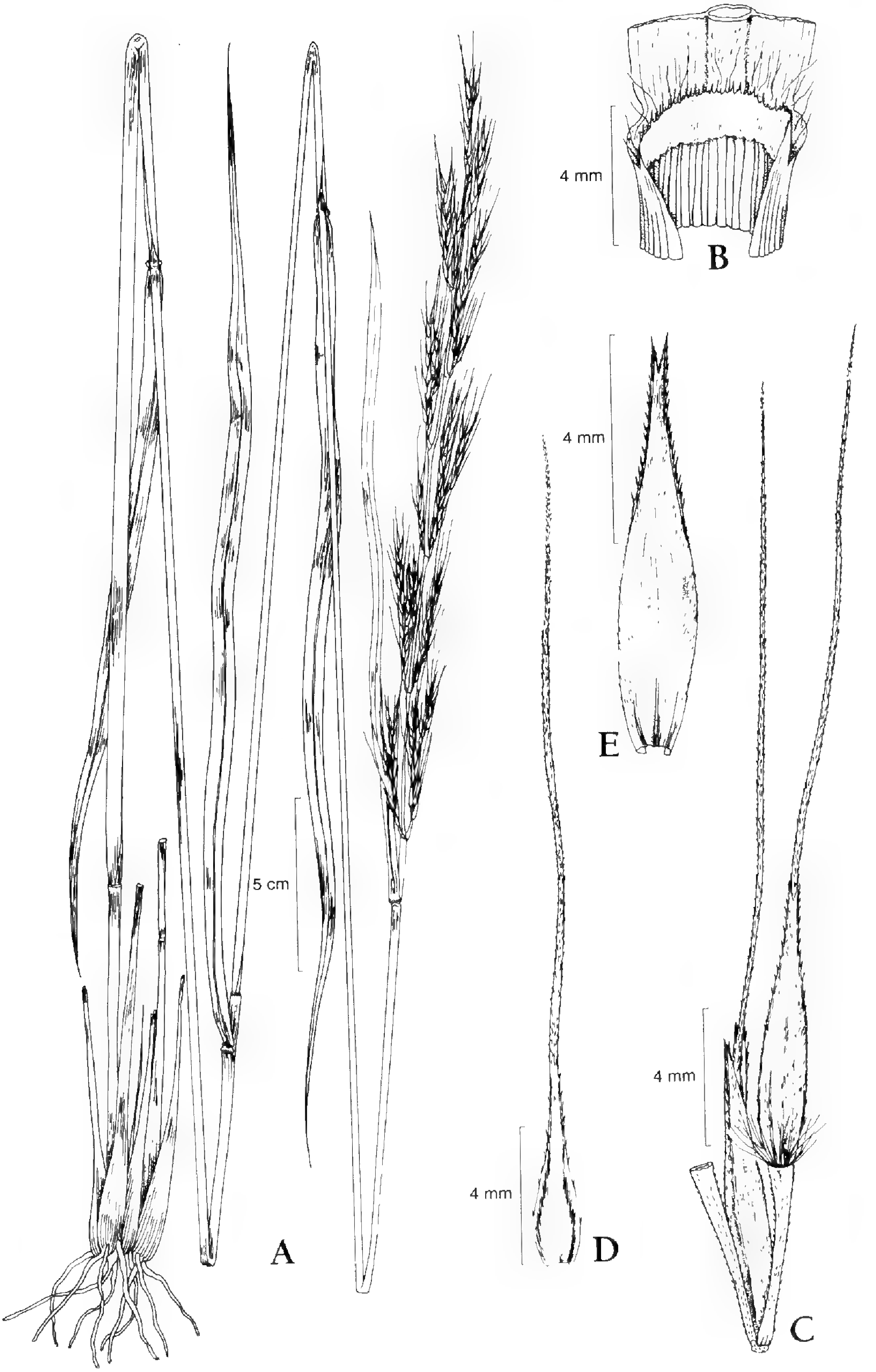

FIG. 2. *Saccharum baldwinii.* A. Habit, B. Ligule, C. Spikelet pair, D. First Glume, E. Upper Lemma and awn.

ern limit is southern Missouri, Tennessee, to northern Virginia. It commonly occurs in sandy shaded river and stream bottoms. Other members of the complex inhabit open wet or seasonally wet areas as well as forest margins where moisture is not a limiting factor. Because of these limiting ecological factors, *S. baldwinii* is not as common as other members of this complex. Vegetative characters that are important in distinguishing *S. baldwinii* include culm height, absence of culm hairs, and auricle shape. Typically, specimens of *S. baldwinii* are much shorter than other members of the complex. In addition, the culm internodes are not thick and the leaf blades are narrow. The most interesting vegetative characteristic is the presence of minute sheath auricles which are ovate and measure about 1 mm in length. Significant characteristics of the inflorescence include the complete lack of pilose hairs, a narrow inflorescence, and homomorphic spikelets. The narrow inflorescence is correlated with the lack of hairs. That is, the long inflorescence hairs of *S. alopecuroideum* and *S. giganteum* result in a wide inflorescence. Significant spikelet characters include glabrous spikelets and a straight upper lemma awn. The most morphologically similar species to *S. baldwinii* is *S. coarctatum*.

Representative specimens examined. **ALABAMA:** Autauga Co.: 1 mi NE of Autaugaville, 24 Sep 1934, *Harper 3268* (GH, MO, NY, PH). Tuscalosa Co.: Hurricane Creek, 24 Oct 1908, *Harper 136* (F, GH, MO, NY). **ARKANSAS:** Clay Co.: P.O. Corning, 8–25–1939, *Demaree 20330* (MO, NY); N Knobel, 21 Aug 1896, *Eggert s.n.* (ISC, MO). Hempstead Co.: near McNab, 4 Oct 1923, *Greenman 4385* (MO). Lonoke Co.: Carlisle, 3 Oct 1931, *Demaree 8401* (GH, MO, NY, BM). Miller Co.: Texarkana, Pine Woods, 20 Oct 1894, *Litterman 9* (MO). Pulaski Co.: Sep 1886, *Hasse s.n.* (NY); Aug 1885, *Hasse s.n.* (F). **FLORIDA:** 1879, *Curtiss s.n.* (F). Baker Co.: old field and pasture, Sep 1920, *King & McRainey 2695* (PH). Columbia Co.: Osceola National Forest, 2 Nov 1981, *Correll 53099* (NY). Gadsden Co.: N of US Hwy 90 bridge, Ochlockenee River, *Kral 1641* (GH). Manatee Co.: Palmetto, Orange Bend, 23 Sep 1907, *Chase s.n.* (US). Monroe Co.: Ponce de Leon, 7 Oct 1901, *Curtiss 6936* (GH, MO, NY, US). Walton Co.: 6.7 mi S of Ponce de Leon, 27 Sep 1957, *Kral & Godfrey 5991* (GH). **GEORGIA:** Berrien Co.: SW of Tifton, 29 Sep 1902, *Harper 1691* (F, GH, MO, NY, US). McIntosh Co.: Cox, 10 Aug 1975, *Abraitys s.n.* (PH). Richmond Co.: Augusta, 6 Feb 1973, *Baldwin s.n.* (PH). Upson Co.: W of Thomaston, at Pasley Shoals of Flint R., 9 Sep 1947, *Piedmont 4674* (GH, MICH, PH, US). **LOUISIANA:** Allen Parish: 10 mi W of Kinder, 20 Oct 1940, *Brown & Nyland 8710* (GH); 1.8 mi E of junct. with La. 26, ca. 3 mi E of Elton, 12 Nov 1960, *Reese 3986* (F). Cameron Parish: Oberlin, 9 Sep 1898, *Ball 207* (GH, NY). East Baton Rouge Parish: 5 mi E of Harelson store on Hanel's Ferry road, 9 Oct 1927, *Brown 1927* (NY, US); Elton, 12 Nov 1960 *Reese 3986* (F, GH). Evangeline Parish: 4 mi E Barber on La. Hwy 10, Bayou Nezpique, 10 Jun 1960, *Ewab 19985* (US). Franklin Parish: 4.7 mi NNE of Winnsboro, 19 Sep 1956, *Shinners 24.653* (GH). Livingston Parish: 4 1/4 mi S of Denham Springs. Section 44., 27 Sep 1966, *Thieret 24813* (US). Ouachita Parish: Sec. 31 Tl7N R4E, 3 Oct 1988, *Thomas 107.586* (MO). Rapides Parish: Alexandria, *Hale s.n.* (PH, US). St. Tammany Parish: Convington, 1832, *Drummon s.n.* (BM); Slidell, 5 Oct 1891, *Langlois s.n.* (NY); Covington, Sulphur Springs, Oct 1919, *Arsene 11566* (US); 3 mi from Covington, 24 Sep

1913, *s.n.* (US). Tangipahoa Parish: E of Robert, 23 Oct 1946, *Brown & Bell 8800* (GH). Union Parish: Sec. 20 T2ON, R3E, 28 Sep 1987, *Thomas 102,051* (NY). Vernon Parish: Oberlin, 9 Sep 1898, *Ball 207* (US); along Devils Creek, section 4. ca. 5 mi NNW of Temple, 30 Oct 1966, *Thieret 25199* (US). Winn Parish: along La. 501, 1.4 mi S of Mill, 20 Sep 1981, *Kessler 1893* (L). **MISSISSIPPI:** Harrison Co.: Nicholson, along Pearl River, 11 Oct 1896, *Kearney Jr. 365* (NY); Biloxi Kashtaw, 13 Oct 1898, *Tracy 4672* (GH, NY). Jackson Co.: Vancleave, Ocean Springs, 24 Sep 1953, *Demaree 34378* (US). Pearl River Co.: 2 mi SW of Picayune, 27 Sep 1966, *Sargent 8929* (MO); 2 mi W of Picayune, 19 Sep 1967, *Sargent 9467* (MICH). **MISSOURI:** Dunklin Co.: Campbell, 7 Oct 1910, *Bush 6384* (GH, MO, NY, US). **NORTH CAROLINA:** Anson Co.: 3 mi S of Ansonville, 18 Sep 1950, *Boyce 1501* (NY). Columbus Co.: Waccamaw River Bridge on Co. Rt. 1928, 23 Oct 1968, *Leonard & Radford 2203* (BM, BR, ISC, MICH). Cumberland Co.: along stream and low woods, 16 Aug 1932, *Blomquist 334* (US); 3 mi E of falcon, Rt. 102, 14 Oct 1951, *Boyce & Fox 1682* (ISC, US). Harnett Co.: near Dunn, 6 Oct 1933, *Blomquist 728* (F). Pender Co.: Burgaw, 1 Sep 1938, *Godfrey 6489* (GH, US); edge of Angola Bay Highway 53, 16 Sep 1937, *Blomquist 10,088* (GH, NY, PH). **SOUTH CAROLINA:** Georgetown Co.: 5 mi S of Georgetown, 9 Sep 1939, *Godfrey 8127* (F, GH, MO, NY, US). Orangeburg Co.: 8–19–1905, *Hitchcock 236* (F, GH, L, MO, NY, US). Williamsburg Co.: 1 mi E of Greeleyville, 22 Aug 1957, *Radford 28387* (NY); 1.8 mi NE of Greeleyville, 19 Oct 1957, *Radford 31158* (GH). **TENNESSEE:** Carroll Co.: Hollow Rock Jc., 27 Aug 1922, *Svenson 463* (GH). Coffee Co.: 15 Oct 1880, *Gettinger s.n.* (ISC, MO); Jul 1886 (NY). Davidson Co.: Nashville, *162* (NY). Madison Co.: Jackson bottoms, Sep 1892, *Bain s.n.* (US); Tullahoma, Sep 1882, *Curtiss s.n.* (GH, US); Tullahoma, Sep 1879, *Gattinger 3629* (BM, F, ISC, MO, NY, US); SE side of Manchester near jct US 41, 20 Aug 1992, *Kral 43,672* (BM); Oak barrens N of Manchester, 6 Aug 1938, *Svenson 8934* (US); Sep 1892, *S.M.B. 198* (NY). **TEXAS:** Anderson Co.: along Catfish Creek at Palestine, 19 Sep 1971, *Hatch 1059* (MO); 6 mi NW of Tennessee Colony, 22 Oct 1983, *Hatch 5080* (MICH). Bowie Co.: Texarkana, 20 Oct 1894, *Letterman s.n.* (NY, BM, PH). Harris Co.: Houston, 1842, *Engelmann s.n.* (GH); Houston, Jun 1841, *Lindheimer s.n.* (MO); Houston Co.: Grapeland, 22 Sep 1917, *Palmer 12823* (NY). Jefferson Co.: McFadden Beach, 5 Oct 1934, *Cory 11021* (GH); Forest Lawn Cemetery, Beaumont, 3 Oct 1945 *Cory 50010* (GH, MICH, NY, US); S of Beaumont, 30 Sep 1940, *Silveus 6444* (US). Liberty Co.: 2.5 mi E of Rye on Hwy 105, 24 Sep 1966, *Gould 121005* (US). Upshur Co.: between S.L. & S.W. railroad and the Gilmer to Big Sandy Hwy, 28 Nov 1941, *Moon 110* (US); 3.3 mi S of New Diana, 15 Sep 1953, *Shinners 15987* (ISC). **VIRGINIA:** Dinwiddie Co.: W of Winfield's Mill, 13 Oct 1941, *Fernald & Long 13885* (GH, PH). Greenville Co.: N of Emporia, Three Creek 19 Sep 1938, *Fernald & Long 9241* (GH, PH). Prince George Co.: SE of Disputanta, 7–20–1938, *Fernald & Long 8581* (F, GH, MO, PH, US). Southampton Co.: E of Drewryville, Terrapin Ridge, 21 Aug 1938, *Fernald & Long 8917* (GH, PH); sandy alluvia bottomlands of Three Creek, 14 Sep 1941 *Fernald & Long 13550* (GH). Sussex Co.: SE of Waverly, 10 Sep 1937, *Fernald & Long 7299* (GH, NY, PH, US); 2 mi E of Stony Creek, 24 Aug 1938, *Fernald & Long 8918* (GH, PH). York Co.: NW of Grafton, 18 Sep 1937, *Fernald & Long 7300* (GH, PH, US).

Saccharum brevibarbe (Michx.) Pers., Syn. Pl. 1:103. 1805. *Erianthus brevibarbis* Michx., Fl. Bor.-Amer. 1:55. 1803. *Erianthus alopecuroides* (L.) Elliott var. *brevibarbis* (Michx.) Chapm., Fl. South. U.S. 583. 1860. *Erianthus saccharoides* Michx. subsp. *brevibarbis* (Michx.) Hack., Monogr. Phan. 6:131. 1889. TYPE: TENNESSEE and CAROLINA, *Michaux s.n.* (HOLOTYPE: P, photograph seen). Fig. 3.

Rhizomes with compacted nodes. Flowering culms 8–25 dm tall. Nodes glabrous or hairy. Internodes hollow. Leaves without auricles. Sheaths not ciliate. Ligule 1–2 mm long. Collar not differentiated; glabrous. Leaf blades mostly 40–60 cm long; 7–25 mm wide; glabrous. Peduncle mostly 45–75 cm long; glabrous (occ. pubescent or minutely pilose). Inflorescence linear or oblong; mostly 4–10 cm wide. Lowermost inflorescence node smooth. Main axis (10–)30–50 cm long; glabrous or sparsely hairy; pilose. Primary branches appressed to the main axis; typically 7–14 cm long; hairy; ciliate. Rachis internode 4–6 mm long; 0.4–0.5 mm wide; hairy. Pedicels 3–4 mm long; hairy. Callus hairy. Callus hairs white to straw-colored; 3–6.5 mm long; shorter than the spikelet. Spikelets heteromorphic; purple or straw-colored; 6.5–10.5 mm long; 1.2–1.5 mm wide. First glume 5-nerved; smooth (scabrous at the apex). Second glume indistinctly 5-nerved. Lemma of lower floret 5.5–8 mm long; nerveless. Upper floret 0.9–1 times the length of the lower floret. Lemma of upper floret 5.5–7.5 mm long; 3-nerved; entire or bifid. Lateral lobes of upper lemma 2–2.5 mm long. Awn of upper lemma 10–22 mm long; basally flattened; basally spiraled or not basally spiraled. Lodicules with nerves extending into hair-like projections or not extending into hair-like projections.

Saccharum brevibarbe occurs throughout the southeastern United States. Its western geographic limit is the pineywoods of east Texas and Oklahoma, with the northern limit from Tennessee to Delaware. Diagnostic features include the presence and relative length of the callus hairs, length of the upper lemma awn, and whether the awn is basally flattened. It is most similar to *S. coarctatum*, but can be distinguished by the above-stated characters. *Erianthus smallii* Nash was described to account for specimens with long (8–10 mm) spikelets and dense hairs associated with the apex of the peduncle and main axis. Examination of type material and numerous similar specimens show continuous variation of these characters; therefore, *E. smallii* is placed as a synonym.

The typical variety is common in central and southern Arkansas, eastern Oklahoma, the pineywoods vegetation region of eastern Texas, and northern Louisiana. Relatively few collections were found in Mississippi, Alabama, and Tennessee. One collection was found in a coastal county of North Carolina. *Saccharum brevibarbe* var. *contortum* (Elliott) R. Webster occurs throughout the range previously given for the species. Both varieties occur in similar habitats. They commonly occur in clay or loamy open or marginal sites that are prone to seasonal flooding; however, seasonal flooding is not a critical factor since this species frequently inhabits well-drained clay slopes.

The varieties differ only in morphology of the lemma awn and corre-

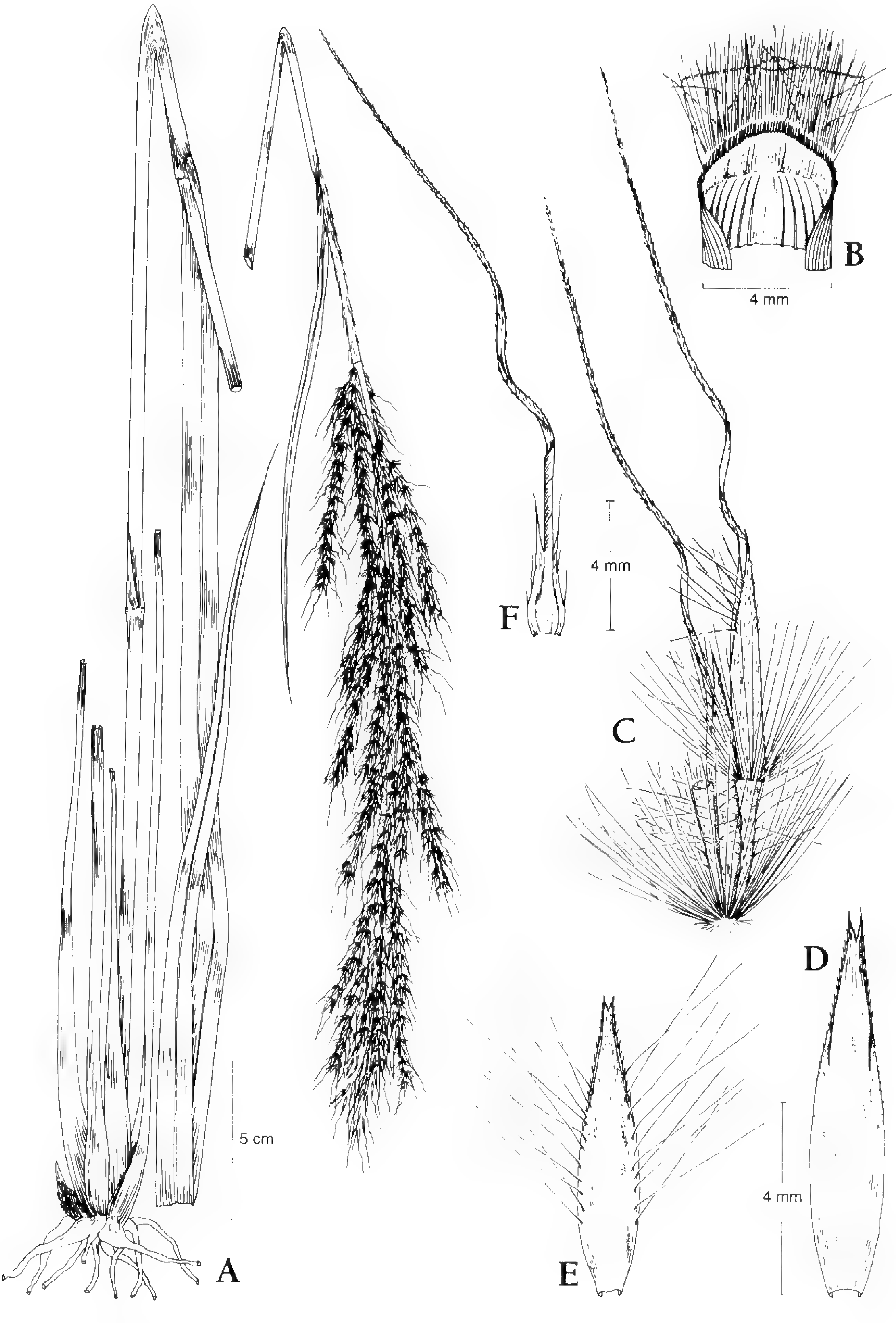

FIG. 3. *Saccharum brevibarbe* var. *contortum*. A. Habit, B. Ligule, C. Spikelet Pair, D. First Glume (upper spikelet), E. First glume (lower spikelet), F. Upper lemma and awn.

lated characters. In variety *contortum* the awn is relatively long, basally flat, geniculate, and tightly coiled or spiraled at the base. Typically 2 to 4 (usually 3) tight spirals occur at the base and 2–4 loose spirals occur above the base. Early in inflorescence development, prior to release from the upper sheath, the awn is not coiled, the apex of the upper lemma is not bifid, and lateral lobes are not present. Once the inflorescence is released from the sheath and as the spikelets mature, the awns quickly develop the spiraling morphology described above. Development of the basal spirals results in tearing the lemma apex from the central awn and producing the lateral lobes characteristic of variety *contortum*. In *S. brevibarbe* var. *brevibarbe* the awn is usually shorter, basally flat, but not tightly spiraled at the base. As a result the lateral lobes are not present. Absence of tight spirals and lateral lobes may be the result of a relatively shorter awn.

The status and interpretation of *E. brevibarbis* Michx. (= *S.* brevibarbe var. *brevibarbe*) has been the source of taxonomic confusion. This problem was addressed in detail by Fernald (1943), who failed to compare this taxon to *E. contortus* Baldw. (= *S. brevibarbe* var. *contortum*). Fernald recognized that Michaux's type of *E. brevibarbis* was morphologically different from the specimens to which the name was being applied. For these specimens he provided the new name, *E. coarctatus* Fernald. The name *E. brevibarbis* was restricted to the type and only one additional specimen (*Demaree 8228*). That concept was followed by Hitchcock (1951).

Michaux's type was clearly illustrated in Fernald (1943) and an original photograph was examined for the present study. Spikelets from the type exhibit callus hairs shorter than the spikelets and the upper lemma awn slightly coiled at the base. Numerous specimens were found showing the same features. These specimens are otherwise identical to specimens previously treated as *E. contortus* Elliott. Intermediate specimens between the taxa are not uncommon. Combining these taxa as varieties of *S. brevibarbe* was considered the most appropriate way to reflect the biological relationship.

KEY TO THE VARIETIES

Awn of upper lemma basally spiraled; lemma of upper floret bifid with lateral lobes about 2.0 mm long .... *S. brevibarbe* var. *contortum*

Awn of upper lemma not basally spiraled; lemma of upper floret entire .... *S. brevibarbe* var. *brevibarbe*

Saccharum brevibarbe (Michx.) Pers. var. **brevibarbe**

Lemma of upper floret entire. Awn of upper lemma 10–18 mm long; not basally spiraled.

Representative specimens examined. **ALABAMA**: Russell Co.: 4.5 mi SE Hurtsboro, 12 Sep 1968, *Kral 33291* (BRIT). **ARKANSAS:** Ashley Co.: P.O. Hamburg, 27 Sep 1937, *Demaree 16386* (BRIT, MO). Clark Co.: P.O. Okolona, 11 Oct 1939, *Demaree 20713* (BRIT). Drew Co.: low waste meadows, P.O. Monticello, 8 Oct 1938, *Demaree 18287* (BRIT, MO). Garland Co.: Hot Springs National Park, 6 Sep 1934, *Demaree 11017* (BRIT). Howard Co.: mineral springs, 14 Oct 1932, *Demaree 9699* (BRIT, GH); mineral springs, 14 Oct 1932, *Demaree 9744* (BRIT, MO, NY, US). Lafayette Co.: P.O. Lewisville, 19 Oct 1959, *Demaree 41930* (BRIT). Pike Co.: Murfreesboro, 28 Sep 1932, *Demaree 9362* (BRIT, GH, MO, NY); near Tokio, 22 Oct 1932, *Demaree 9939* (BRIT, GH, MO, US). Polk Co.: 20 mi N of De Queen, 30 Nov 1958, *Van Schaack 3625* (MO). Pulaski Co.: Pulaski Hts., Little Rock, 21 Sep 1031, *Demaree 8228* (BRIT, GH, MO, NY, US). Saline Co.: P.O. Benton, 6 Sep 1942, *Demaree 23959* (BRIT, MO). Union Co.: El Dorado, 4 Oct 1953, *Hoiberg 371* (BRIT); 10 mi NE El Dorado, 7 Oct 1953, *Hoiberg 378* (BRIT). **LOUISIANA:** Caddo Parish: about 3 mi S of Longwood, 3 Oct 1965, *Thiret 21194* (US). Lincoln Parish: 2 mi W of Ruston, 14 Sep 1970, *Hill 28* (MO). Ouachita Parish: La. 557 just N of Cypress turnoff W of Luna, 7 Oct 1985, *Thomas 93,843* (MO). **MISSISSIPPI:** Copiah Co.: P.O. Barlow, 18 Sep 1954, *Demaree 36190* (BRIT, US). Jackson Co.: Ocean Springs, 23 Sep 1898, *Tracy 4540* (MICH, MO, US). Oktibbeha Co.: Starkville, 1893, *Tracy 2228* (US); near Starkville, 27 Sep 1896, *Kearney Jr. 29* (MO); near Starkville, 29 Sep 1896, *Kearney Jr. 56* (US). **NORTH CAROLINA:** Beaufort Co.: 1.4 mi NE of Washington, 12 Oct 1958, *Radford 42167* (NY). **OKLAHOMA:** Lefore Co.: near Page, 8 Sep 1913, *Stevens 2662* (GH, NY, US); Sec. 9–10, T. 3 S., R. 25 E, State Game Preserve, 2 Jul 1930, *Little Jr., 501* (US); near Bokhoma, 11 Oct 1937, *Palmer 44090* (MO). **TEXAS:** Bowie Co.: Texarkana, Oct 1894, *Letterman s.n.* (MO, NY, PH, US); near Texarkana, Aug 1883, *Letterman s.n.* (MO); S of Dalby Cass Co.: Hwy 11 E, Cypress Creek, 25 Sep 1948, *Whitehouse 20291a* (BRIT). Harrison Co.: 3.2 mi W of Marshall, 31 Oct 1953, *Shinners 16766* (BRIT, ISC). Walker Co.: 9 1/2 mi N of Huntsville, 29 Sep 1934, *Cory 10356* (GH).

Saccharum brevibarbe (Michx.) Pers. var. **contortum** (Elliott) R. Webster, comb. nov. *Erianthus contortus* Elliott, Sketch Bot. S. Carolina 1:40. 1816. *Saccharum contortum* (Elliott) Nutt., Gen. Pl. 1:60. 1818. *Erianthus alopecuroides* (L.) Elliott var. *contortus* (Elliott) Chapm., Fl. South. U.S. 582. 1860. *Erianthus saccharoides* Michx. subsp. *contortus* (Elliott) Hack., Monogr. Phan. 6:131. 1860. TYPE: GEORGIA, *Baldwin s.n.*

Calamagrostis rubra Bosc ex Kunth, Enum. Pl. 1:478. 1833 (fide Hitchcock 1950).
Erianthus smallii Nash, N.Y. Bot. Gard. Bull. 1:429. 1900. TYPE: GEORGIA, *Small s.n.* (HOLOTYPE: NY!).

Lemma of upper floret bifid. Lateral lobes of upper lemma 2–2.5 mm long. Awn of upper lemma 15–22 mm long. Awn of upper lemma basally spiraled (typically with 2–4 complete spirals).

Representative specimens examined. **ALABAMA:** Barbour Co.: 20 Oct 1943, *Koepper, Justice and Isely s.n.* (NY). Cherokee Co.: 2 mi E Leesburg on US 431, 14 Sep 1968, *Kral 33378* (BRIT, C). Clay Co.: jct Ala. 77 and 49 near Mellow Valley, 13 Sep 1968, *Kral 33422* (BRIT). Cleburne Co.: 1 mi E Piedmont on cty 70, 16 Sep 1971, *Kral 44175* (MO). Cullman Co.: 12 Sep 1897, *Eggert s.n.* (MO, US); N Johnson, 24 Sep 1898, *Eggert s.n.* (BM, MO). Greene Co.: NE Eutaw on Ala 14 toward Clinton, 8 Oct 1968, *Kral 33894* (MO); Ala. 69, 4.6 mi N Greensboro, 20 Sep 1971, *Kral 44451* (NY). Lee Co.: Auburn, 25 Aug 1897, *Baker 1090* (NY); Auburn, 10 Sep 1897, *Earle & Baker s.n.* (NY); Auburn, 14 Oct 1900, *Earle s.n.* (NY). Macon Co.: 4 mi E of Tuskegee, 14 Aug 1927, *Wiegand & Manning*

124 (GH). Marion Co.: 8 mi N of Haleyville on Ala. 5, 6 Oct 1967, *Kral 29478* (BRIT). Mobile Co.: W of open Pine barrens, Sep 1876, *Mohr s.n.* (US). Montgomery Co.: Montgomery, 19 Oct 1943, *Isely 2979* (ISC, NY); Montgomery, Feb 1890, *McCarthy 1888* (GH, MICH, PH). Shelby Co.: 4 mi N jct Ala 25 and Calera, 4 Oct 1968, *Kral 33585* (BRIT). Tuscaloosa Co.: 12 Oct 1966, *Deramus, Johnson & N Augle 902* (GH); in Hurricane Creek, 24 Oct 1908, *Harper 137* (F, GH, MO, NY); 15 mi SW of Tuscaloosa along Hwy 59, 20 Aug 1981, *Hatch 4607* (MO). **ARKANSAS:** Calhoun Co.: small bottoms, 20 Oct 1941, *Demaree 22687* (BRIT, US). Drew Co.: P.O. Monticello, 12 Sep 1936, *Demaree 13688* (BRIT); meandering stream bottoms, P.O. Plantersville, 30 Sep 1937, *Demaree 16410* (BRIT, MO, NY); low waste meadows, P.O. Monticello, 8 Oct 1938, *Demaree 18512* (BRIT, ISC, MO, US). Grant Co.: small creek bottoms P.O. Sheridan, *Demaree 16548* (BRIT, MO). Logan Co.: Magazine Mt., Sep 1947, *Moore 470657* (US). Nevada Co.: P.O. Prescott, 6 Oct 1940, *Demaree 21744* (BRIT, GH, ISC, MO). Pike Co.: prairie creek Murfreesboro, 13 Oct 1932, *Demaree 9689* (BRIT, MO). Pulaski Co.: Pulaski Hts. Little Rock, 15 Sep 1931, *Demaree 8165* (BRIT, MO, NY); W of Little Rock, Sep 1835, *Engelmann s.n.* (MO). Yell Co.: P.O. Aly, 19 Sep 1970, *Demaree 62853* (BRIT). **DELAWARE:** 1 mi NW of Georgetown, 13 Sep 1936, *Fogg, Jr. 11469* (GH, PH). **FLORIDA:** Jefferson Co.: 5 mi W of Monticello, 10 Oct 1957, *Kral 6164* (GH). Leon Co.: near Tallahassee, *Berg s.n.* (NY); frequent in open pine–grassland, 14 Oct 1974, *Godfrey 74002* (BM); 7 mi E of Concord, 7 Oct 1956, *Kral 3609* (GH). **GEORGIA:** Bartow Co.: 4.8 mi E35 degree's of Adairsville, 18 Sep 1951, *Duncan 13140* (GH). Columbia Co.: above Little Kickee Creek, 24 Apr 1936, *Leeds & Harper 2770* (PH, US). De Kalb Co.: Stone Mountain, 16 Oct 1907, *Chase 4520* (ISC, US); Stone Mountain, Aug 1905, *Hitchcock s.n.* (US). Elbert Co.: ca 1.5 mi S of Coldwater Creek, 10 Oct 1979, *Credle 2649* (NY); Atlanta, 21 Sep 1895, *Lippincott 129* (PH). Gwinnett Co.: near Mcquire's Mill, 20 Jul 1893, *Small s.n.* (NY, US). Jackson Co.: 11 mi N of Athens, 21 Sep 1947, *Cronquist 4736* (BRIT, GH, PH, US). Jasper Co.: Monticello, Jul 1846, *Porter s.n.* (MO). Hall Co.: near Gainesville, 21 Aug 1936, *Correll 6613* (GH). Muscogee Co.: moist, sandy soil, Columbus, 7 Sep 1899, *3858b* (US). Oglethorpe Co.: 9.3 mi N 45 degree E of Lexington, 23 Sep 1967, *Blake 944* (PH). Putnam Co.: near Rock Eagle Lake, 30 Sep 1947, *Cronquist 4763* (GH, NY). Rockdale Co.: 6 mi SW of Logansville, 18 Oct 1936, *Pyron & McV Augh 1118* (US). Wilkes Co.: 9.3 mi S 60 degree E of Washington, 16 Oct 1949, *Duncan 10634* (BM). **LOUISIANA:** Bienville Parish: roadside near Driskill Mtn., 27 Jul 1955, *Moore 6252* (US); highway 507 near Driskill Mountain, 17 Oct 1987, *Thomas 102,917* (NY). Bossier Parish: 3 mi NE of Alden Bridge, 7 Aug 1938, *Correll 10129* (F, NY). Caddo Parish: 4.7 mi SW of Greenwood, 14 Jul 1955, *Shinners 20740* (BRIT). Caldwell Parish: 3 mi SW of Grayson, 7 Oct 1955, *Shinners 21884* (BRIT, GH). De Soto Parish: 2 mi W of Hunter, 10 Aug 1938, *Correll 10183* (GH, US); 4 mi SW of Mansfield, 2 Sep 1967, *Thieret 27341* (US). Jackson Parish: 2 mi S of Ansley, 6 Sep 1955, *Shinners 21263* (BRIT, GH). St. Helena Parish: 3 mi NW of Greensburg, 25 Sep 1966, *Thieret 24873* (US). Ouachita Parish: 10 mi SW of Monroe, 1 Oct 1941, *Smith s.n.* (GH); Sec. 6, T19N, R1E, 18 Sep 1987, *Thomas 101,981* (NY). **MARYLAND:** Dorchester Co.: near Cambridge, Fork Neck Rd., 7 Oct 1989, *Cohen 1* (US). Somerset Co.: Costen Station, 16 Oct 1935, *Fernald, Long & Fog 5575* (GH, PH); Princes Anne, Sep 1866, *Canby s.n.* (NY, PH). Wicomico Co.: Rt. 313, 2.9 mi S of Rt. 348, Sharptown, 12 Oct 1981, *Hill & Riefner 10851* (GH, NY); 0.2 mi W of Walston, 2 Oct 1983, *Hill 13280* (GH, NY). Worcester Co.: Snow Hill, 30 Sep 1931, *Moldenke 6591* (NY, US). **MISSISSIPPI:** Greene Co.: near US. 13, 3.7 mi NW of Jason, *Radford 40346* (C). Harrison Co.: Biloxi, 27 Oct 1893, *Tracy 2227* (US); Biloxi 9 Oct 1898, *Tracy 4670* (NY). Jasper Co.: 6 mi via rd. from Enterprise along Souinlovey Creek, 8 Sep 1967 *Jones 15150* (US). Leake Co.: Natchez

Trace Pkwy, 14 Sep 1947, *McDougall 1494* (US). Lowndes Co.: Starkville, 12 Oct 1907, *Chase 4462* (US); Starkville, 22 Oct 1893, *Tracy s.n.* (US); Starkville, 6 Oct 1895, *Tracy s.n.* (NY); Starkville, 4 Oct 1890, *Tracy s.n.* (NY); pine lands Columbus, 28 Sep 1900, *5858d* (US). Tishomingo Co.: 20 mi NW of Iuka, 12 Oct 1956, *Ray, Jr. 7559* (GH). Wayne Co.: Waynesboro, 8 Aug 1896, *Pollard 1247* (GH, MO, US). **NORTH CAROLINA:** Anson Co.: open dry hillside near Polkton, 25 Oct 1936, *Correll 7102* (MICH, US). Beaufort Co.: 5 mi E of Washington, Hwy 264, 10 Oct 1936, *Blomquist 8000 (NY).* Bertie Co.: near Windsor, 15 Oct 1938, *Godfrey 7002* (GH). Craven Co.: 6.8 mi SE. of New Bern, 10 Sep 1958 *Radford 40150* (NY). Halifax Co.: Scotland Neck, 15 Oct 1938, *Godfrey 7019* (GH). New Hanover Co.: Carolina Beach, 30 Aug 1938, *Godfrey 6376* (US). Harnett Co.: near Angier, 15 Aug 1932, *Blomquist s.n.* (F); 2 mi N of Pine View Station, 29 Feb 1940, *Walker 1412* (PH). Hyde Co.: near Leechville, 13 Oct 1938, *Godfrey & White 6862* (GH). Lee Co.: pine woodland near Sanford, 14 Oct 1938, *Godfrey 6921* (GH); 3.8 mi S of Harnett–Lee county line on NC 87, 29 Sep 1956, *Laing 351* (US). Stokes Co.: 2.5 mi NE of Walnut Cove, 2 Oct 1958, *Radford 41284* (BRIT). Pamlico Co.: near Grantsboro, 13 Oct 1938, *Godfrey & White 6803* (GH). Pitt Co.: 6 mi E of Greenville, Hwy 264, 11 Oct 1936, *Blomquist 8113* (PH). Polk Co.: 1 mi E of Columbus, 16 Oct 1953, *Freeman 53589* (US). Tyrrell Co.: along rt. 64, 3.8 mi E of Columbia, 22 Oct 1970, *Terrell 4364* (US); 1.4 mi E of Columbia, along rt. 64, 22 Oct 1970, *Terrell 4365* (US). Wake Co.: Raleigh, 7–25–1930, *Blomquist 44* (US); Raleigh, 10 Sep 1938, *Godfrey 6600* (GH). **OKLAHOMA:** Lefore Co.: 20 mi N of Broken Bow, 16 Oct 1937, *Hopkins & Cross 2493* (US); 2.5 mi E of Page, 13 Oct 1948, *Robbins 3201* (BRIT, NY); 7 mi E of Broken Bow, 28 Aug 1938, *Smith 502* (MO); 12 mi N of Bethel, 14 Oct 1951, *Waterfall 10505* (US). **SOUTH CAROLINA:** Aiken Co.: Oct 1889, *Ravenel s.n.* (US). Anderson Co.: Anderson, 2 Sep 1919, *Davis 1280* (F); Anderson, 26 Aug 1921, *Davis 2063* (BM, MO); Anderson, 14 Sep 1919, *Davis 9109* (BM); Anderson, 5 Oct 1920, *Davis s.n.* (US); McKinney Springs, 8 Sep 1917, *Davis s.n.* (MO); between Pendleton Place apts. and landfill entrance gate, 13 Sep 1987, *Hill 18791* (GH, NY). Florence Co.: jct of S.C. 237 and US 52, 17 Oct 1968, *Leonard & Radford 2149* (MO). Greenwood Co.: Bradley, Sep 1920, *Davis s.n.* (BM). McCormick Co.: 6 mi SW of McCormick, 18 Sep 1949, *Duncan 10395* (US); 6 mi SE of Clarks Hill, 13 Oct 1957, *Radford 30638* (GH). Oconee Co.: 1 Oct 1897, *Anderson 1426* (GH, US). Orangeburg Co.: 16 Aug 1905, *Hitchcock 234* (BM, C, F, GH, NY, PH, US). Union Co.: Carlisle, 11 Jul 1906, *House 2478* (US). **TENNESSEE:** Hardin Co.: ca. 15 mi SE Maddox, 13 Sep 1971, *Kral 43905* (MO). Polk Co.: Hiwassee Valley, 30 Sep 1893, *Ruth s.n.* (US); Hiwassee River, Aug 1895, *Ruth s.n.* (MO); Hiwassee River, Aug 1894, *Ruth s.n.* (NY). McNairy Co.: Pine–oak forest W of Ramer., 16 Oct 1949, *Woods 14654* (US). **TEXAS:** Bowie Co.: Springs, 20 Oct 1961, *Correll & Correll 24771* (GH). Camp Co.: Pittsburg, 13 Sep 1923, *Tharp 1970* (US). Gregg Co.: 27 Sep 1941, *York s.n.* (GH, MO). Henderson Co.: 3 mi E of Athens, 9 Nov 1962, *Correll 26699* (MO). Hopkins Co.: 7.8 mi S of Sulphur Springs, 11 Sep 1949, *Turner 1419* (BRIT). Houston Co.: 3 mi SE of rt. 21, 1 Dec 1962, *Correll 26906* (NY). Leon Co.: 1/4 mi E of Keechi, 5 Oct 1937, *Cory 25229* (US). Morris Co.: 2 mi W of Omaha, 17 Oct 1962, *Correll 26317* (NY). Rusk Co.: Texas, 1884, *Nealley s.n.* (US). Smith Co.: western Tyler, N of Pine Burr Road, 18 Aug 1949, *Cory 56858* (BRIT, US); 8 mi NE of Tyler, 10 Oct 1943, *Moore, Jr. 545* (GH, US); glades in oak–hickory woods Amigo, 14 Oct 1945, *Moore Jr. 1053* (BM, C, F, GH, ISC, MICH, NY, PH, US); near Gumwood, 27 Sep 1926, *Palmer 31751* (US). Titus Co.: 6 mi SW of Mt. Pleasant, 23 Sep 1971, *Amerson 733* (BRIT). Upshur Co.: 3.3 mi S of New Diana, 15 Sep 1953, *Shinners 16020* (BRIT, ISC). **VIRGINIA:** Norfolk Co.: near Norfolk, 10 Nov 1890, *Blanchard s.n.* (F); 19 Jul 1898, *Kearney 1741* (US); Virginia Beach, 22 Sep 1900, *Williams 3112* (GH, US). Accomack

Co.: Oak Hall, 16 Oct 1935, *Fernald, Long & Fogg, Jr. 5576* (GH, PH); 1882, *Mears s.n.* (US). Charles City Co.: near Malvin Hill, 26 Sep 1936, *Erlanson 134* (US); near Malvin Hill, 26 Sep 1936, *Erlanson 163* (US). Henrico Co.: W of Elko Station, 21 Sep 1938, *Fernald & Long 9243* (F, GH, PH); Richmond, 1876, *Wood et al 2309* (US). Greensville Co.: E of Slagle's Pond, N of Emporia, 20 Sep 1938, *Fernald & Long 9245* (GH, PH). Isle of Wight Co.: N of Windsor, 13 Jul 1938, *Fernald & Long 8580* (GH, PH). James City Co.: 20 mi W of Williamsburg, Highway 60, 31 Aug 1956, *Meyer s.n.* (MO). Nansemond Co.: Factory Hill, 26 Aug 1936, *Fernald & Long 6457* (GH, PH); 2 mi SE of Cleopus, 15 Oct 1938, *Fernald & Long 9507* (GH, MICH, PH, US); Portsmouth, 9 Sep 1895, *Noys 48* (US). Norfolk Co.: near Ocean View, 11 Nov 1898, *Kearney, Jr. 2398* (US). Northampton Co.: Meadows, 10 Oct 1891, *Canby s.n.* (NY); Belle Haven, 8 Sep 1935, *Fogg, Jr., 9726* (GH, PH). Southampton Co.: Swale, Courtland, 11 Sep 1937, *Fernald & Long 7302* (GH, PH).

Saccharum coarctatum (Fern.) R. Webster, comb. nov. *Erianthus coarctatus* Fernald, Rhodora 45:246. pl. 758. 1943. TYPE: VIRGINIA, *Fernald & Long 7301* (HOLOTYPE: US!). Fig. 4.

Erianthus coarctatus var. *elliottianus* Fernald, Rhodora 45:246. 1943. TYPE: FLORIDA, *Curtiss 6940* (HOLOTYPE: US!).

Rhizomes with compacted nodes. Flowering culms 10–25 dm tall. Nodes hairy (the hairs ca. 1–3 mm long). Internodes spongy or hollow. Leaves with sheath auricles. Auricles 0.3–1 mm long. Sheaths not ciliate. Ligule 1–2 mm long. Collar differentiated or not; glabrous or hairy. Leaf blades 15–40 cm long; 7–12 mm wide; glabrous. Peduncle 35–45 cm long; glabrous. Inflorescence linear or oblong; 30–70 mm wide. Lowermost inflorescence node smooth. Main axis 13–35 cm long; glabrous or sparsely hairy; pilose. Primary branches appressed to the main axis; 5–12 cm long; hairy; ciliate. Rachis internode 3–6 mm long; 0.3–0.4 mm wide; hairy. Pedicels 3–5 mm long; hairy. Callus hairy. Callus hairs white or straw-colored hairs; 3–5 mm long; shorter than the spikelet. Spikelets homomorphic or heteromorphic; brown; 6–8 mm long; 0.9–1.2 mm wide. First glume 5-nerved; smooth or scabrous. Second glume 3-nerved. Lemma of lower floret 5.8–7.5 mm long; 3-nerved. Upper floret 0.7–0.8 times the length of the lower floret. Lemma of upper floret 4–5.5 mm long; 3-nerved; entire. Awn of upper lemma mostly 16–26 mm long; basally terete; not basally spiraled. Lodicules with nerves extending into hair-like projections.

Saccharum coarctatum is common on the coastal plain of the southeastern United States from Louisiana to Florida and north to Delaware. Species such as *S. alopecuroideum*, *S. giganteum*, and *S. brevibarbe* occur commonly in the central part of the southeast. *Saccharum coarctatum* is restricted to the lower elevations of the sandy coastal plain. Its northern geographic limit is southern Louisiana, Mississippi, Alabama, Florida, and Georgia. On the east coast it is common in eastern Georgia, South Carolina, North Carolina, Virginia, Maryland, and Delaware. *Saccharum coarctatum* prefers open, moist, and loamy habitats, which are seasonally flooded. Diagnostic veg-

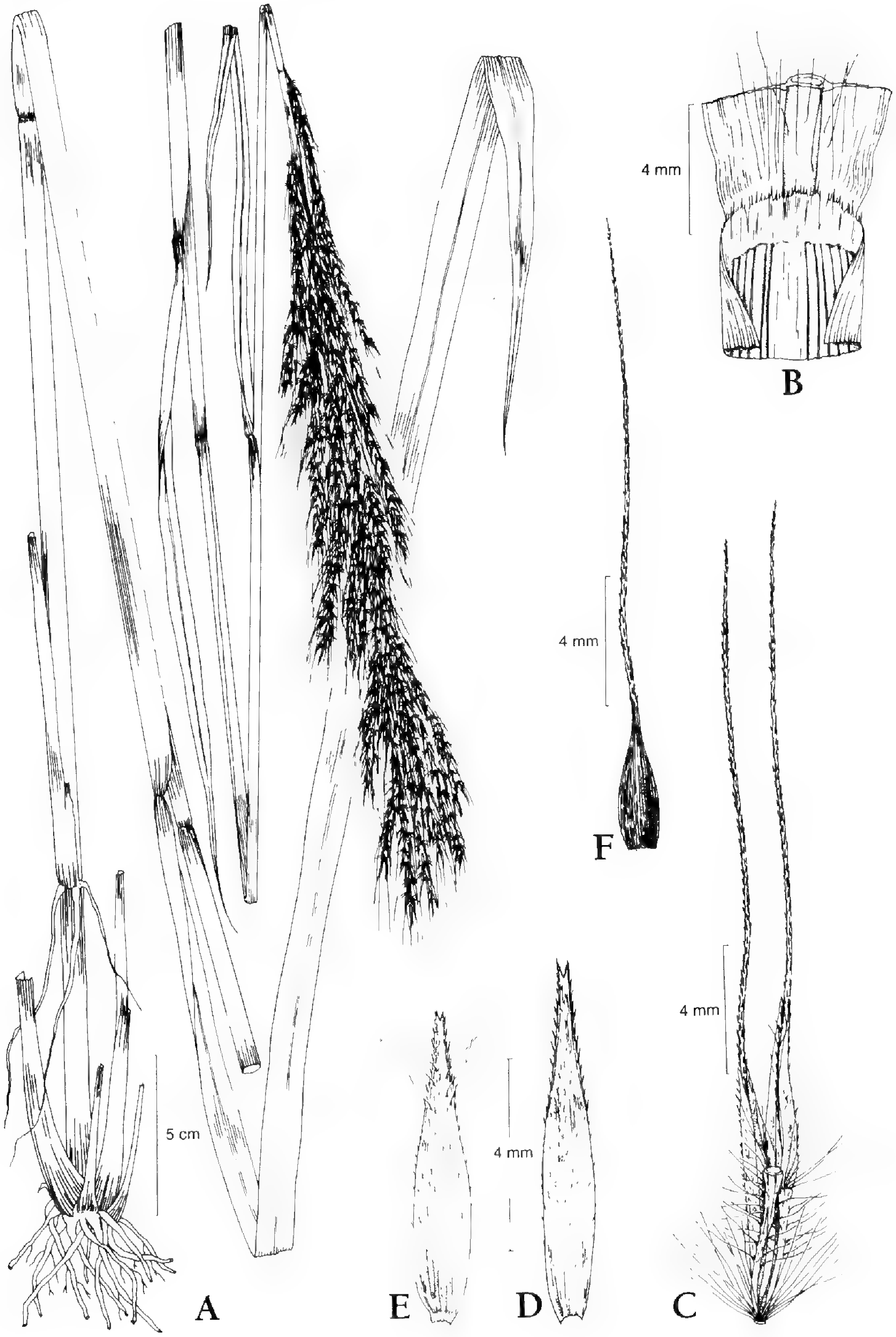

FIG. 4. *Saccharum coarctatum*. A. Habit, B. Ligule, C. Spikelet Pair, D. First Glume, E. Second Glume, F. Upper Lemma and Awn.

etative characters for *S. coarctatum* include relatively narrow leaf blades, narrow culm internodes, and essentially glabrous culms. These features are similar to those of *S. baldwinii*, which is best Sep arated from *S. coarctatum* on the presence of hairy nodes; however, the nodes of *S. coarctatum* frequently become glabrous at maturity. The most reliable distinguishing characters for *S. coarctatum* are the straight non-spiraled awn of the upper lemma and callus hairs that are about half the length of the spikelet. An interesting characteristic of this species is that the nerves of the lodicules extend into hair-like projections that measure about 0.6 mm long.

Fernald (1943) described the taxon, *Erianthus coarctatus* var. *elliotianus* Fern. and distinguished it from the typical variety on the basis of its relatively wider culm internodes, higher culm height, wider leaf blades, longer inflorescence main axis, and a wider inflorescence. When the variation among all specimens is considered, these characters intergrade with the typical variety. Therefore, no formal taxonomic rank was given to these somewhat larger specimens.

Representative specimens examined. **ALABAMA:** Covington Co.: pine savanna 9.5 mi S Opp., 5 Oct 1968, *Kral 33679* (MO). Escambia Co.: 0.5 mi E Canoe, 7 Oct 1968, *Kral 33888* (MO). Mobile Co.: 10.7 mi S Theodore on Ala. 59, 8 Oct 1967, *Kral 29731* (US). **DELAWARE:** Sussex Co.: dry sandy soil, Sep 1894, *Canby s.n.* (PH); 5 mi W of Milleboro on road to Laurel, 12 Oct 1898, *Canby. Sargent & Muir s.n.* (PH). Ellendale, 25 Sep 1873, *Commons s.n.* (NY, PH, US); fencerow, 1/4 mi E of Ellendale, 12 Oct 1940, *Tatnall 4745* (GH, PH); few mi W of Ellendale, 06 Nov 1961, *Terrell & Thornton 3625* (US). **FLORIDA:** Alachua Co.: 3 mi W of Gainsville, 5 Nov 1938, *Swallen 5565* (US). Suwannee Co.: Live Oak, 9–17–1900, *Curtiss 3858* (US); near Live Oak, 10 Oct 1901, *Curtiss 6940* (NY, US). Union Co.: W of Lake Butler, 26 Oct 1940, *Silveus 6746* (US). **GEORGIA:** Berrien Co.: base of sand–hills of Little River, SW of Tifton, 29 Sep 1902, *Harper 1693* (BM, GH, MO, NY, US). McIntosh Co.: 2.3 mi W of S tip of Blackbeard Island, 17 Oct 1956, *Duncan 20662* (ISC, US). Tift Co.: Brookfield, 9–1978, *Quarin 3605* (C, MO). **LOUISIANA:** Calcasieu Parish: Oberlin, 8 Sep 1898, *Ball 194* (NY, US). Rapides Parish: Alexandria, *Hale s.n.* (PH). **MARYLAND:** Dorchester Co.: Robinson's Neck, Taylor's Island, Oct 1979, *Reese s.n.* (US). Somerset Co.: 5 mi N of Princess Anne, 2 Oct 1937, *Tatnall 3574* (GH, PH). Wicomico Co.: 3 mi SW of Salisbury, 4 Sep 1937, *Wilkens 5364* (PH). **NORTH CAROLINA:** Brunswick Co.: S of Wilmington, 8 Oct 1933, *Blomquist 721* (NY); Wilmington, 8–1905, *Hitchcock s.n.* (US). Columbus Co.: old Dock, 8–29–1938, *Godfrey 6339* (GH, US). Duplin Co.: between Faison and Warsaw, 5 Oct 1935, *Correll & Blomquist 4823* (GH, US). Johnston Co.: between Clayton and Smithfield, 2 Sep 1932, *Blomquist 333* (F, US). Robeson Co.: 5.1 mi SW of St. Pauls, 18 Oct 1958, *Britt 2851* (MICH). **SOUTH CAROLINA:** Georgetown Co.: 5 mi S of Andrews, 11 Sep 1939, *Godfrey 8191* (F, GH, MO, NY, PH, US); 5 mi N of Georgetown, 15 Sep 1939, *Godfrey & Tryon 8229* (GH, US). Sumter Co.: 5 mi E of Sumter, 4 Oct 1957, *Radford 29591* (GH, NY). **VIRGINIA:** Sussex Co.: 4 mi NW of Homerville, 20 Sep 1937, *Fernald & Long 7301* (F, PH); NW of Owen's Store, 14 Oct 1941, *Fernald & Long 13884* (GH, PH).

Saccharum giganteum (Walt.) Pers., Syn. Pl. 1:103. 1805. *Anthoxanthum giganteum* Walt., Fl. Carol. 65. 1788. *Erianthus saccharoides* Michx., Fl. Bor.-Amer.

1:55. 1803, *nom. illeg. Erianthus giganteus* (Walt.) C. E. Hubb., Rhodora 14:166. 1912, *non Muhlenb.* 1813. *Saccharum erianthoides* Raspail, Ann. Sci. Nat., Bot. 5:308. 1825, *nom. illeg. Andropogon erianthus* Link, Hort. Berol. 1:243. 1827, *nom. illeg.* TYPE: SOUTH CAROLINA. Georgetown Co.: *Godfrey 8192* (NEOTYPE: MO, here designated). Fig. 5.

Erianthus saccharoides Michx. var. *michauxii* Hack., in Mart., Fl. Bras. 2:57. 1883 (fide Hitchcock 1951).

Erianthus laxus Nash, Bull. Torrey Bot. Club 24:344. 1897. TYPE: FLORIDA. Paola, *Swingle 1732a* (HOLOTYPE: NY!).

Erianthus compactus Nash, Bull. Torrey Bot. Club 22:419. 1895. *Erianthus saccharoides* Michx. var. *compactus* (Nash) Fernald, Rhodora 45:252. 1943. TYPE: Washington, D.C., *Nash s.n.* (HOLOTYPE: NY!).

Rhizomes with compacted nodes. Flowering culms mostly 10–25 dm tall. Nodes hairy (the hairs ca. 5 mm long). Internodes hollow. Leaves without auricles. Sheaths ciliate at the apex. Ligule 2–6 mm long. Collar differentiated; hairy. Leaf blades mostly 35–70 cm long; 8–30 mm wide; hairy on the upper surface. Peduncle mostly 40–80 cm long; hairy (pilose). Inflorescence oblong or lanceolate; 6–15 cm wide. Lowermost inflorescence node differentiated; densely hairy. Main axis mostly 15–30 cm long; hairy; pilose; densely or sparsely hairy. Primary branches appressed to the main axis (spreading at anthesis); 2–13 cm long; hairy; ciliate. Rachis internode 2–5.5 mm long; about 0.3 mm wide; hairy. Pedicels 2.5–5.0 mm long; hairy. Callus hairy. Callus hairs straw-colored or brown; 7–25 mm long (mostly 15–20); longer than the spikelet. Spikelets heteromorphic (the lower spikelet commonly glabrous and the upper spikelet pilose); straw-colored; 4.2–6 mm long; 0.8–1.1 mm wide. First glume indistinctly 5-nerved; smooth. Second glume indistinctly 3 or 5-nerved. Lemma of lower floret 3–5 mm long; nerveless. Upper floret subequal to the lower floret. Lemma of upper floret 2.5–3.5 mm long; 1-nerved; entire. Awn of upper lemma usually 12–26 mm long; basally terete; not basally spiraled. Lodicules with nerves extending or not extending into hair-like projections.

Saccharum giganteum is a polymorphic species that occurs throughout the southeastern United States and extends into Central America where its morphological relationship with *S. trinii* (Hack.) Renv. is unclear. In North America its western limit is the savannas and prairies of east Texas, and its northern limit is Arkansas through Tennessee to southern Pennsylvania and New Jersey. Within this complex, *S. giganteum* is distinguished by the presence of a straight upper lemma awn and callus hairs longer than the spikelet. It is most similar to *S. alopecuroideum*, and intermediate specimens are occasionally encountered. *Saccharum giganteum* commonly exists in a variety of ecological conditions ranging from standing water and loamy soils to dry red clay on open hillsides. It prefers open marshy conditions

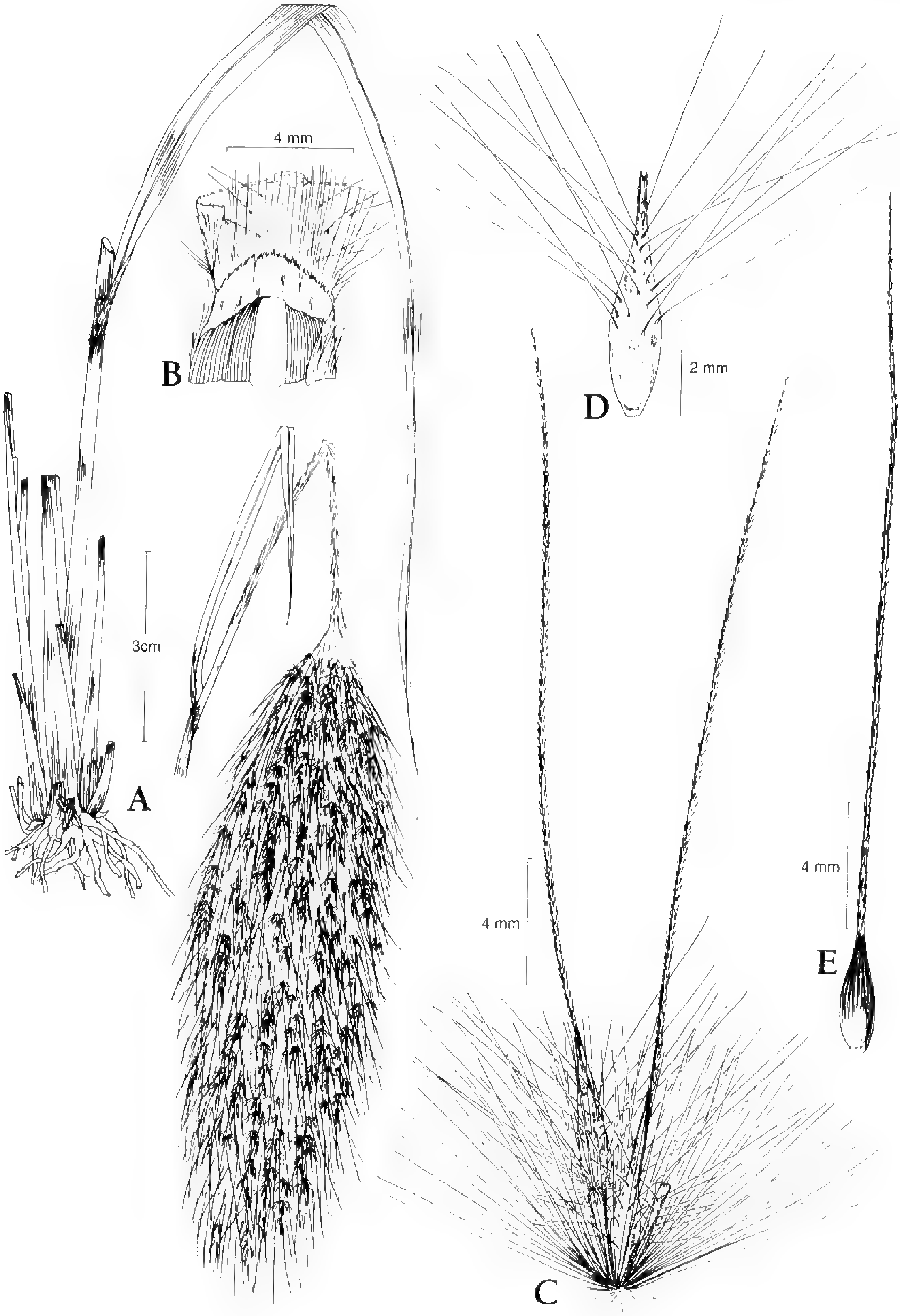

FIG. 5. *Saccharum giganteum*. A. Habit, B. Ligule, C. Spikelet Pair, D. First Glume, E. Upper Lemma and Awn.

where it frequently grows to 2.5 m. in height with large, bushy inflorescences. It is also common in the clay pineland savannas of northern Florida and southern Mississippi, where it may be only a meter in height with a relatively small compacted inflorescence.

Nash (1913) recognized three taxa that Hitchcock (1951) placed in synonymy. Nash Sep arated *E. laxus* from *E. saccharoides* (= *S. giganteum*) on the basis of elongate primary branches, longer rachis internodes, and longer basal hairs. These characters and others exhibited by the type specimen cannot be used to differentiate *E. laxus* from the typical form; therefore, the name *E. laxus* was placed in synonymy. Nash delimited *E. compactus* on the basis of a compact panicle with short branches, short rachis internodes, and crowded small spikelets. These characters cannot be used in a consistent manner. Many of the specimens with these characteristics also exhibit evidence of seasonal burning, mowing, or growth in less than favorable habitats. It was suspected that these smaller plants with compacted inflorescences, which are common in Delaware and New Jersey, are the result of the above negative growth factors and *E. compactus* was placed as a synonym. Nash's *E. tracyii* poses a different problem. The type specimen has a densely pilose inflorescence with long white callus hairs and the awn of the upper lemma is spiraled at the base. Based on the presence of the spiraled awn, *E. tracyii* was placed as a synonym of *S. alopecuoideum*. Other specimens [*Pollard 1341* (NY), *Kearney 6* (PH, NY), *Tracy 5332* (NY)], collected near Starkville, Mississippi in the fall of 1896 are similar to the type of *E. tracyii* but possess a short straight awn. These specimens appear similar to the South American species, *S. trinii*. It seems possible that *S. trinii* was introduced at the agricultural station at Starkville, escaped, collected, and since disappeared. Future studies of the variation in the South American species may show that *S. trinii* may rarely occur in southern Florida.

Representative specimens examined. **ALABAMA:** Aut Auga Co.: 2 mi NE of Aut Augaville, 24 Sep 1934, *Harper 3272* (GH, PH). Cullman Co.: 17 Sep 1897, *Eggert s.n.* (GH, NY). Escambia Co.: 2 mi W of Brewton, 6 Oct 1968, *Kral 33730* (BRIT). Geneva Co.: 4 mi W of Geneva on county 4, 6 Oct 1958, *Kral 22771* (BRIT). Mobile Co.: 1 mi N Mt. Vernon, 7 Oct 1967, *Kral 29520B* (BRIT). **ARKANSAS:** Ashley Co.: Wilson Lake, 11 Oct 1936, *Demaree 13892* (BRIT, GH, NY). Bradley Co.: Drew and Bradley Co. line, 5 Oct 1940, *Demaree 21822* (BRIT, GH, MO, NY). Calhoun Co.: P.O. Tinsman, 20 Oct 1941, *Demaree 22688* (BRIT, NY). Columbia Co.: P.O. Magnolia 6 Oct 1940, *Demaree 21785* (BRIT, NY). Crittenden Co.: P.O. W of Memphis, 3 Oct 1969, *Demaree 61271* (BRIT). Phillips Co.: P.O. W of Helena, 15 Oct 1950, *Demaree 30246* (BRIT). **DELAWARE:** New Castle Co.: 1 1/2 mi SW toward Vandyke, 20 Sep 1907, *Van Pelt s.n.* (PH). Sussex Co.: 1.3 mi N of Bethany Beach, 12 Oct 1940, *Chase 12626* (MICH). **DISTRICT OF COLUMBIA:** Brightwood, 7 Oct 1905, *Hitchcock 235* (GH). **FLORIDA:** Brevard Co.: Okeechobee region, 22 Sep 1903, *Fredholm 6017* (GH). Calhoun Co.: near Jacksonville, *Curtiss 3627* (MICH). Dade Co.: SW of Homestead, 12 Oct 1962, *Craighead 9228*

(GH). Dixie Co.: 4 mi N of Suwannee, 12 Oct 1957, *Godfrey 56180* (GH, NY). Duval Co.: Ft. Caroline and Merrill Roads, *F. C. & Greager 282* (GH). Hamilton Co.: 1.2 mi WNW of Jennings–Blue Springs exit Hwy I–75, 13 Nov 1970, *Thigpen 325* (NY). Lee Co.: Central Sanibel, 6 Oct 1972, *Brumbach 8046* (GH). Leon Co.: 5 mi N of Tallahassee, 11 Oct 1957, *Godfrey 56136* (GH). Madison Co.: 7 mi W of Greenville, 2 Oct 1955, *Kral & Gillespie 53999* (NY). Seminole Co.: Altamonte Springs, 5 Oct 1959, *Schallert 486* (MICH). **GEORGIA:** Colquit Co.: in small pine–barren stream, 23 Sep 1902, *Harper 1662* (GH). McIntosh Co.: 5 mi NW of Townsend, 10 Mar 1940, *Walker 1486* (PH). **LOUISIANA:** Avoyelles Parish: 8 mi S of Bunkie, 17 Sep 1968, *Harvey 8098* (MICH). Madison Parish: 5.8 mi N of Waverly, 8 Sep 1979, *Rich et al 1499* (NY). Natchitoches Parish: Sec. 1 T12N R6W, 17 Oct 1986, *Thomas & Gilmore 98848* (MO, NY). St. Landry Parish: 3.3 mi W of Opelousas, 5 Oct 1956, *Shinners 25,008* (BRIT). Tensas Parish: 3.7 mi S of La. 4 and Newellton, 1 Oct 1987, *Thomas 102,260* (NY). **MARYLAND:** Caroline Co.: 1 mi N of Hollingsworth crossroads, 14 Sep 1986, *Hill 17378* (NY). Dorchester Co.: 11 mi SW of Cambridge, 5 Sep 1937, *Earle 1636* (GH, PH). Prince Georges Co.: Kenilworth swamp, 24 Sep 1897, *Pieters s.n.* (MICH). Talbot Co.: 2 1/2 mi NE by N of Easton, *Earle 4774* (GH); 1 1/2 mi WNW. of Easton, 17 Sep 1967, *Earle 5401* (PH). Wicomico Co.: Rt. 50 crossing at Nanticoke River, 12 Oct 1981, *Hill 10859* (GH). **MISSISSIPI:** Franklin Co.: 4 mi W of jct Miss. 33 near Leesdale, 25 Sep 1970, *Westmoreland 707* (F). Pearl River Co.: Picayune, 6 Oct 1964, *Sargent 8476* (MICH). **NEW JERSEY:** Burlington Co.: Indian Mills, 9 Sep 1922, *Drisbork 1144* (F, GH, PH). Camden Co.: 1 Sep 1871, *Parker s.n.* (F). Cape May Co.: Ocean City, 14 Sep 1907, *Van Pelt 1907* (GH, PH). Cumberland Co.: W of Cedarville, 17 Mar 1935, *Long 45538* (PH). Gloucester Co.: 18 Sep 1868, *Parker s.n.* (GH). Ocean Co.: Forked river, 3 Nov 1937, *Koster 05-85-2* (MICH). **NORTH CAROLINA:** Anson Co.: near Polkton, 25 Oct 1936, *Correll 7101* (MICH). Beaufort Co.: Savannah near Edward, 13 Oct 1938, *Godfrey 6890* (GH). Brunswick Co.: The Oaks, 4 Oct 1941, *Radford 10110* (NY). Buncombe Co.: near Biltmore, 2 Sep 1938, 5847 (F, GH). Cartaret Co.: 1 Sep –1938, *Godfrey 6499* (GH). Craven Co.: New Bern, 11 Nov 1903, *E.B.H. 4177* (GH). Durham Co.: Duke Forest, 20 Oct 1932, *Blomquist 708* (F). Edgecombe Co.: 3.2 mi S of Battleboro, 23 Sep 1958, *Radford 40595* (BR). Gates Co.: near Gatesville, 15 Oct 1938, *Godfrey 7043* (GH). New Hanover Co.: Carolina Beach, 30 Aug 1938, *Godfrey 6375* (GH). Hoke Co.: 6 mi S of Southern Pines, 25 Oct 1935, *Blomquist 7176* (MICH). Hyde Co.: near Leechville, 13 Oct 1938, *Godfrey & White 6863* (GH). Macon Co.: near Franklin, 10 Sep 1933, *Alexander et al s.n.* (NY). Nash Co.: Pineland at Middlesex, 9 Oct 1938, *Godrey & Kerr 6616* (GH). Pamlico Co.: roadside near Grantaboro, 13 Oct 1938, *Godfrey & White 6820* (GH). Pitt Co.: 1.5 mi sec. of Stokes, 9 Oct 1958, *Radford 41756* (NY). Swain Co.: Smoke Mountains, 20 Aug 1891, *Beardslee & Kofoid s.n.* (GH). Wake Co.: sphagnum bog at Method, 10 Oct 1938, *Godrey 6730* (GH). Wilson Co.: near US. 264, 3 mi W of Sims, 25 Sep 1958, *Radford 40709* (MICH). **PENNSYLVANIA:** Bucks Co.: bank of Delaware river, *Martindale s.n.* (GH). **SOUTH CAROLINA:** Berkeley Co.: Swale, St. Stephens, 15 Sep 1939, *Godfrey 8199* (GH). Georgetown Co.: 5 mi S of Andrews, *Godfrey 8192* (GH, MO). Jasper Co.: 4 mi NNW of Hardeeville, 12 Oct 1974, *Boufford 15848* (GH). Lee Co.: 4 mi WSW of Ashland, 3 Oct 1957, *Radford 29301* (GH). Williamsburg Co.: 5.4 mi ene of Kingstree, 19 Oct 1957, *Radford 31233* (BRIT). **TENNESSEE:** Sumner Co.: pond near Mitchelville, Aug 1886, *Gattinger s.n.* (GH). Tipton Co.: 9.7 mi SW of Covington, 23 Oct 1958, *Shinners 27,674* (BRIT). **TEXAS:** Brazoria Co.: 3 mi N of F. M. 2004, 28 Oct 1974, *Waller & Bauml 3293* (GH). Cass Co.: 2 mi SW of Linden, 18 Oct 1962, *Correll 26424* (MO). Galveston Co.: 3/4 mi E I. H. 45, N of Dickinson, 18 Nov 1974, *Waller & Bauml 3301* (GH). Gonzales Co.: Palmetto State Park, 3 Oct 1943, *Barkley 13697* (BRIT, GH, NY, PH). Henderson Co.: 2 mi SE of Athens, 12 Oct 1962, *Correll 26187* (NY). Jasper Co.: 2 mi W of McGee Bend Dam., 13 Nov 1963, *Correll 28644* (NY). Milam Co.: 4 mi NW of Milano, 30 Oct 1933, *Wolff 4873* (BRIT). Orange Co.: 6 1/2 mi W of Orange, 16 Nov 1945, *Cory 50885* (BRIT, MICH). San Augustine Co.: Boykin Spring Camp, E of Zavalla, 19 Sep 1952, *Gould & Leinweber 6544* (BRIT). Wood Co.: near Little Hope, E. of Quitman, 19 Jan 1979, *Gritz 102* (BRIT). **VIRGINIA:** Campbell Co.: 3/4 mi W of Waterlick road, 28 Sep 1947, *Freer 1913* (GH). Dinwiddie Co.: 4 mi S of Petersburg, 11 Oct 1938, *Fernald & Long 9505* (GH). Fairfax Co.: near Fairfax, 21 Sep 1936, *Allard 2303* (GH, NY); U.S. Highway 50, E of Merrifield, 22 Sep 1939, *Hermann & Martin s.n.* (MICH, NY). Greenville Co.: 1 mi NW of Dahlia, 18 Sep 1938, *Fernald & Long 9244* (GH). Nansemond Co.: Factory Hill, 26 Aug 1936, *Fernald & Long 6456* (GH). Prince George Co.: N of Gray Church, 25 Aug 1936, *Fernald & Long 6455* (GH, PH). Stafford Co.: 1/4 mi E, 3 Sep 1939, *Hermann 10395* (GH). Southampton Co.: Swale, Courtland, 11 Sep 1937, *Fernald & Long 7304* (GH, PH). Sussex Co.: NW of Wakefield, 11 Sep 1937, *Fernald & Long 7303* (GH).

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NOTEWORTHY PLANTS FROM NORTH FLORIDA. VI

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ABSTRACT

The following appear to be first reports for the state of Florida: *Anredera baselloides*, *Chimaphila maculata*, *Scirpus subterminalis*, *Silene caroliniana*, and *Zigadenus leimanthoides*. Some additions to the Florida panhandle are documented also, and several significant range extensions, particularly for rare or endangered taxa within our area, are given.

RESUMEN

Las plantas siguientes parecen ser primeras citas para el estado de Florida: *Anredera baselloides*, *Chimaphila maculata*, *Scirpus subterminalis*, *Silene caroliniana* y *Zygadenus leimanthoides*. Se documentan también algunas adiciones para el extremo de Florida y se dan varias extensiones de área significativas, particularmente para plantas raras o en peligro dentro de este área.

Recent botanical discoveries in the western part of the state prompted this sixth installment of a series (Anderson 1984, 1986, 1988a, 1989, 1991) to update our knowledge of the flora of the Florida panhandle and Clewell's (1985) guide to the flora. The area of coverage is from the Suwannee River west to the Alabama state line.

New discoveries—i.e., taxa not listed by Clewell—and range extensions of selected rare or otherwise noteworthy taxa are given here. Only general locations are given for some of the rarer taxa; most Eglin Air Force Base localities are closed to the public, and the area is patrolled and protected by military and civilian personnel. Exotics that appear to be adventive or naturalized are also listed. Herbarium specimens are at FSU unless noted otherwise.

TAXA NEW TO THE AREA

Amaranthus palmeri Watson. Gadsden Co.: fallow field, Quincy, 3 Nov 1965, *R. K. Godfrey 67534* (FLAS, FSU), originally identified as *A. hybridus*; Jefferson Co.: frequent bordering pastures along Hwy 221 just N of Ashville, 19 Sep 1988, *L.C. Anderson 11833*; Leon Co.: roadside weed in Tallahassee, 12 Jul 1991, *L.C. Anderson 13469* (staminate plant), *13470* (pistillate plant); naturalized, new to Florida panhandle.

Anredera baselloides (H.B.K.) Baill. Leon Co.: locally common along

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railroad embankment, W of Cadiz Street in Tallahassee, 4 Aug 1993, *L.C. Anderson 14506*, 27 Oct 1993, *L.C. Anderson 14614*; naturalized, new to Florida. A tendency toward imperfect or functionally imperfect flowers exists in the genus (Bogle 1969). Our plants have bisexual flowers; the pollen appears fertile (as determined by microscopic examination of stained grains), but no fruits have been found. Another species, *A. leptostachya* (Moq.) Steenis occurs sporadically in peninsular Florida. Its flowers have three bifid styles and are subtended by separate, caducous bracteoles, whereas flowers of *A. baselloides* have single styles with three capitate stigmas and are subtended by connate, persistent bracteoles.

Belamcanda chinensis (L.) DC. Leon Co.: along fence at San Luis Ridge park, 1 Aug 1994, *L.C. Anderson 15168*; naturalized, new to Florida panhandle.

Blechnum serrulatum L.C. Richard. Bay Co.: large, local population in wet pine flatwoods in St. Andrews State Recreation Area near Grand Lagoon, 22 Jan 1995, *L. O'Kane s.n.*; naturalized (or native?), new to Florida panhandle.

Chimaphila maculata (L.) Pursh. Leon Co.: 15–20 stems seen in shade of magnolia-beech-oak woodland near Chaires, 27 Apr 1993, *L.C. Anderson 14185*; native, new to Florida.

Ficus pumila L. Leon Co.: Tallahassee, *R.K. Godfrey* ; Florida State University campus, Tallahassee, 12 Oct 1994, *L.C. Anderson 15306*; naturalized in Tallahassee for many years (apparently overlooked by Clewell).

Galactia elliottii Nutt. Taylor Co.: locally common in coarse sandy soil along Rte 361, ca. 10 air mi NW of Steinhatchee, 13 Jul 1992, *L.C. Anderson 13649*, native, new to Florida panhandle.

Lindera subcoriacea Wofford. Okaloosa Co.: shaded floodplain of Metts Creek, Eglin Air Force Base, 31 Jul 1992, *L.C. Anderson 13851*, 15 Jul 1993, *L.C. Anderson 14451*; native, new to Florida panhandle (possibly new to the state). Some collections from peninsular Florida have been tentatively identified as this species (McCartney et al. 1989), but B. Sorrie (pers. comm.) claims those plants represent *L. benzoin* (L.) Blume var. *pubescens* Palmer & Steyermark.

Melampodium divaricatum (Rich. in Pers.) DC. Leon Co.: Leon Sinks Geological Area in Apalachicola National Forest, 25 Oct 1993, *L.C. Anderson 15283*. A single plant of this Central American species was found (it is available through local nurseries for horticultural use and may become naturalized).

Monotropa hypopithys L. Okaloosa Co.: slopes of Silver Creek, E of Rte 85 on Eglin Air Force Base, 27 Jun 1994, *A. Schotz 1100*; Walton Co.: dried flowering stems infrequent along crest of steep head, Eglin Air Force Base, generally N of Choctaw Beach, 30 May 1994, *A. Schotz 1157*; new to

Florida panhandle. This endangered species (Coile 1993b) is known to occur in central peninsular Florida (Ward 1966).

Scirpus subterminalis Torr. Santa Rosa Co.: collected via canoe along edge of Big Coldwater Creek, T3N, R28W, Sec 13, 30 May 1994, *L. Chafin 2051*; frequent in coarse sand of shallow, shaded shoal, submersed in 10–15 cm water with *S. etuberculatus* (Steud.) Kuntze along bank of Big Coldwater Creek between Bass Brinks Creek and Wolfe Creek, ca. 7.5 air mi NNE of Milton, 1 Jul 1994, *L.C. Anderson 15053*; native, new to Florida.

Koyama (1962) concluded that *S. subterminalis* and *S. etuberculatus* were conspecific and made the combination *S. subterminalis* var. *cylindricus* (Torr.) Koyama for the latter. He reasoned that *S. torreyi* Olney should be merged with *S. subterminalis* and that *S. etuberculatus* was just a southern form of *S. torreyi* (hence all three belonged to one species), but Gleason and Cronquist (1991) treat all three as distinct species.

Apparently, *S. subterminalis* and *S. etuberculatus* do hybridize in South Carolina (A. Pittman, pers. comm.). He suggests the two morphologies (i.e., *S. subterminalis* with flaccid, terete submerged stems with inflorescences as single spikes and *S. etuberculatus* with rigid, triangular emergent stems with umbellate inflorescences) may be due to the respective plants growing at different levels in the water column. I found the two growing side by side on the same shallowly submerged shoal with no sign of intergradation; further, populations of typical *S. etuberculatus* are scattered across much of Florida, yet *S. subterminalis* has just now been found in the state—it should be more wide spread if it is indeed just an ecotypic variant. I consider the two as distinct species that may exhibit some hybridization in limited portions of their ranges.

Silene caroliniana Walt. Okaloosa Co.: infrequent at base of shaded N-facing bluff bordering Rocky Bayou, E of Niceville, 21 Jun 1994, *L.C. Anderson 15021*; native, new to Florida. This may be a relictual population persisting in a suitable niche in an otherwise inhospitable environment; a similar circumstance has been suggested for *S. virginica* L. (Anderson 1991; Kral 1966).

Solanum viarum Dunal. Leon Co.: wooded slope above Dog Lake, Apalachicola National Forest, 20 Oct 1994, *R.K. Godfrey 84074*; single plant seen and destroyed (naturalized?), first report for Florida panhandle. This noxious weed was recently found in southern Florida (Coile 1993a) and now infests considerable acreage there.

Sphagneticola trilobata (L.) Pruski. Leon Co.: roadside ditch, Tallahassee, 20 Jul 1994, *L.C. Anderson 15107*; naturalized, new to Florida panhandle. The species is widely cultivated and naturalized in peninsular Florida and around New Orleans; this new report represents the northern-most population known for the species.

This species was placed in *Wedelia* for many years. Strother (1991) said it should be in a separate genus, which he named *Complaya*, but Pruski (1995) noted the earliest available generic name is *Sphagneticola*.

Zigadenus leimanthoides A. Gray. Escambia Co.: along creek S of Nine Mile Rd, W of Pensacola, 27 May 1984, *J.R. Burkhalter 9390* (FLAS, FSU); Okaloosa Co.: shaded floodplain along Metts Creek, Eglin Air Force Base, 31 Jul 1992, *L.C. Anderson 13847*; shaded floodplain along Middle Creek, Eglin Air Force Base, 2 Jun 1994, *L.C. Anderson 14913*; sunny seepage slope under power line along Turkey Creek, Eglin Air Force Base, 9 Jun 1994, *L.C. Anderson 14944*; Walton Co.: northwest [part of county], 17 May 1938, *E.G. Hume s.n.* (FLAS); shaded bay-gall bordering seepage slope, Blount Mill Creek drainage, 29 Jul 1994, *L.C. Anderson 15140*; native, new to Florida.

The Burkhalter specimens are labeled *Z. densus* (Desr.) Fern., but that species is characterized as having racemose inflorescences as opposed to paniculate ones in *Z. leimanthoides*. Preece (1956) states the two species are closely related but distinct (he did not see the Hume specimen), whereas W. McDearman (pers. comm.) considers the two conspecific. The two species appear ecologically and morphologically distinct in the Florida panhandle. The taxonomic relationships are complicated further because the type specimens of *Z. leimanthoides* are relatively small plants from the mountains of North Carolina, whereas plants from the Florida coastal plain are very robust (they may represent a separate taxon).

ADDITIONAL RANGE EXTENSIONS

Asclepias viridula Chapm. Walton Co.: scattered in wet flatwoods at Alaqua Point, S of Rte 20, 1 Jul 1994, *A. Schotz 1104*; new to western panhandle (Wilhelm 1984, pers. comm.). This taxon is considered threatened in Florida (Coile 1993b).

Calycanthus floridus L. Walton Co.: in semi-shade of oak-sourwood-pine woodland along Rocky Creek, 6 mi NE of Niceville, 26 Apr 1994, *A. Schotz 1019*; new to western panhandle (Wilhelm 1984, pers. comm.). This species is considered endangered in Florida (Coile 1993b).

Coelorachis tuberculosa (Nash) Nash. Santa Rosa Co.: infrequent in depression marsh at Goose Ponds, Blackwater River State Forest, 11 Sep 1994, *J. Jensen s.n.*; new to western panhandle (Wilhelm 1984, pers. comm.).

Crataegus phaenopyrum (L. f.) Medic. Liberty Co.: swamp, Ochlockonee River, 4 May 1987, *H.G. Grant s.n.* (FLAS); Wakulla Co.: frequent on Ochlockonee River floodplain with *Nyssa ogechee*, *N. biflora*, *Liquidambar styraciflua*, and *Taxodium ascendens*, Apalachicola National Forest, T3S, R4W, Sec 18, 1 Jul 1993, *G. Anglin s.n.*, 12 Jul 1994, *L.C. Anderson 15067*; Walton Co.: *Nyssa ogeche* swamp, N side Sister River in

Choctawhatchee River delta, 17 Oct 1988, *A.F. Clewell s.n.* (FLAS). The Wakulla County trees are 7–12 m tall, and the erect, leafless trunks (8–10 cm DBH) are armed with patches of thorns. This species is rare in Florida (Anderson 1986) and is listed as endangered (Coile 1993b). Coker and Totten (1934) reported this species (as *C. youngii* Sarg.) from Wakulla County; it has now been rediscovered for the county.

Cyperus hystricinus Fern. Okaloosa Co.: infrequent in dry sand of open hickory-pine woods at Rocky Bayou State Recreation Area, Niceville, 21 Jul 1994, *L.C. Anderson 15014*; this constitutes the second record for this species in the state. Carter (1988) reported the species from Walton County.

Eleocharis confervoides (Poir.) Tucker. Okaloosa Co.: common (vegetative) in Blue Spring, Eglin Air Force Base, 12 Mar 1994, *L.C. Anderson 14670*; Santa Rosa Co.: abundant (fruiting) in shallow waters of Atwell Pond on Eglin Air Force Base, 31 Jul 1992, *L.C. Anderson 13833*. This infrequently collected species was long assigned to the genus *Websteria*.

Liatris earlei (Greene) K. Schumann. Okaloosa Co.: open pine-oak woodland, Rocky Bayou State Recreation Area, 28 Jul 1994, *L.C. Anderson 15127*; infrequent in northern Florida, new to western panhandle (Wilhelm 1984, pers. comm.).

Linum westii Rogers. Okaloosa Co.: frequent in peaty sand along margin of small *Taxodium ascendens-Ilex myrtifolia* swamp on Eglin Air Force Base, N of Wynnehaven Beach, 14 Aug 1992, *L.C. Anderson 13911*. This is a significant extension westward for this endangered species (Coile 1993b).

Matelea alabamensis (Vail) Woodson. Walton Co.: locally common on wooded slopes above Piney Creek, N of Choctaw Beach, 17 Jul 1994, *A. Schotz 1125*. This species is endangered in Florida (Coile 1993b) and new to the western panhandle (Drapalik 1970; Wilhelm 1984, pers. comm).

Panicum nudicaule Vasey. Walton Co.: locally common on seepage slopes, Blount Mill Creek drainage, 28 Jul 1994, *L.C. Anderson 15120*, 29 Jul 1994, *L.C. Anderson 15142*. Clewell (1985) included this species in *Dichanthelium dichotomum* (L.) Gould [i.e., *P. dichotomum*], but the two are very distinct in morphology and habitat preference. This rare species (Hitchcock 1950, Lelong 1988) is considered a species of special concern by the Florida Natural Areas Inventory.

Pinguicula ionantha Godfrey. Wakulla Co.: frequent with *P. pumila* along upper edge of wet, roadside depression, N edge of St. Marks, 11 Mar 1986, *L.C. Anderson 9117*. This is a new county of record for this endangered species (Coile 1993b).

Rhexia parviflora Chapm. Santa Rosa Co.: outer edge of small gum pond in Blackwater River State Forest, ca. 7 air mi E of Munson, 21 Sep 1989, *S.L. Orzell & E.L. Bridges 12482*; locally abundant along edge of *Ilex myrtifolia* marsh at Goose Ponds, Blackwater River State Forest, 9 Jul 1994, *J. Jensen s.n.*; Walton Co.: edge of titi-gallberry depression at Alaqua Point, 1 Jul 1994, *A. Schotz 1103*; drainage ditch in pine flatwoods at Alaqua Point, 16 Jul 1994, *L.C. Anderson 15095*. These represent two new counties of record for this "rarest of the *Rhexia* species" (Bounds 1987) that is considered endangered in Florida (Coile 1993b).

Rhynchospora crinipes Gale. Okaloosa Co.: forming mats with *Sphagnum* along Malone Creek, 30 Jul 1992, *L.C. Anderson 13807*; infrequent (semi-floating) on shaded, wet bank of Metts Creek, Eglin Air Force Base, ca. 10 air mi W of Rte 85, 15 Jul 1993, *L.C. Anderson 14450*. These constitute an additional county of record in the Florida panhandle for this rare species (Anderson 1988b).

Rhynchospora leptocarpa (Chapm.) Small. Okaloosa Co.: frequent in wet peat near headwaters of Point Lookout Creek, Eglin Air Force Base, 23 Jul 1992, *L.C. Anderson 13746*; upper edge of tidal marsh on Rocky Bayou, 0.5 mi E of Niceville, 21 Jun 1994, *L.C. Anderson 14980*. This species is rarely collected in Florida.

Kral (pers. comm.) considers this species conspecific with the widespread *R. capitellata* (Michx.) Vahl. The latter is a more delicate plant with darker brown floral scales from higher elevations (piedmont and mountains), whereas the coastal plants of *R. leptocarpa* are more robust and frequently form tussocks with 30–40 culms which are gracefully arching to 12 dm long. The two geographical populations appear to be distinct in achene morphology (Blake 1918); this complex needs further study.

Ruellia pedunculata Torr. ex Gray ssp. **pinetorum** (Fern.) R.W. Long. Liberty Co.: frequent in seasonally wet depressions in pine woods, Apalachicola National Forest, 11 air mi SSW of Bristol, 26 Jun 1992, *L.C. Anderson 13660, 13675*. These represent the second county of record in the Florida panhandle for this infrequently encountered species.

Sideroxylon lycioides L. Santa Rosa Co.: floodplain swamp near E end of Grimes Lake, S of Yellow River, Eglin Air Force Base (ca. 1.95 mi E of Parkerville), 1 Aug 1994, *A. Schotz 1142*. This species, formerly known as *Bumelia* (see Pennington 1991 for evidence supporting transfer to *Sideroxylon*), is endangered in Florida (Coile 1993b); it is new to the western panhandle (Wilhelm 1984, pers. comm.).

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BOOK REVIEW

ZOMLEFER, WENDY B. 1994. **Guide to Flowering Plants Families.** (ISBN 0-8078-2160-8, hbk.; ISBN 0-8078-4470-5, pbk.). The University of North Carolina Press, Chapel Hill and London. $55.00 (hbk); $27.50 (pbk). 430 pp., 165 text figures, 302 glossary figures, 22 tables, 2 appendices.

Rarely are the talents of a superb botanical illustrator and a qualified botanist combined in one person. Wendy Zomlefer is such a person, and her *Guide to Flowering Plant Families* is proof. Even a quick perusal of the illustrations shows them to be accurate, botanically significant, life-like, and crisp. The book is intended to be adopted as a laboratory manual or atlas of flowering plant families for a college/universities plant systematics or field botany course; although, it also makes a very nice reference for professionals and enthusiasts, as well.

Approximately 325 pages are devoted to 130 family treatments consisting of 1) full page plates illustrating whole plants, details, dissections, and even diagnostic anatomical features;. 2) a written diagnosis and important characters; 3) lists of important genera; 4) distribution; 5) economic members, 6) and commentaries on reproductive biology and phylogenetic problems and/or current studies.

The choice of taxa illustrated focuses on warm temperate and tropical U.S. representatives (a few cultivated ones also) to aid students in mentally generalizing from typical members of the family. Often, several taxa showing the range of variation are illustrated. Of special interest is the inclusion of tropical families usually left out of an introductory course but which are of major world wide importance, notably the Lauraceae, Sapotaceae, Sterculiaceae, Bombacaceae, Rhizophoraceae, Malpighiaceae, Rutaceae, Meliaceae, Sapindaceae, Combretaceae, Myrtaceae, Bignoniaceae, Palmae, Bromeliaceae, Zingiberaceae, and Marantaceae.

The book has several added bonuses for the student. First and foremost is an illustrated glossary showing structures of real species (cross referenced to the family plate), not some diagrammatic idealization. Secondly, in Appendix B is a complete chart comparing each family in term of size, distribution, vegetative habit, floral formula, fruit types, and any special diagnostic field characters. Also, there are introductory chapters on 1) illustration techniques and floral diagrams, and 2) cladistic concepts that are important in understanding the commentary. Because she has adopted Thorne's system (which she defends well), Cronquists' system is outlined in Appendix A as a cross reference.

In summary, this comprehensive atlas is up-to-date, well drawn, well planned, and user-friendly. It is highly recommended as a supplement to a text on systematic principles or as a general reference in every botanist's library.—*Roger W. Sanders.*

NOTES

ARISTIDA DESMANTHA (POACEAE), NEW TO MISSOURI.—*Aristida desmantha* Trin. & Rupr. is an annual grass occurring on dry, sandy soil in Texas, Louisiana, Illinois, and Nebraska (Hitchcock 1951; Mohlenbrock 1973; Gould 1975; Allen 1992). During recent surveys for *Cyperus grayoides* Mohlenbrock in southeastern Missouri, a population of *Aristida desmantha* was discovered in Scott County.

Voucher specimens: U.S.A. MISSOURI. Scott Co.: ca. 1 mi E of the intersection of Rt. H and Co. Rd. 504; last field on north side of Co. Rd. 504 before intersection with Co. Rd. 505; T28N, R14E, SW1/4 of SE1/4 of SE1/4 of Sec. 28, 15 Oct 1992, *McKenzie 1165* (LSU, MO, NMC, UMO); same location, 7 Sep 1993, *McKenzie 1286* with Sherry Holmes and John Logan (MO).

Habitat at the discovery site is a dry, remnant sand prairie with recent history of disturbance. The deep, sandy soil is eolian (i.e., wind deposited) in origin (Saucier 1978; Bridges & Orzell 1989), and has been classified as belonging to the Scotco Association (Festervand 1981; Carter & Bryson 1991). Such habitats in southeastern Missouri are remnants of what were formerly more extensive sand prairies as classified by Nelson (1985). These sand prairies were apparently derived from sand dune formations associated with deposition of Wisconsinan Stage glacial outwash by the Mississippi-Missouri rivers east and west of Crowley's Ridge in southeastern Missouri and northeastern Arkansas (Saucier 1978). Most remaining tracts of remnant sand prairies in the region have been greatly altered by human activities (Carter & Bryson 1991). At the discovery site, *Aristida desmantha* was associated with *Andropogon ternarius* Michx., *Digitaria cognata* (Schultes) Pilger, *Diodia teres* Walt. var. *teres*, *Froelichia gracilis* (Hook.) Moq., *Cyperus grayoides, Opuntia humifusa* Raf. var. *humifusa*, and *Triplasis purpurea* (Walt.) Chapman. During the 7 Sep 1993 visit, tens of thousands of plants were estimated to occur at the site. Searches in similar, adjacent habitat have failed to produce any additional populations. The Scott County site is ca. 320 km SSW of the nearest locality in west central Illinois. While *Aristida desmantha* is currently known only from the discovery site, further surveys in appropriate sand prairie habitat in southeastern Missouri are likely to yield additional records. The species should be considered as a candidate for state-endangered status following guidelines established by the Missouri Department of Conservation (1992).

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Smith and Doug Newman, Missouri Department of Conservation reviewed an earlier draft of the manuscript.—*Paul M. McKenzie, U.S. Fish and Wildlife Service, 608 E. Cherry St., Rm. 200, Columbia, MO 65201, U.S.A.*

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MALAXIS WENDTII (ORCHIDACEAE) IN THE UNITED STATES.—Recently Gerardo Salazar (Orquidea 13:281–284. 1993) separated *Malaxis wendtii* Salazar from *Malaxis ehrenbergii* (Reichb.f.) Kuntze based on its papillose flora segments (vs. glabrous) and its narrowly sagittate lip (vs. broadly triangular hastate). The type specimen and other specimens cited by Salazar are all from Coahuila, Mexico, two of the latter being from Sierra del Carmen and Serranias del Burro directly east across the Rio Grande from the Chisos Mountains of Big Bend National Park. It is therefore not surprising that the two specimens at SRSC collected by Barton Warnock (*Warnock 23382*) in the Chisos Mountains and labeled *M. ehrenbergii* are typical *M. wendtii*.

All specimens of *M. ehrenbergii* examined at ASU, TUC, NMC, and UNM that are from Arizona or New Mexico show the papillae characteristic of *M. wendtii* as do two specimens from Durango and Sonora. Specimens there from further south in Mexico are typical *M. ehrenbergii*. Specimens are known from Apache (*Worthington 8680,* OCLA), Cochise, Pima and Santa Cruz counties in Arizona; from Catron (*Worthington 7587,* OCLA), Grant (*Worthington 7497, 7501, 7505,* OCLA), Lincoln (*Worthington 7463, 12267,* OCLA), Los Alamos and Otero (*Worthington 8680, 12330*, OCLA) counties in New Mexico; and from Brewster County in Texas. It is interesting that the flowers in the 10x photograph of *M. ehrenbergii* shown of Plate 81 of Luer's *The Native Orchids of the United States and Canada* (1975), which he photographed in Cochise County, Arizona, exhibit the papillae of *M. wendtii*. I thank Lawrence K. Magrath (OCLA) for providing additional collection data from Arizona and New Mexico.—*Thomas K. Todsen, Department of Biology, New Mexico State University, Las Cruces, NM 88003, U.S.A.*

CAREX AMPLIFOLIA AND *CAREX ROSSII* (CYPERACEAE), NEW TO NEW MEXICO AND A KEY TO SECTION *MONTANAE* IN NEW MEXICO.—*Carex amplifolia* F. Boott, a western wetland caric-sedge, and *C. rossii* F. Boott, a predominantly Rocky Mountain caric-sedge, previously unreported for New Mexico, have been found in the northern Black Range of the Gila National Forest.

Carex amplifolia section *Anomalae* Carey, was reported from Idaho to British Columbia, and southward to San Mateo and Tulare counties, California by Mackenzie (1935). Mackenzie cited specimens from Idaho, British Columbia, Washington, Oregon, and California. Other authors (Hermann 1970; Cronquist et al. 1977; Hickman 1993) have mirrored Mackenzie's distribution. This species was not included in the flora of New Mexico by Correll and Correll (1972) and Martin and Hutchins (1980). With this new location, the range of this species has been extended ca. 1000 km (625 mi) east from Tulare County, California.

Carex amplifolia is the only representative of section *Anomalae* in New Mexico. The most closely related taxon in New Mexico is *C. limosa* L. of section *Limosae* Tuckerman. *Carex limosa* differs from *C. amplifolia* by having beakless or very slightly beaked perigynia and pistillate spikes 2.5 cm or less long. However, the existence of *C. limosa* in New Mexico is dubious. We have not seen specimens from New Mexico and the only reference to its existence in the state is Martin and Hutchins (1980). Excluding *C. limosa*, *C. amplifolia* differs from all other *Carex* in New Mexico that share a trigonous achene, a style jointed with the achene, and glabrous perigynia by having its lower bracts being sheathless or very short sheathing. *Carex amplifolia* is characterized by having long, stout rhizomes with erect culms up to ca. 7.5 dm tall; leaves usually greater than 1 cm wide; the terminal one or two spikes being staminate with the lower four to five spikes being pistillate; each pistillate spike bearing over 100 perigynia; and perigynia are ovoid, obtusely trigonous, smooth or nearly so, and abruptly contracted into a conic, more-or-less excurved beak.

Carex amplifolia was located along the edge of Diamond Creek in association with *C. bella* L.H. Bailey, *C. disperma* C. Dewey, *Pteridium aquilinum* (L.) Kuhn var. *pubescens* Underwood, and *Alnus tenuifolia* Nuttall in a mixed conifer forest of *Picea engelmannii* Parry ex Engelmann var. *engelmannii*, *Pseudotsuga menziesii* (Mirbel) Franco var. *glauca* (Beissner) Mayr, and *Pinus ponderosa* P. Lawson var. *scopulorum* Engelmann. The elevation of the collection location is ca. 2438 m (8000 ft) and is situated along the border of Sections 1 and 2 of Range 10W, Township 12S. This population was located near the NW corner of the Aldo Leopold Wilderness, which can be

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accessed from NM 51 along U.S. Forest Routes 226 and 500. The population is ca. 2 miles S by foot from the terminus of USFR 500.

Voucher specimen. U.S.A. NEW MEXICO. **Sierra Co.**: along edge of Diamond Creek, ca. 3.5 air mi N of Diamond Peak, W-SW of Winston, 16 Jun 1994, *Roalson 879* (NMCR, sdj = pers. herb. of Stanley D. Jones).

Carex rossii, section *Montanae* Fries, is known from the mountains of Colorado to middle California, and northward to Yukon, eastward to the Black Hills of South Dakota, and locally to northern Michigan (Mackenzie 1935). Hermann (1970) and Cronquist et al. (1977) reported a similar range with the addition of the Kaibab Plateau in northern Arizona. This location extends its known range by ca. 490 km (306 mi) from northern Arizona. This species was not included in the flora of New Mexico by Martin and Hutchins (1980). While looking through unidentified specimens of *Carex* at UNM, a specimen of *C. rossii* collected in 1963 was discovered. This specimen was collected in Taos County, New Mexico, N of the small town of La Lama. Other representatives of section *Montanae* in New Mexico are *C. heliophila* Mackenzie, and *C. geophila* Mackenzie.

KEY TO *CAREX* SECTION *MONTANAE* IN NEW MEXICO

1a. Fertile culms all alike, bearing both staminate and pistillate spikes; basal spikes absent. .... *C. heliophila* Mackenzie
1b. Fertile culms of two types, some short, 1–5 cm. long, partly hidden among the densely tufted leaf-bases and bearing only pistillate spikes, other culms elongated, 5–30 cm. long, and bearing both staminate and pistillate spikes. 2
    2a. Bract of the lowest nonbasal pistillate spike leaf-like, normally exceeding the culm. .... *C. rossii* F. Boott
    2b. Bract of the lowest nonbasal pistillate spike squamiform, shorter than the culm. .... *C. geophila* Mackenzie

Carex rossii is characterized by having medium-sized, more-or-less densely cespitose clumps, without long horizontal stolons; culms 5–30 cm high, slender but erect and strict; leaf blades usually less than 6 cm long, 1–2.5 mm wide, thin but firm; staminate spike sessile or short-peduncled, erect, 3–15 mm long, exceeding the contiguous pistillate spike; pistillate spikes 3–5, sessile or short-peduncled, perigynia 3–15, lower bract leaf-like, normally exceeding the culm; perigynia 3–4.5 mm long, abruptly contracted into a conic, ciliate-serrulate, deeply bidentate beak. *Carex rossii* was collected on N-facing slopes that had been burned in a forest fire in July 1990. The area is now dominated by *Populus tremuloides* A. Michaux var. *aurea* (Tidestrom) Daniels, *Physocarpus monogynus* (Torrey) Coulter, *Rubus strigosus* A. Michaux var. *arizonicus* (Greene) Kearney and Peebles, and *Robinia*

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neomexicana A. Gray var. *neomexicana*. Tufted plants of *Carex deweyana* Schweinitz were commonly associated with the tufts of *C. rossii. Zigadenus virescens* (Kunth) Macbride and *Symphoricarpos* spp. were common on the slopes. The elevation at the collection site is ca. 2865 m (9400 ft) and is located in Range 10W, Township 12S, Section 24. The Continental Divide Trail runs along this slope in several switchbacks from the base to summit of the ridge.

Voucher specimen. U.S.A. NEW MEXICO. **Sierra Co.:** silty slopes along Continental Divide Trail, N of Diamond Peak, N-facing slope, SW of Winston, 27 Jul 1994, *Roalson* 975 (NMCR, MICH). **Taos Co.:** 2 mi N of La Lama, S13 T28N R12E, 7800 ft, 30 Jul 1963, *Goodrow* 375 (UNM).

We thank A.A. Reznicek (MICH) for verifying our specimens.

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SALVINIA MINIMA (SALVINACEAE), NEW TO TEXAS.—Recent collections from the J.D. Murphree Wildlife Management Area near Port Arthur, Texas, have yielded specimens of *Salvinia minima* Baker. This is a new record for Texas according to Hatch et al. (1990) and Correll and Johnston (1970). Previous collections have been reported from Louisiana, Georgia, Florida, Alabama; Mexico; the West Indies; and Central America (Nauman 1993) (Lellinger 1985).

Salvinia minima, water spangles or floating fern, is locally abundant in the water of J.D. Murphree Wildlife Management Area SW of Port Arthur, Texas in association with *Echinochloa, Zizaniopsis,* and *Leptochloa.* This species is so abundant that populations are shading out some submerged plants species.

This floating species has long thin rhizomes and floating fronds. The frond blades are elliptic to round with a round to cordate base, a round to notched apex, and with rows of whitish, multicellular hairs on the upper surfaces. The apex of each hair is divided into four separate branches.

Voucher specimen: TEXAS. **Jefferson Co.:** J.D. Murphree Wildlife Management Area, SW of Port Arthur, 30 Oct 1993, *Hatch 6403* (TAES).

—*Stephan L. Hatch, S. M. Tracy Herbarium, (TAES), Department of Rangeland Ecology and Management, Texas A&M University, College Station, Texas, 77843-2126, U.S.A.*

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RHYNCHOSPORA CAPITELLATA (CYPERACEAE), NEW TO KANSAS.—Five species of *Rhynchospora* have been verified in the Great Plains (Great Plains Flora Association 1986), with *R. globularis* (Chapman) Small var. *globularis*, *R. harveyi* W. Boott, and *R. macrostachya* Torr. ex A. Gray occurring in Kansas (Magrath and Johnson 1971). Field surveys in central Kansas during the fall of 1994 yielded a beakrush previously unknown in the state. *Rhynchospora capitellata* (Michx.) Vahl was discovered at a single site in extreme southeastern Rice County. Plants were growing in several

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low, mesic to wet-mesic depressions among stabilized sand dunes in grazed, sand prairie. Soils in the general area are coarse-textured and formed in eolian sands of Pleistocene age (Horsch 1974). The dominant vegetation in the prairie is *Andropogon hallii* Hack., *Sorghastrum nutans* (L.) Nash, *Schizachyrium scoparium* (Michx.) Nash, and *Panicum virgatum* L. Common associates in the swales include *Fimbristylis autumnalis* (L.) Roemer & Schultes, *Bulbostylis capillaris* (L.) Clarke, *Lipocarpha drummondii* (Nees) G.C. Tucker, *Agalinis tenuifolia* (M. Vahl) Raf., *Juncus scirpoides* Lam., *J. diffusissimus* Buckley, and *Eleocharis obtusa* (Willd.) Schultes var. *detonsa* (A. Gray) Drapalik & Mohl.

Gale (1944) mapped the range of *Rhynchospora capitellata* from Nova Scotia to southern Ontario and Wisconsin, south to northern Florida and the Gulf Coast, and west to eastern Texas, eastern Oklahoma, and western Missouri. She also reported isolated occurrences in northern California and southern Oregon. The species was included in the *Flora of the Great Plains* (Great Plains Flora Association 1986) based on Missouri populations. Steyermark (1963) reported *R. capitellata* from the southern one-third of Missouri, with stations in the southwest part of the state in Newton, Jasper, Barton, Dade, Lawrence, and Greene counties. The Kansas population—in grazed, rolling, sandhill prairie with scattered, interdunal ponds and wet depressions—is some 200 miles west of these nearest eastern stations. Additional field surveys are needed to determine if other populations of this species exist in similar habitat elsewhere in the Arkansas River Lowlands of central Kansas.

Voucher specimen: KANSAS. Rice Co.: locally abundant in wet depressions, 6 mi W, 1 mi N of Medora just N of Highland Estates and Country Club, elev 1,660–1,690 ft, SE 1/4 sec 35, T21S, R6W, 13 Sep 1994, *Freeman 6710* (KANU).

—*Craig C. Freeman, R.L. McGregor Herbarium, The University of Kansas, 2045 Constant Ave., Lawrence, KS 66047, U.S.A.*

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POSSIBLE EPONYMY OF THE GENERIC NAME *BRASENIA* SCHREB. (CABOMBACEAE).—The genus *Brasenia* Schreb. comprises only *B. schreberi* J.F. Gmel., water-shield, a floating-leaved aquatic species native from scattered tropical American localities north to the Alaska panhandle and the Gaspé Peninsula of Québec, and in eastern Asia at comparable latitudes, southern Africa, and eastern Australia. Standard floras and other references generally indicate that the generic name is "of uncertain origin" (Fernald 1950; similarly, "unexplained," Britton 1901; "of unknown meaning," Gleason 1952; "origin unknown," Stone 1993, among others). The only suggestions of its derivation that I have encountered were Gray's (1895) speculative "unexplained, perhaps named for some obscure botanist," and Rafinesque's (1828) more definite "from a German botanist, Brasen." Rafinesque, however, provided no given name or initials, nor any other identifying data such as association with an institution, city, or any of the kingdoms or duchies into which Germany was divided at that time (admittedly not always feasible when boundaries were unstable and political refugees were numerous), that would indicate that he was speculating any less than Gray as to the existence of such an individual.

Schreber's (1789) publication of the name *Brasenia*, in keeping with the format of the successive editions of *Genera Plantarum*, included no statement as to the derivation of the name. Unless evidence is discovered in extant correspondence written by or to Schreber, therefore, it will remain impossible to be certain as to his basis for coining this name. Circumstantial evidence, however, suggests that the genus was named for Christoph Brasen, a Moravian missionary who collected botanical specimens in Greenland and Labrador.

Christoph Brasen was born 3 January 1738 at Ripen, Jutland (now Ribe, Denmark; the "new style" calendar was already in use there). As a missionary of the Moravian Church (Church of the United Brethren; Unitas Fratrum; Brüder-Gemeine), he served first at Godthåb (now Nûk), Greenland. In 1767 and 1768, he collected plant specimens in the vicinity of Godthåb Fjord (Porsild 1935). In 1771, by which time he had established a reputation as being "knowledgeable in botany," he was selected to be superintendent of the mission to be founded at Nain, Labrador, to which he went that year with his wife, née Maria Catharina Federhahn, also from Ripen. Brasen brought the valuable expertise of a "skilled surgeon" to the new mission, and was already fluent in Inuktitut from his years in Greenland. On 15 September 1774, en route back to Nain from a reconnaissance voyage to the site where the Okak mission was subsequently established, Brasen's vessel was wrecked and he drowned in the attempt to reach shore (Anonymous 1835; Roemer et al. 1871; Davey 1905; Peacock 1976).

Brasen is known to have collected botanical specimens in Labrador because of those cited by Georg Heinrich Weber (1784), professor at Kiel, in his *Plantarum Minus Cognitarum Decuria*. (This work is sometimes attributed to Sebastian Grauer. According to Sprague [1922], Weber was the author of this work and of the new botanical names therein. Grauer, the "respondent," discussed or defended it as a requirement for his doctorate.) *Ribes glandulosum* (Grossulariaceae), described as a new species, was based on a specimen collected by Brasen in Labrador (Lysaght 1971).

Johann Christian Daniel von Schreber (1739–1810), who named the genus *Brasenia,* was professor of natural history and director of the botanical garden at Erlangen, Bavaria (Stafleu & Cowan 1985). He was one of many botanists of his time and later who acquired specimens collected by Moravian missionaries. Most such specimens were initially sent from the missions to the Moravian Church headquarters in Herrnhut, Saxony, where some of the officials were themselves active in botany and aware of the interest among botanists in specimens from distant parts of the world. From Herrnhut, some specimens were given to botanical scholars among the clergy and lay members of the Moravian Church, and some were sold to other botanists to raise funds for the missions. These recipients sometimes divided the collections further for exchange purposes. Schreber acquired specimens collected in Labrador by Benjamin Gottlieb Kohlmeister (1756–1844), one of the most important early contributors of botanical specimens from Labrador. Schreber did not publish upon these plants, but after his death the specimens were studied by Franz von Paula von Schrank, professor and director of the botanical garden at Munich, who published a paper on the flora of Labrador (Schrank 1818), which included an account of the history of these specimens (Pringle 1992).

The specimens from Schreber's herbarium do not indicate a direct link with Brasen, but they do indicate that during the latter part of the eighteenth century, Schreber communicated with Moravian churchmen who were interested in botany, from whom he acquired specimens collected by at least one of the Moravian missionaries in Labrador. It seems quite likely that he learned from his Moravian correspondents that one of the missionaries in Labrador, whose own knowledge in botany had been respected and who had contributed specimens for botanical research, had died. Such a message might have included a suggestion that, if and when Schreber discovered a plant new to science, it might be named as a memorial to this early botanical collector. None of the Labrador specimens acquired by

Schreber represented an unnamed genus, so Schreber could not name a genus native to Labrador for Brasen, but he was able to give such a name to a genus native to North America, in (according to Stafleu & Cowan 1985) his first major botanical publication following Brasen's death. No specimens were cited by Schreber (1789), but the specimens from his herbarium now at Munich (M) might be searched for any that would indicate the basis of his knowledge of *Brasenia* and the source of any specimens of that genus that Schreber might have acquired.—*James S. Pringle, Royal Botanical Gardens, Box 399, Hamilton, Ontario, Canada L8N 3H8.*

This is Contribution No. 89 from the Royal Botanical Gardens.

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BOOK REVIEWS

STEPHENSON, STEVEN L. and HENRY STEMPEN. 1994. **Myxomycetes: A Handbook of Slime Molds.** (ISBN 0-88192-277-3, hbk.). Timber Press, Inc., 133 S. W. Second Avenue, Suite 450, Portland, OR 97204-3527. $34.95. 200 pp, 16 color plates, 15 b&w photos, 69 line drawings, 6" × 9".

The authors state in the preface that the intent of this book is to serve as a field guide to 175 common and cosmopolitan species of Myxomycetes for the general naturalist, amateur mycologist or interested lay person and as a useful introductory text for the more serious student of the Myxomycetes. The descriptions and keys included in the book are based mostly upon specimens collected in eastern North America.

The book is divided into seven chapters: an introduction that discusses general topics such as the life cycle and a definition of the Myxomycetes and related groups. A chapter on structural features of Myxomycetes that describes, defines and illustrates with black and white line drawings and photomicrographs, the fruiting body types and their structural parts. Chapter three is devoted to the collection, culture and study of Myxomycetes both in the field and in the laboratory. There is a topical section here on moist chamber cultures using bark from living trees. The distribution of Myxomycetes around the world is a chapter that discusses geographical distribution, snowbank species, high-latitude species, desert species, species on living trees and litter, dung and soil as a microhabitat. Some of this information is general knowledge but some is new, such as the high-latitude species from Alaska, with many of the references cited after 1970. The chapter on the ecology of Myxomycetes represents the special forte of Stephenson and much of the information under trophic stages, substrate relationships, fruiting season, insect associates, myxomyceticolous fungi and bryophyte-myxomycete associations is new and not available in other books on the Myxomycetes. The chapter entitled classification and identification includes a discussion of taxonomic names and reversible dichotomous keys that lead to the orders of the Myxomycetes: Ceratiomyxales, Liceales, Echinosteliales, Trichiales, Physarales, Stemonitales. This is followed by keys to selected species in the orders and, finally, descriptions of the species. Families are not included in any of the keys. Species descriptions are given in sufficient detail to identify the species and compare the species with the specimen at hand. There is also a substrate and comments section, the latter contains the distinguishing characters of the species and notes on similar and look-alike species. There are 175 species mentioned in the book but only 54 species are illustrated and given species descriptions.

Detailed watercolor portraits (16), pen-and-ink drawings (69), and black and white light photomicrographs (15) illustrate the form and features of the various life stages of myxomycetes. The line drawings are of high quality, accurate and illustrate the habit of the fruiting bodies, the various structural parts such as peridial dehiscence, capillitium and spores. The light photomicrographs illustrate the capillitium and spores. Unfortunately, some of these illustrations are at too low a magnification to show relevant features in detail such as the pseudocapillitium of *Lycogala epidendrum* in Figure 2-8 and the crystals of *Mucilago crustacea* in Figure 6-4. The water color plates in many cases appear flat and lack the vivid bright colors that characterize many species of Myxomycetes. Examples of this are *Elaeomyxa miyazakiensis* (a rare species in the United States), *Lamproderma sauteri* (restricted to alpine areas) and *Diachea leucopodia*, and in the latter two species the iridescence or metallic sheen is not apparent. The beautiful and accurate rendition of the white *Diderma effusum* plasmodiocarp is an exception and contrasts nicely against the brownish surface of a leaf.

References, a comprehensive glossary and an index complete the work. The glossary has 159 terms that are defined. There is a well balanced selection of 150 references on the biology, ecology and floristics of Myxomycetes that represent publications mostly since 1960. Many of these references do not appear in other books on the Myxomycetes. The text is carefully edited and free from typographical errors. The book is apparently only available in a hardback edition and is rather expensive for a book of 183 pages. Persons venturing into the wonderful world of Myxomycetes will find this book a welcome addition and helpful in picture keying many of the more common species.—*Harold W. Keller, Research Associate, BRIT.*

SMITH, EDWIN B. 1994. **Keys to the Flora of Arkansas.** (ISBN 1-55728-312-5, pbk.). The University of Arkansas Press, Fayetteville, AR 72701. $30.00. 363 pp, 7" × 10".

A brief introduction notes that the author has devoted more than 25 years to the study of the Arkansas flora. This publication follows the author's 1988 "An Atlas and Annotated List of the Vascular Plants of Arkansas" that provided synonymy, distribution by county dot maps, and chromosome numbers. The dichotomous keys are designed specifically for the Arkansas flora. There are general keys to the ferns, gymnosperms and flowering plants; the latter divided into monocots and dicots. Dichotomous keys lead to the families of ferns and fern allies, families of gymnosperms, the dicot families with a series of separate keys leading to the aquatic dicots, woody dicots with leaves absent at flowering time or partially expanded, woody plants with leaves opposites or whorled, woody plants with leaves alternate and plants herbaceous and terrestrial. The keys ultimately identify genera and species represented by 2,518 taxa that are presently known for Arkansas with an additional 300 species most likely to occur. The author requests voucher specimens for any of the possible additional species since these would represent new state records. The families are arranged according to the old Engler and Prantl system traditionally used in floras. The genera are arranged alphabetically within families. Common names are provided for families and genera but no synonymy is given.

A glossary defines many of the terms used in the keys with examples of representative taxa given in a few cases. More examples of taxa that illustrate a given defined term would make the glossary even more user friendly. The four corners of the outside edge of the book are rounded to prevent the cover and pages from becoming dog-eared from use over time. This book represents an important contribution toward a comprehensive flora of Arkansas that should eventually include keys, species descriptions, and illustrations to all of the known species in the state.—*Harold W. Keller, Research Associate, BRIT.*

SIDA 16(3): 602. 1995

NATIONAL RESEARCH COUNCIL, COMMITTEE ON THE FORMATION OF THE NATIONAL BIOLOGICAL SURVEY. 1994. **A Biological Survey for the Nation.** (ISBN 0-309-04984-0, pbk. 2nd printing). Academy Press, 2101 Constitution Avenue, N.W., Washington, D.C. 20418. $26.00. pp. 205, 6" × 9".

The mission of the National Biological Survey is "to gather, analyze, and disseminate the information necessary for the wise stewardship of our Nation's natural resources, and to foster an understanding of our biological systems and the benefits they provide to society. The NBS will act as an independent science bureau without advocating positions on resource management issues and without regulatory or land and water development authorities." The National Research Council, in an advisory role to the Secretary of the Interior, conducted a study on the formation of the NBS. This book represents the findings of the Committee on the Formation of the NBS. This committee consisted of 19 people from diverse backgrounds chaired by Peter H. Raven from the Missouri Botanical Garden.

The central theme of the book provides the answers to a series of questions: 1. What should a biological survey for the nation entail? 2. What should the NBS in the Department of Interior (DOI) be to serve the needs of the department and others: 3. How should information relevant to the survey be managed? 4. How can existing and new survey related activities and information be made most useful for policy management, and scientific purposes within and outside the DOI? 5. How can federal and other entities best collaborate for these purposes? The NBS will be a new administrative entity in the DOI but formed from preexisting programs. It will have responsibilities for inventorying, mapping, and monitoring biotic resources; performing basic and applied research on species, groups of species, populations, and ecosystems; and providing the scientific support and technical assistance needed for managerial and policy decisions by DOI. There is a preface and executive summary that outlines the parameters of the NBS, followed by five units: 1. The Value of a Biological Survey for the Nation; 2. Meeting the Information Needs of NBS clients; 4. Coordination of the National Partnership for the Biological Survey; 5. Implementation.

What are the needs for the NBS? The following represent the issues outlined: finding ways to preserve the nation's biological heritage; managing biological resources in a sustainable manner; maintaining essential ecological services, such as water supply, flood and erosion control, and climate amelioration; understanding the impact of human settlement patterns on biological resources; maintaining contributions of our nation's biota to the aesthetic quality of life; understanding the effects of climate change; deriving new economic wealth from biological resources; restoring degraded environments.

To create the NBS, the Secretary of the Interior has proposed combining a substantial portion of the biological research and survey activities in three DOI bureaus —the Fish and Wildlife Service, the National Park Service, and the Bureau of Land Management — with smaller portions of five other departments — the Minerals Management Service, the Office of Surface Mining Reclamation and Enforcement, the Bureau of Reclamation, the U.S. Geological Survey, and the Bureau of Mines.

A National Partnership for Biological Survey is proposed that will be able to conduct creditable science; be able to stimulate and coordinate appropriate research; be organized for program continuity; be user friendly and adapted to a variety of users. The key scientific objectives should include: determining what biotic specimens and data exist in our nation's institutional collections; discover, describe, classify and map species of selected taxa; establish taxonomic specialists, collections, and databases for large and important taxa; study the biology of selected species of importance; develop classification systems for ecological units and a set of core ecosystem attributes and protocols; develop predictive models to facilitate sustainable management; perform research on the restoration of degraded environments; perform research to develop biological protocols for pollution; establish collaborative pilot projects for interdisciplinary research on biological resources in selected regions.

The book uses bold face type to highlight paragraphs and a series of 38 recommendations. The reader can quickly scan the recommendations and grasp the overriding themes of this book. After certain topical headings, bullets are used to highlight specific points. One of the specific recommendations of the committee was to develop a National Biotic Resource Information System. This effort would develop a system of shared databases designed to make existing information more accessible and to establish mechanisms for efficient, coordinated collection and dissemination of new information.

It is interesting to note that none of the distinguished panel members assembled to conduct this study had a extensive research background in fungal biology. Yet it is clear in a number of sections of the book that our understanding of fungi and the specific expertise to identify fungal taxonomic groups is lacking in many cases. This point is addressed under the section entitled Preserving the Nation's Biota, for example, "... for many groups of organisms (e.g., fungi, mites, nematodes, and marine invertebrates), most species have not yet been described and named, even within the borders of the United States."

Appendix A: gives the biographical information on committee members and professional staff; Appendix B: gives the national biological survey Fiscal Year 1994 budget justification; and the Index is helpful in locating topical subject matter. This book should be required reading for anyone who wishes to be well informed about the future of the biota of the United States of America.—*Harold W. Keller, Research Associate, BRIT.*

PUTZ, FRANCIS E. and HAROLD A. MOONEY, eds. 1991. **The Biology of Vines.** (ISBN 0 521 39250 0, hbk.). Press Syndicate of the University of Cambridge, 40 West 20th Street, New York, NY 10011-4211. Price unknown. 526 pp, 6 3/4" × 10".

In the Foreword Paul Richards notes that vines have attracted relatively little scientific attention save for Charles Darwin in his *Movement and Habits of Climbing Plants* (1875) and Schenck in Germany with his two memoirs dealing mainly with stem anatomy (1892-93). This book should fill a gap in the general biology of vines. It is divided into five parts: an introduction devoted to the distribution and evolution of climbing plants; climbing mechanics and stem form; vine physiology and development; community ecology of vines; economic importance of vines. Each of the contributed chapters have a summary or concluding remarks that enable the reader to assimilate the salient points.

The numbers of climbers are impressive. A total of at least 133 families include a few climbers. At least 97 seed plant families have climbers that are found in the New World. The three largest families of climbers in the New World are the Asclepiadaceae with 1,000 species, the Convolvulaceae with 750 and Leguminosae with 720.

The contribution by Oliver Phillips entitled *The Ethnobotany and Economic Botany of Tropcial Vines* has a treasure trouve of information about vines that will be of interest to the general reader. Factoids are cited such as 80% of the population of developing countries rely on traditional medicine for primary health care. About a billion people that live in industrialized nations take about 40% of their prescribed medicines that contain chemicals originally isolated from plants. Many tropical vines are harvested for their fiber content and used in cordage, baskets, hammocks, and fishing nets. The best known fibrous lianas are the rattans (climbing palms from Southeast Asia). Starchy tubers from *Dioscorea* and *Ipomoea* make up a major contribution to the diet of many people in the tropics. There are 16 families listed and each with genera that have useful climbing plants in the tropics. Several examples will suffice. *Philodendron* provides the widest range of uses among aroid lianas. In Colombia *P. craspedodromum* Schultes is used by the Desana Indians for a fish poison. Other species of *Philodendron* are are used for treating snake-bites, removing warts, for skin rashes and used as a female contraceptive. The Arecaceae (the palms) provide spices, waxes, gums, poisons, food, shelter, fuel, fiber and medicines. The Bignoniaceae is the most speciose neotropical liana family and has an impressive array of ethnobotanical uses. This family has been scarcely sampled by chemists for biologically active medicinal compounds. The Jivaro in northern Peru use an *Arrabidaea* as a cure for thrush, a fungal disease of the throat and mouth. The juice extracted from the root of *Martinella* is used by many different Indian tribes in different places to treat eye inflammation or irritation. The Convolvulaceae is mostly a tropical climbing family that is best known for its edible tubers (sweet potato). *Ipomoea tricolor* (cultivated as 'Morning Glory") from tropical America has egoline alkaloids in its seeds. This was a sacred plant of the Aztecs and became popular in the 1960's for its LSD-type effects. The Cucurbitaceae produce fruits that have significant economic importance as food plants, for example, cucumbers, squashes, pumpkins, and watermelons. There are many other examples to numerous to mention that could be cited. This chapter is valuable as a reference source for information presented in tabular form (genus name, use as food or medicinal properties and author - literature reference) for the families and genera of climbers.

There is a general subject index and also a taxonomic index that facilitates locating specific taxa in the book. This book should be on the bookshelf of every botanist that has an interest in vines or the collection of plants in tropical areas of the world.—*Harold W. Keller, Research Associate, BRIT.*

CALLAWAY, M. BRETT and CHARLES A. FRANCIS, eds. 1993. **Crop Improvement for Sustainable Agriculture.** (ISBN 0-8032-1462-, hbk.). University of Nebraska Press, 901 N. 17th Street, Lincoln, NE 68588-0520. $35.00. 261 pp., 6" × 9 1/4".

The primary focus of this book is the adaptation of crop plants to agricultural systems and prevailing conditions rather than the expensive modification of the field environment to fit current crops. The crop improvement theme is presented in a series of 11 chapters: Crop Improvement for Future Farming Systems; History of Crop Improvement in Sustainable Agriculture; Choosing Germplasm for Breeding Program Success; The Role of Seed Companies in Crop Improvement; Crop Breeding Objectives and Methods; Breeding for Resistance to Insects and Plant Pathogens; Crop Tolerance to Weeds; Tree Improvement for Agroforestry Systems; Contributions of Biotechnology to Crop Improvement; Genotype by Environment Interaction in Crop Improvement; Statistical Design and Analysis of Intercropping Experiments.

Early in the book there is a review of definitions used for sustainable agriculture that range from Wendell Berry's, the most desirable systems are those that degrade "neither land nor people", to Francis and Youngberg's "Sustainable agriculture is a philosophy based on human goals and on understanding the long-term impact of our activities on the environment and on other species. Use of this philosophy guides our application of prior experience and the latest scientific advances to create integrated, resource-conserving, equitable farming systems. These systems reduce environmental degradation, maintain agricultural productivity, promote economic viability in both the short and long term, and maintain stable rural communities and quality of life".

Crop improvement in the future will place new emphasis on tolerance to biotic and abiotic stress. There is a discussion of stress tolerance to cold, prolonged heat and drought. Special, potential new crops such as perennial cereal grains and legumes, as proposed by Wes Jackson at The Land Institute, holds promise for a perennial polyculture that would be represented by multiple species of plants with different life cycles, nutrient, and water needs, and contributions to food and feed supply. This cropping system would have the added advantage of providing soil protection by a permanent ground cover, low cost maintenance and less tillage, and restructuring of the soil profile found in a native prairie ecosystem.

Each chapter ends with a set of references that for the most part are based on publications that have appeared in the last ten years. Readers will find a wealth of information and ideas about breeding programs that will lead to a more sustainable agriculture as an alternative to the high use of chemical pesticides, monocultures, and high tillage practices that ultimately degrade the environment.—*Harold W. Keller, Research Associate, BRIT.*

PAHLOW, MANNFRIED. 1978. **Healing Plants.** (ISBN 0-8120-1498-7, pbk.). Barron's Educational Series, Inc., 250 Wireless Boulevard, Hauppauge, NY 11788. $16.95. 224 pp, 86 full-color photographs, 6 1/2" × 9 1/4".

This book focuses on healing plants used for the self treatment of the most common ailments, complaints, and disorders such as the common cold, sleep dysfunctions, and stomach complaints to mention a few. The organization and narrative are written for a general audience. The introductory pages serve as a guide and warning about the proper treatment procedures. There are four rules to follow given as topical headings and along with an explanation: 1. Evaluate your complaint properly; 2. Select the application carefully; 3. Prepare and administer the application as directed; 4. Observe the limits of self treatment. The table of contents consists of self-help with healing plants; nervousness and sleep disturbances; colds; bladder and kidney complaints; stomach and intestinal complaints; rheumatism and gout; gallbladder and liver complaints; childhood diseases; gynecological complaints and menopause; geriatric complaints; cardiac and circulatory disorders; minor injuries, skin irritations; compendium of medicinal plants; appendix.

There are precautions and warnings that the reader assumes full responsibility for actions taken and the admonition to always consult with a physician before treating yourself with healing plants. But these warnings may go unnoticed because in some cases they are not highlighted with oversized and boldfaced letters that stand out against the rest of the text narrative. The self-treatment preparations derived from medicinal plants include teas, tinctures, baths, inhalations, compresses, poultices, and washes. The examples selected by the author are primarily those medicinal plants that have been subjected to extensive scientific research and are recognized as possessing therapeutic effects, and, in most cases, approved as natural medicines by the German Office of Health.

There is an informative section on what you need to know about medicinal plants and includes a topical section on - how do medicinal plants act? and - medicinal plants and the substances they contain. Information is given about how to store medicinal plants correctly, weighing, mixing, and measuring plant substances, collecting medicinal plants yourself, and how to grow plants under the section compendium of medicinal plants. About half of the book deals with self-help treatments organized as units that focus on complaints or ailments. Rheumatism and gout will serve as an example of these units. There is a section that defines these metabolic diseases and the help given from healing plants. The healing plants used to provide relief and efficacy and the preparation procedures before application or use are described in great detail. The plant preparations are based on specific recipes and dosages. The directions and instructions for using plant preparations appear detailed and specific.

The last half of the book is a Compendium of Medicinal Plants arranged alphabetically by common name. Each plant or distinctive plant part is illustrated in color as a quarter or half page photograph. The color reproduction is of outstanding quality. The scientific name is given for each plant, requirements for cultivation, uses of the plant in general and in folk medicine and in some cases interesting facts pertaining to historical accounts of the plant

The appendix contains a section on using healing plants properly and instructions for preparing and applying teas. There is an index that has common and scientific names and subject words that facilitates finding information. A brief glossary of 74 terms, mostly botanical, helps the lay reader to understand the botanical descriptions. There is a section on sources of herbs, sources of herb seeds, and sources of information that gives names and addresses. There is a section for further reading that has a list of 11 books and four addresses for journal publications.

This book will appeal to readers with a general interest in natural medicines, to gardeners who may wish to grow these plants, and botanists who wish to collect medicinal plants for purely botanical reasons.—*Harold W. Keller, Research Associate, BRIT.*

ARVIGO, ROSITA and MICHAEL BALICK. 1993. **Rainforest Remedies, One Hundred Healing Herbs of Belize.** (ISBN 0-914955-13-6, pbk.). Lotus Press, Box 325, Twin Lakes, Wisconsin 53181 $9.95. 219 pp, 100 black and white line drawings (text illustrations by Laura Evans), size 5 1/4" × 8 1/2".

This book chronicles the work of The Belize Ethnobotany Project initiated in 1987 that has recorded the author's findings about plants used as medicines, foods, fiber, in construction and agriculture, during religious ceremonies, and as part of spiritual beliefs. This project has resulted in the creation of The Ix Chel Tropical Research Foundation, dedicated to traditional medicine, ethnobotanical studies, Belizean culture, and rainforest conservation.

The introductory pages describe the country of Belize under the topical heading background. The methodology and purpose, scope of book, and organization of text and illustrations explain the formatting of the descriptions and illustrations of plants that follow.

The English *common name* is given in bold and capital typeface at the top of each page and used as the primary means of identification . The plants are arranged alphabetically according to these names. Fortunately the *scientific name and author* are also given for each plant to eliminate confusion. The plant *family name* is given according to the classification system of the late Arthur Cronquist. Under the heading *description* appears a brief field description of the plant giving the habit, type of leaves, inflorescence and fruits. The *habitat* represents the most common areas where the plant is found either in the wild or in cultivation. *Traditional uses* represents a compilation of information from healers and personal observations of plant use in Belize. *Research results a*re the results of laboratory research with appropriate references cited. *Illustrations* are full page black and white line drawings which illustrate one or more key features useful in the field identification of the plant. There is a glossary of medical and botanical terms that is helpful to better understand the plant descriptions and uses.

There is a 12-page list of references mostly from the last 15 years. A number of the journals cited are published in South and Latin America and this adds to the utility of the book, especially for many in the United States. There is an index of scientific and common names.

The authors have made a valuable contribution to preserve the traditions and customs of the indigenous peoples of Belize. The authors have donated the proceeds from the sale of this book to support the native traditional healers and ecosystem preservation in Central American rainforests. The sensitivity, concern, and goodwill shown by Rosita Arvigo and Michael Balick for native peoples represents a model for others to emulate.—*Harold W. Keller, Research Associate, BRIT.*

SIDA 16(3): 608. 1995

ANNOUNCEMENT

Volume 1 is on the way! Volume 1 of the 12 volume *Useful Wild Plants of Texas, the Southeastern and Southwestern United States, the Southern Plains, and Northern Mexico* will be available in the fall of 1995. Co-authored by Scooter Cheatham and Marshall Johnston, this series is a mammoth quest to systematically chronicle the economically useful plants of the region centered in Texas and radiating through the southern half of the United States and the northern part of Mexico. Information on these plants has been gathered not only from the area itself, but draws on the extensive use of these and closely related species around the world. This work underscores Texas' unique position in North America and the need to "save the rainforest in our own backyard."

Volume 1 includes 86 genera from *Abronia* through *Arundo.* Volume 2 will begin with the genus *Asclepias.* The complete series will include descriptions, photographs, distribution maps, and use information on over 3,000 species of native or naturalized Texas plants.

This will be a hands-on resource for botanists, field researchers, foresters, ranchers, landowners and leaseholders, archeologists, teachers, biochemists, chefs and many other professions and interests, with its extensive coverage of thousands of uses of native plants for food, medicine, pharmaceuticals, oils, rubbers, fuels, and fibers, and many other domestic, industrial, and commercial uses. It underscores the need to develop new crops and future resource bases from native plants.

In addition to the ecological, recreational, aesthetic, and ethical arguments for conservation, this work provides an economic basis for arguing for the preservation of land and the plant life that is inextricably linked to the land. This work will also support environmental impact statements, the development of wise land-use policies, and the development of educational curricula.

This series is being published by Useful Wild Plants, Inc., For information on ordering direct correspondence to Useful Wild Plants, Inc., Dept. B95, 2612 Sweeney Lane, Austin, TX 78723, USA, or call 512-928-4441.

Specs: 592 pages, 304 color photos, 268 color distribution maps.

ANUNCIO

¡El Volumen 1 está en camino! El primero de los 12 volúmenes de *Useful Wild Plants of Texas, the Southeastern and Southwestern United States, the Southern Plains, and Northern Mexico* estará disponible en el otoño de 1995. Los autores son Scooter Cheatham y Marshall Johnston. Esta serie es una búsqueda gigantesca para hacer la crónica sistemática de las plantas con utilidad económica de la región que teniendo su centro en Texas se extiende por la mitad sur de los Estados Unidos y la parte norte de México. La información sobre estas plantas ha sido recogida no sólo en este área sino que se recurre al uso extensivo de estas especies y otras muy relacionadas de todo el mundo. Este trabajo subraya la posición única de Texas en Norteamérica y la necesidad de "salvar la pluvisilva en nuestro propio patio".

El volumen 1 incluye 86 géneros, desde *Abronia* hasta *Arundo*. El volumen 2 comenzará con el género *Asclepias*. La serie completa incluirá descripciones, fotografías, mapas de distribución, e información sobre el uso de más de 3.000 especies nativas o naturalizadas en Texas.

Será una fuente de transmisión para botánicos, investigadores de campo, forestales, rancheros, propietarios y arrendatarios de tierras, arqueólogos, profesores, bioquímicos, cocineros, y otras muchas profesiones e intereses, con su extensa cobertura de miles de usos de plantas nativas para alimento, medicina, farmacia, aceites, gomas, combustibles, fibras y muchos otros usos domésticos, industriales y comerciales. Subraya la necesidad de desarrollar nuevas plantas de cultivo y futuras bases de recursos a partir de plantas nativas.

Además de los argumentos ecológicos, recreativos, estéticos y éticos para la conservación, este trabajo ofrece una base económica para apoyar que la conservación del territorio y la vida vegetal, que está indisolublemente ligada a dicho territorio. Este trabajo también tendrá utilidad en la evaluación de impactos ambientales, el desarrollo de políticas de uso del territorio prudentes y sabias, y el desarrollo de curricula educacionales. Esta serie se publica por Useful Wild Plants, Inc. Para información sobre los pedidos, dirija su correspondencia a: Useful Wild Plants, Inc., Dept. B95, 2612 Sweeney Lane, Austin, TX 78723, USA, o llame al 512.928.4441.

Especificaciones: 592 páginas, 304 fotos en color, 268 mapas de distribución en color.

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A REVISION OF *MIRABILIS* SECTION *MIRABILIS* (NYCTAGINACEAE)

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ABSTRACT

The genus *Mirabilis* includes the formerly recognized genera *Allionia* in part, *Hesperonia*, *Oxybaphus* and *Quamoclidion*. It is comprised of about 60 species of tropical and temperate herbs distributed primarily in the Americas. Currently the genus is arranged in six sections, generally along the boundaries of the former genera. This study considers the section *Mirabilis*. Based on comparative morphology, including extensive field studies and observations in the greenhouse, scanning electron microsopy studies of pollen and fruit (anthocarp) characters, two species, *M. donahooiana*, *M. polonii* and one variety *M. sanguinea* var. *breviflora* are described as new. In addition, one new combination is proposed, *M. gracilis*.

RESUMEN

El género *Mirabilis* incluye los géneros anteriormente reconocidos *Allionia* en parte y *Hesperonia*, *Oxybaphus* y *Quamoclidion*. Está compuesto por aproximadamente 60 especies de plantas tropicales y clima templado, distribuido principalmente en las Américas. Actualmente el género está organizado en seis secciones generalmente dentro de los límites del anterior género. Este estudio considera la sección *Mirabilis*. Está basado en morfología comarativs, incluyendo estudios extensivos de campo, observaciones en invernadero, caracteristicas del polen y fruto (antocarpo) estudiadas con microscopía electrónica, se describen dos nuevas especies *M. donahooiana*, *M. polonii* y una variedad *M. sanguinea* var. *breviflora*. Además se propone una nueva combinación: *M. gracilis*.

The genus *Mirabilis*, in the family Nyctaginaceae, comprises approximately 60 species distributed primarily in tropical and temperate regions of the Americas. A large number of species are centered in the warm temperate regions, especially the deserts, of North America. Several species occur in Mesoamerica, some of these extend into northern South America, while other species are exclusively South American. One species, *M. himalaica* (Edgew.) Heimerl is reported from the Himalayas, the only species native outside of the western hemisphere. Several of the American species are common and widespread; others appear as localized endemics. Historically, generic and specific delimitations of *Mirabilis* have varied. *Mirabilis* was formally proposed by Linnaeus in 1753. The first synopsis of the genus was provided by Choisy (1849). He recognized in the genus *Mirabilis* only

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species which today are included in *Mirabilis* section *Mirabilis*. His treatment regarded as distinct the genera *Quamoclidion* Choisy and *Oxybaphus* L'Her. The treatment by Asa Gray (1859) recognized only *Mirabilis* and *Oxybaphus* as distinct genera. Gray separated *Mirabilis* (incl. *Quamoclidion*) and *Oxybaphus* on characters of the involucre, stamen number, and fruit. Beginning in 1889, Dr. Anton Heimerl of Vienna, probably the foremost authority on this group, contributed several excellent discussions and treatments, in over four decades of study (1889, 1897, 1934). Standley (1909) considered Heimerl's treatment of *Mirabilis* to be exceedingly conservative, largely because the latter considered the long recognized genus *Allionia* Loefl. (*Oxybaphus*) to be only a section of *Mirabilis*. Standley's treatment (1909, 1911, 1918) of the North American species used characters of fruit, involucre, and flowers to recognize *Allionia*, *Allioniella* Rydb., *Quamoclidion Hesperonia* Standley, and *Mirabilis* as genera. However, by the 1930s both Standley (1931a, 1931b) and Heimerl (1934), recognized but a single genus, *Mirabilis*. Standley, reflecting on his new treatment, said, "If only the species of North America are considered, such genera as *Oxybaphus*, *Quamoclidion*, and *Hesperonia* seem to be differentiated by good and constant characters, but as so often happens, when extralimital species are taken into account, the characters supposed to separate the groups break down. It seems necessary, therefore, to follow Heimerl in considering all the plants of the group as representing a single genus." Most subsequent workers in North America, and several workers before Standley's time (Gray 1859; Jepson 1914; Macbride 1918), have recognized the segregate genera, albeit as subgenera within an expanded *Mirabilis*. Shinners (1951) considered the species of *Oxybaphus* to be quite distinct, but satisfactory as a subgenus of *Mirabilis*. Pilz (1978) maintained *Quamoclidion* as a subgenus, but reduced the heretofore regarded monotypic genus *Hermidium* S. Wats., to subgeneric rank within *Mirabilis*.

The results of this study and additional studies by the author (Le Duc 1993) support the aforementioned expanded genus *Mirabilis*. However, after spending three summers in the field in Mexico (from Neuevo Leon to Chiapas) and day to day observations of collected plants grown in the greenhouse for four years, I support a sectional treatment. No set of characters is distinctive enough to elevate any section to subgeneric level when such species as *M. triflora*, *M. exserta*, *M. urbanii*, and *M. sanguinea* are taken into account.

Mirabilis L., Sp. Pl. 1:177. 1753. *Nyctago* Juss., Gen. 90. 1789. TYPE: *Mirabilis jalapa* L.

Herbaceous perennials, stems erect, semidecumbent or decumbent, simple or branched from the base, with a pseudodichotomous branching pattern; roots often tuberous. Leaves opposite, petiolate or sessile, the blades variously shaped, linear, lanceolate, ovate, obovate, cordate or round, glabrous or pubescent, some glandular, green or glaucous. Flowers axillary or in terminal inflorescences, or both. Involucres 1-many flowered, 5-lobed, sometimes enlarged and membranous in fruit. Perianth constricted above the ovary, the tube campanulate, funnelform or salverform. Stamens 3–6, unequal in length, filiform, incurved, united at the base into a fleshy cup around the ovary. Anthocarps usually 5-angled or 5-ribbed, glabrous or pubescent. Perisperm mealy. Base chromosome numbers, reportedly x = 26, 29, 33.

Adapting Hooker's (1880) treatment, Heimerl (1934) defined six sections of the genus *Mirabilis* as follows:

1. Section *Mirabilis.* Involucres ± narrowly campanulate, 1-flowered, slightly accrescent in age. Perianth conspicuous, funnelform or nearly (tubular) salverform, the limb expanded. Stamens 5. Anthocarps ellipsoid, ± pubescent, ± angular or ribbed, surface smooth or warty, not mucilaginous when wet (*Mirabilis* sensu stricto).

2. Section *Watsoniella.* Involucres ± narrowly campanulate, 1-flowered, lobes unequal in length, slightly accrescent in age. Perianth slender, the tube becoming wider above, the margin plain, scarcely lobed. Stamens 3. Anthocarps ellipsoid, short hairs, 5 obtuse ribs, tuberculate, constricted at the base (monotypic *M. watsoniana* Heimerl).

3. Section *Quamoclidion* (*Paramirabilis*). Involucres broadly campanulate, 2–12 flowered, slightly accrescent in age. Perianth broadly funnelform to funnelform-campanulate, the tube consistently longer than broad, deeply constricted just above the ovary, the limb expanded. Stamens 5. Anthocarps obovoid, ellipsoid to almost spheroid, consistently glabrous. (Hiemerl excluded *M. triflora*.) Following the Int. Code of Botanical Nomenclature (1989), Article 22, Section *Paramirabilis* of Heimerl becomes Section *Quamoclidion*, the first valid publication at the sectional level (Hooker 1880).

4. Section *Mirabilopsis.* Involucres broadly campanulate, 2–3 flowered, slightly accrescent in age. Perianth campanulate-funnelform, consistently longer than broad, deeply 5-lobed. Stamens 4–5. Anthocarps obovoid, obtuse apex, obtuse ribs and narrow furrows, fine pubescence, mucilaginous when wet (monotypic *M. coccinea* (Torr.) Hook.).

5. Section *Oxybaphus.* Involucres campanulate 2–3(–1) flowered, very accrescent, membranous, flattened, lobes equal in age. Perianth campanulate, funnelform or almost rotate (deeply constricted just above ovary), the tube lacking or very short. Stamens 3–5. Anthocarps ellipsoid, obovoid or clavoid, 5 ± strong ribs, mostly pubescent, base truncate, mucilaginous when wet (incl. *Allionia* in part).

6. Section *Oxybaphoides.* Involucres campanulate, 1-flowered, lobes equal,

only slightly accrescent in age. Perianth campanulate, funnelform or almost rotate, (deeply constricted just above ovary), the tube lacking or very short, seldom narrowly campanulate. Anthocarps ellipsoid or obovoid, surface nearly always glabrous, rough or somewhat angled, mucilaginous when wet (incl. *Oxybaphus* in part, *Hesperonia*, & *Allioniella*).

KEY TO SECTIONS OF THE GENUS *MIRABILIS*

1. Involucre 1-flowered, only slightly enlarged in fruit.
  2. Anthocarp mucilaginous when wet; suffruticose perennials; roots not tuberous. .... Section *Oxybaphoides*
  2. Anthocarp not mucilaginous when wet; perennials; roots tuberous.
    3. Stamens 3; perianth limb not noticeably lobed. .... Section *Watsoniella*
    3. Stamens 5; perianth limb distinctly 5-lobed, (*M. hintoniorum* only shallowly lobed.) .... Section *Mirabilis*
1. Involucre 2–3-flowered or more, sometimes much enlarged in fruit.
  4. Anthocarp ellipsoid, obovoid or clavoid, glandular or nonglandular pubescent, mucilaginous when wet.
    5. Involucre only slightly enlarged and not membranous in fruit; stamens 5. .... Section *Mirabilopsis*
    5. Involucre very enlarged and membranous in fruit; stamens 3 or 5. .... Section *Oxybaphus*
  4. Anthocarp obovoid, ellipsoid to spheroid, glabrous, mucilaginous when wet, or not. .... Section *Quamoclidion*

The purpose of this treatment is to provide a difinitive means of identification and circumcription of the species of section *Mirabilis*. These species are characterized by single-flowered involucres only slightly accrescent after anthesis, the perianth conspicuous with limb expanded, and five stamens. This study recognizes ten species within the section, two species, a variety newly discribed herein and a variety elevated to specific level. The native distribution is prodominently in Mexico the exception *Mirabilis longiflora* var. *wrightiana* is also found in the Mountain regions of southern Arizona, southern New Mexico and extreme western Texas. Habitat is mainly disturbed or open areas in subtropical deciduous and scrub vegetation. Again, *M. longiflora* var. *wrightiana* differs, it has a desert to juniper woodland habitat. *Mirabilis jalapa*. the common Four O' clock, widely used as a garden plant by the Pre-Columbian people of Mexico and Europeans, has become a weed in many areas of the world.

MORPHOLOGY

The morphological characters of taxonomic significance within the section *Mirabilis* include: stem size, internodal length; leaf blade shape and attachment; pubescence; inflorescence structure; involucre shape during anthesis and maturation of the anthocarp; perianth shape and color; stamen length and color, and anthocarp shape, topography and indumentum.

Section *Mirabilis* is comprised of perennials which grade from herbaceous to suffruticose. Most species have erect or ascending branches. Occasionally, branches of *M. longiflora*, *M. sanguinea*, *M. urbanii* are slender and only weakly ascending to semidecumbent. In well established plants, lower stems may be very stout, 4–6 cm in diameter particularly with *M. gracilis*, *M. jalapa*, and *M. polonii*. All species have a pseudodichotomous branching pattern with swollen nodes bearing a transverse line of puberulence. Internode length varies from 5–7 cm long in *M. urbanii* to 13–23 cm in *M. sanguinea*, with most species having internodes ranging from 7–12 cm in length. Plant height usually varies from ca. 2 dm for *M. sanguinea* and *M. urbanii* to ca. 1.5 m for *M. gracilis* and *M. jalapa*. All species have swollen, fleshy, tuberous roots which range from 3.5–4.0 cm in diameter and ca. 12 cm long in seedlings, to 3 dm diameter and 6–8 dm length in older established plants of *M. gracilis*, *M. jalapa*, *M. longiflora*, and *M. pringlei*. A caudex, 1–8 cm long, may develop above the tuberous root of very mature plants. Leaves are opposite and quite variable in size, large leaves (9–15 cm long) of lower stems to small leaves (2–6 cm long) subtending the inflorescences. Leaf size is greatly effected by environmental conditions. Leaves that subtend the inflorescences often are quite reduced and lanceolate in *M. longiflora*, *M. sanguinea*. Petiole length also decreases toward the shoot tips, with the uppermost leaves sessile or subsessile in *M. exserta*, *M. hintoniorum*, *M. longiflora*, *M. urbanii*. Blade outline of most species is ovate to deltoid, bases vary from cordate in *M. exserta*, *M. longiflora*, *M. pringlei* to truncate or subtruncate and asymmetrical in *M. donahooiana*, *M. gracilis*, *M. polonii* to asymmetrical with the blade grading down the petiole in *M. urbanii*. Leaf apex may be short-acute *M. exserta*, *M. longiflora*, *M. pringlei* or long-attenuate *M. donahooiana*, *M. gracilis*, *M. jalapa*, *M. polonii*. Pubescence is almost always found on the veins of the upper surface, and may be present on the lower surface as well in *M. longiflora* var. *longiflora*, *M. pringlei*, *M. sanguinea* var. *sanguinea*, *M. urbanii*. The absence of pubescence on the undersurfaces of *M. longiflora* var. *wrightiana* and *M. sanguinea* var. *breviflora* is a distinguishing feature. Terminal multiple cymose inflorescences vary from open in *M. exserta*, *M. hintoniorum*, *M. pringlei* to aggregate or glomerate *M. jalapa*, *M. longiflora* var. *longiflora*, *M. sanguinea*. Often, however, the first flowers are solitary and axillary. The peduncles are pubescent, often densely so in *M. donahooiana*, *M. exserta*, *M. longiflora*, *M. polonii*, *M. pringlei*, *M. sanguinea*, *M. urbanii*. This pubescence is predominantly glandular in *M. exserta*, *M. longiflora*, *M. pringlei*. Flowers are perfect, involucrate, with one flower per involucre. The five-lobed involucre appears as a false calyx under a petaloid perianth. This gives the flower every appearance of having a symsepalous calyx and a sympetalous corolla. All species have similar campanulate or narrowly campanulate involucres with 5 lobes as long as, or slightly longer than, the fused portion. Involucres, of all species, are only slightly accrescent in age but display variation in shape at anthocarp maturity. Some involucres are rotate *M. gracilis*, *M. jalapa* and some are campanulate *M. polonii*, *M. pringlei*, *M. sanguinea*, *M. urbanii*. In *M. longiflora*, the involucral lobes are extremely attenuate and valvate until well after the anthocarp has matured. The perianth is composed of a showy petaloid calyx (Joshi & Rao 1934) at least twice as long as the involucre. It consists of three sections: the base which is constricted above the ovary, the tube, and the limb (the basal portion persists and encloses the ovary to become the fruit or anthocarp, the tube and limb abscise at the constriction point and fall off after pollination). The tube in most species is funnelform, though in some it is narrowly so, *M. donahooiana*, *M.exserta*, *M. jalapa*, *M. sanguinea* var. *sanguinea;* others are distinctly salverform *M. gracilis*, *M. longiflora*, *M. polonii*. Perianth color ranges from white in *M. gracilis*, *M. longiflora*, *M. polonii* to pink in *M. exserta*, *M. pringlei*, *M. urbanii* to lavender, purple and red in *M. donahooiana*, *M. jalapa*, *M. sanguinea*. Orange appears only in *M. hintoniorum* and among occasional populations of *M. jalapa*. The perianth limb terminates in five nearly equal usually broadly obtuse lobes with emarginate apices and five nerves which extend along the tube and limb to terminate in tuffs of pubescence. These lobes are induplicate and plicate in bud. *Mirabilis pringlei* has distinctive acute triangular lobes and *M. hintoniorum* has very obscure lobes. In *M. exserta*, *M. gracilis* the shallow emarginate lobes give the perianth limb a ruffled appearance. All species have circinate stamens that are united at the base, forming a collar around the single ovary. This collar may completely contain the ovary in *M. longiflora* and *M. pringlei* or expose as much as the upper 2/3 of the ovary as in *M. urbanii*. Above the collar, stamens are free, though most are appressed to the perianth in the region of constriction, and some remain appressed part way up the perianth tube, *M. gracilis*, *M. polonii*. Stamens are usually unequal in length with presentation to one side of the perianth creating a weakly zygomorphic flower. Filaments of most species are lavender to lavender-pink, except *M. hintoniorum* and the yellow and white flowering forms of *M. jalapa*, which have filaments the same color as the perianth. In most species, the stamens are well-exserted beyond the throat of the perianth tube, the exceptions: *M.donahooiana*, *M. urbanii*, many populations of *M. jalapa*, and some populations of *M.longiflora* var. *longiflora*. Pollen grains are spheroidal, pantoporate, and the sexine sparsely tubuliferous and spinulose. They range in size from 100 mm to 190 mm, (to 210 mm, according to Nowicke 1970). The ovary is superior with a single ovule. The capitate stigma and style, which are longer than the stamens, often remain extended in senescent flowers. The fruit or anthocarp formed from the persistent basal portion of the perianth and the enclosed ovary, may be spheroid, elliptic, or oblong; 5-angled or ribbed; glabrous or pubescent; smooth or warty; black, light brown, brown, or orangish brown. In a survey study of *Mirabilis* anthocarps (forty of the sixty taxa) (Le Duc 1993) no other section displayed as much variablility of anthocarp characters between species as did section *Mirabilis*. The glabrous, elliptic anthocarp with five to ten furrows of *M. exserta*, is similar to several species of section *Quamoclidion* (Plate I–4). The anthocarps of *M. hintoniorum*, *M. sanguinea*, and *M. urbanii* (Plate II–1, 2, 3 & 4) are oblong-ellipsoid, pubescent, 5-angled, ridges tuberculate, with a truncate base and an acute apex. These features are commonly associated with species in section *Oxybaphus*. The other entities of section *Mirabilis* (Plate I–3, 5 & 6; Plate II–5, 6, 7) display various combinations of characters intermediate between the afore described species. One significant character distiguishes all species of section *Mirabilis* from the other sections, a lack of any mucilage production when the anthocarps are wet. (Section *Quamoclidion* includes the only other species that reportedly do not produce mucilage when wet, but it also includes several species that become mucilaginous.) For most individual species in section *Mirabilis* the anthocarpal features remain quite constant. However, considerable variation exists in the two species that are known to have been cultivated as garden plants, first by the Pre-Columbia people, and then by the Europeans, *M. jalapa* and *M. longiflora*. Plate I–1 & 2 and 3 & 5 show two common forms for each of these species.

TAXONOMIC TREATMENT

Section **Mirabilis** Hook., in Benth. & Hook., Gen. Pl. 3:1–11. 1880. TYPE: *Mirabilis jalapa* L.

Herbaceous or suffruticose perennials, erect, ascending or semidecumbent, the root fleshy, the stems slender or stout, puberulent or glabrous. Mid-stem leaves opposite, petiolate; blade thin or slightly succulent, ovate to broadly so; base cordate, truncate or grading into the petiole, veins prominent. Involucres 1-flowered, ± narrowly campanulate, 5-lobed, slightly accrescent in age. Perianth showy, funnelform or nearly salverform, limb with 5 emarginate lobes. Stamens 5, circinate before anthesis, the filaments unequal, capillary, connate at base into a sheath about the ovary. Anthocarp ellipsoid, ± pubescent or glabrous, ± angular or ribbed, surfaces smooth or warty. Not mucilaginous when wet. Base chromosome number possibly x = 29.

KEY TO SPECIES OF SECTION *MIRABILIS*

1. Stamens exserted, filaments at least twice as long as perianth.
  2. Perianth tube slightly swollen above the ovary, the lobes acute. .... 1. *M. pringlei*
  2. Perianth tube not swollen above the ovary, the lobes obtuse.
    3. Anthocarp broadly ellipsoid or ovoid, glabrous; perianth white, pink-tinged to pale lavender. .... 2. *M. exserta*

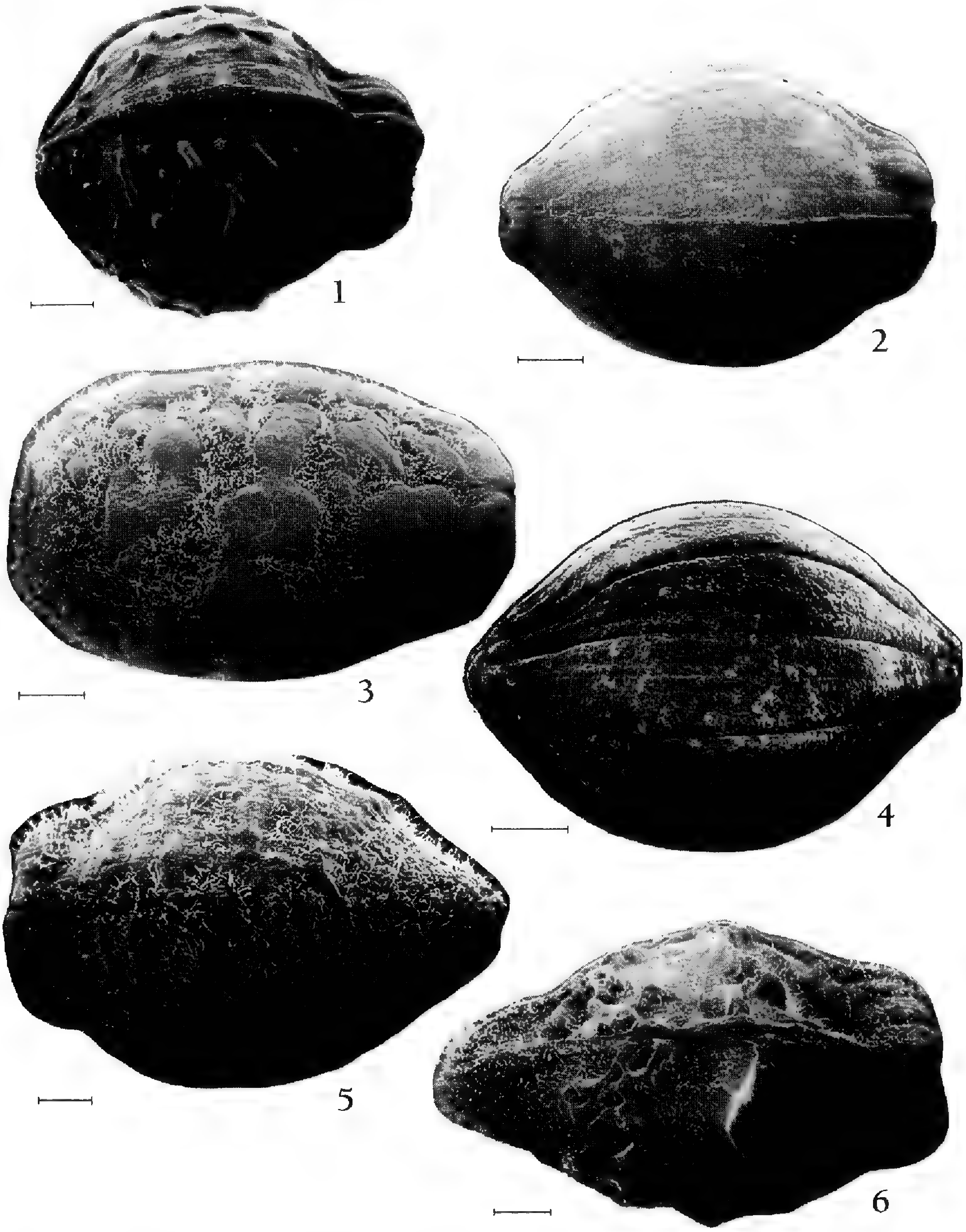

PLATE I. 1. *M. jalapa* Mexico, Veracruz. *Le Duc & Sydor 158* (TEX). 2. *M. jalapa*—Texas, Travis Co. *Le Duc s.n.* (TEX). 3. *M. longiflora* var *longiflora*—Mexico, Tlaxcala. *Le Duc 222* (TEX). 4. *M. exserta*—Mexico, Baja California Sur. *Breedlove 43339* (MO). 5. *M. longiflora* var *wrightiana*—Mexico, Durango. *Le Duc 180* (TEX). 6. *M. gracilis* –Mexico, Jalisco. *Le Duc & Sydor 71* (TEX). Bar = 1.0 mm.

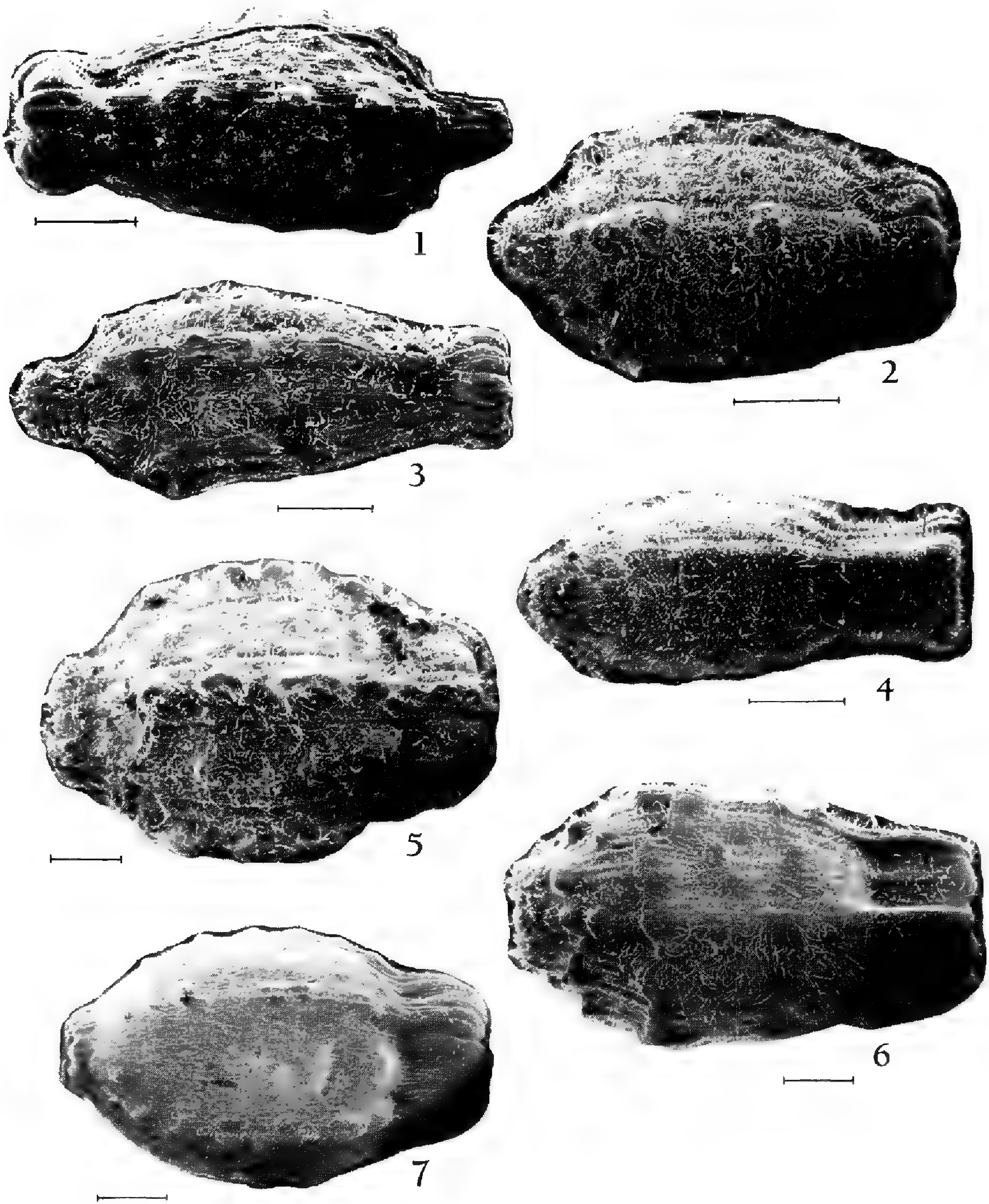

Plate II. 1. *M. sanguinea* var. *sanguinea*—Mexico, Chiapas. *Soule 2357* (TEX). 2. *M. sanguinea* var. *breviflora*—Mexico, Jalisco. *Le Duc 254* (TEX). 3. *M. hintoniorum*—Mexico, Michoacán. *Hinton 13909* (TEX). 4. *M. urbanii*—Mexico, Michoacán. *Le Duc 245* (TEX). 5. *M. polonii*—Mexico, Sinaloa. *Le Duc et al 178* (TEX). 6. *M. donahooiana*—Mexico, Michoacán. *Le Duc 247* (TEX). 7. *M. pringlei*—Mexico, Jalisco. *Le Duc 63* (TEX). Bar = 1.0 mm.

3. Anthocarp oblong-ellipsoid, pubescent; perianth orange. .... 3. *M. hintoniorum*

1. Stamens, if exserted, less than twice as long as perianth.

4. Perianth > 6 cm long.

5. Perianth curved downward (especially before anthesis); leaf base truncate; anthocarp obovoid, 6–7 mm long, constricted and truncate at the base and apex. .... 4. *M. polonii*

5. Perianth straight, erect (especially before anthesis); leaf base cordate; anthocarp ellipsoid to obovoid, 7–8 mm long, constricted and truncate at base only. .... 5. *M. longiflora*

4. Perianth < 6 cm long.

6. Perianth light pink, < 15 mm long; anthocarp with prominent stiff orange hairs. .... 6. *M. urbanii*

6. Perianth red-purple, 15 mm long or longer; anthocarp without stiff orange hairs.

7. Internodes 13–23 cm long. .... 7. *M. sanguinea*

7. Internodes < 13 cm long.

8. Inflorescence open, few-flowered; anthocarp oblong to oblong-obovate. .... 8. *M. donahooiana*

8. Inflorescence compact, many-flowered; anthocarp ovoid to ellipsoid.

9. Perianth tube at least twice as long as limb-width; flowers white with lavender staminal filaments; anthocarp ellipsoid 9–11 mm long. .... 9. *M. gracilis*

9. Perianth tube less than twice as long as limb-width; if flowers white then staminal filaments white; anthocarps ellipsoid to ovoid, 6–9 mm long. .... 10. *M. jalapa*

1. **Mirabilis pringlei** Weath., Proc. Amer. Acad. Arts 45:424. 1910. (Pl. 3-A). TYPE: MEXICO. GUERRERO: under limestone cliffs, Iguala Canyon, 23 Jul 1907, *Pringle 10384* (HOLOTYPE: GH!; ISOTYPES: F!, LL!, MICH!, RSA!, UC!).

Herbaceous or suffruticose perennials, erect or ascending, 1 m high, much-branched, roots tuberous. Stems slender, finely viscid-pubescent, lower internodes 10–15 cm long, nodes villous. Mid-stem leaves: petiole slender, 3–15 cm long; blade 3.5–13.0 cm long, 2–9 cm wide, thin, bright green, sparsely puberulent; base cordate or deltoid-ovate, cordate to unequally subcordate, apex acute to short acuminate, margin ciliolate (pink on young leaves). Inflorescences open, terminal, composed of many-flowered cymes, these subtended by small, short-petioled leaves. Involucre campanulate, 5–8 mm long, glandular-puberulent, slightly revolute in age, lobes ca. 2 mm long, obtuse or acute, margin ciliolate; ultimate peduncles 1–6 mm long, densely glandular-pubescent. Perianth 2–3 cm long, sparsely glandular-pubescent, white to pink, tubular, slightly swollen above ovary, lobes 9–10 mm long, ca. 5 mm wide, triangular, reflexed after anthesis, apices acute. Stamens exserted, nearly twice as long as the perianth, pink to lavender. Style and stigma white. Anthocarp dark brown to grayish brown, broadly obovoid to oblong, 5–7 mm long, 4–5 mm wide, 5-angled, sparsely

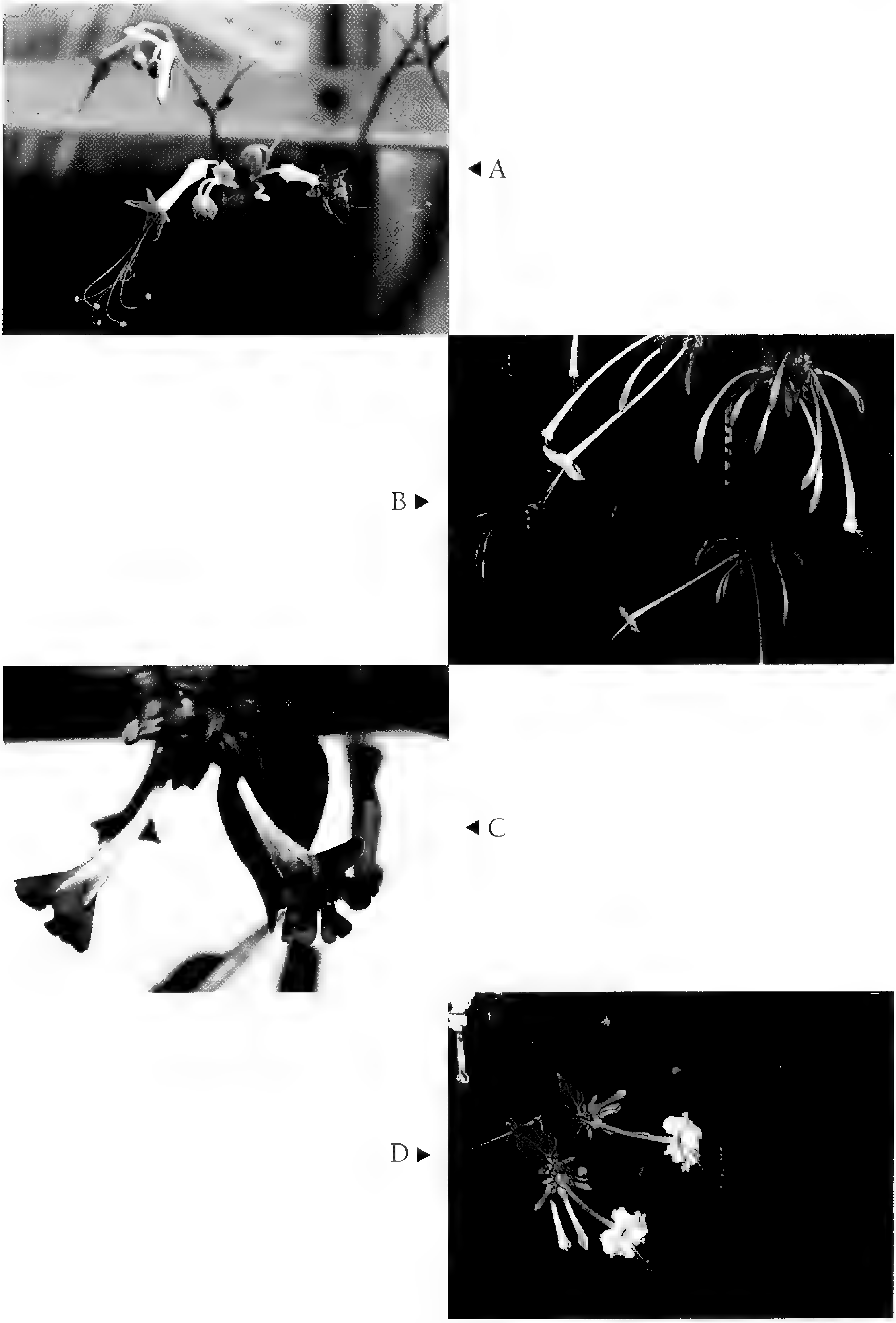

Plate III. A. *Mirabilis pringlei* (*Le Duc 63,* TEX). B. M. *polonii* (*Le Duc 178,* TEX). C. *M. donahooiana* (*Le Duc 248,* TEX). D. *M. gracilis* (*Le Duc 176,* TEX).

warty between ribs, slightly puberulent to glabrate, constricted at both ends, base truncate.

Phenology.—Flowers from late July to September. Flowers open in the evening.

Distribution (Fig. 1).—The Pacific slopes of the Sierra Madre Occidental and western Central Plateau; in full sun to partial shade, crumbly or rocky igneous soil. Altitude 300–2000 m.

Representative specimens: MEXICO. **Guanajuato:** Empalmede, *Rusby 118* (NY). **Guerrero:** Casa Verde, Xochipla, Zumpango de Río, *Rzedouski 16089* (UC). **Jalisco:** El Corcovado, Bridge over Río San Pedro, *Le Duc & Sydor 63* (TEX); Mezquitan, between Autlan & Corcovado, *Le Duc & Sydor 70* (TEX); 25 mi E of El Grullo & W of Ciudad Guzman, *Le Duc 174* (TEX). **Mexico:** Palmar, Temascaltepec, *Hinton 6418* (GH, MICH); Los Cuervos, 8.7 mi NE of Mexico state line along Hwy 130, *Le Duc et al 238* (TEX). **Michoacán:** WSW of Apatzingán, road to Dos Aquas & Aguililla, *Dieterle 4325* (CAS, MICH, MEXU); Tuzantla-Tiquicheo, Zitácuaro, *Hinton 13080* (F, GH, MEXU, MICH, NY, RSA, UC, US); Puerte San Salvador, 54.3 mi N of La Mira junct. HWY 200 & 37, *Le Duc et al. 244* (TEX).

Mirabilis pringlei closely resembles *M. exserta* and *M. hintoniorum* in vegetative characters. It differs markedly from them in perianth structure, having the tube salverform and lobes reflexed. The anthocarps also differ in *M. pringlei* having few contours or warty areas and they are sparsely covered with short hairs.

2. **Mirabilis exserta** Brandegee, Proc. Calif. Acad. Sci. II. 3:165 1891. TYPE: MEXICO. BAJA CALIFORNIA SUR: "Summits of the spurs of Sierra de San Francisquito," 20 Oct 1890, *T.S. Brandegee 480* (HOLOTYPE: UC!; ISOTYPES: GH!, US!).

Herbaceous or suffruticose perennials, erect, 4–6 dm high, much branched. Stems slender, upper densely viscid puberulent, glabrate below, internodes 7–13 cm long. Mid-stem leaves: petiole slender 1.0–2.5 cm long; blade 6–11 cm long, 4.0–10.5 cm wide, thin, bright green, puberulent when young, soon glabrate, base ovate-orbicular, broadly ovate-deltoid or cordate-ovate, subcordate or truncate, apex acute, acuminate to broadly rounded, margin minutely ciliolate. Inflorescences open, terminal, many-flowered cymes, subtended by small sessile or subsessile orbicular or ovate-lanceolate, often puberulent leaves. Involucre broadly campanulate, 6–11 mm long, densely viscid-villous, lobes broadly triangular, obtuse or occasionally acute, shorter than tube, margin ciliolate; ultimate peduncles 1–5 mm long, densely viscid-villous. Perianth 4–5 cm long, sparsely glandular-villous, white tinged with pink to pale lavender, narrowly funnelform, limb 1.5–2.5 cm broad. Stamens ca. twice as long as perianth; style exceeding stamens in length. Anthocarp dark brown, broadly obovoid or oval, 6–8 mm long, obscurely angled, smooth, tapered at both ends.

Phenology.—Flowering from late September to December.

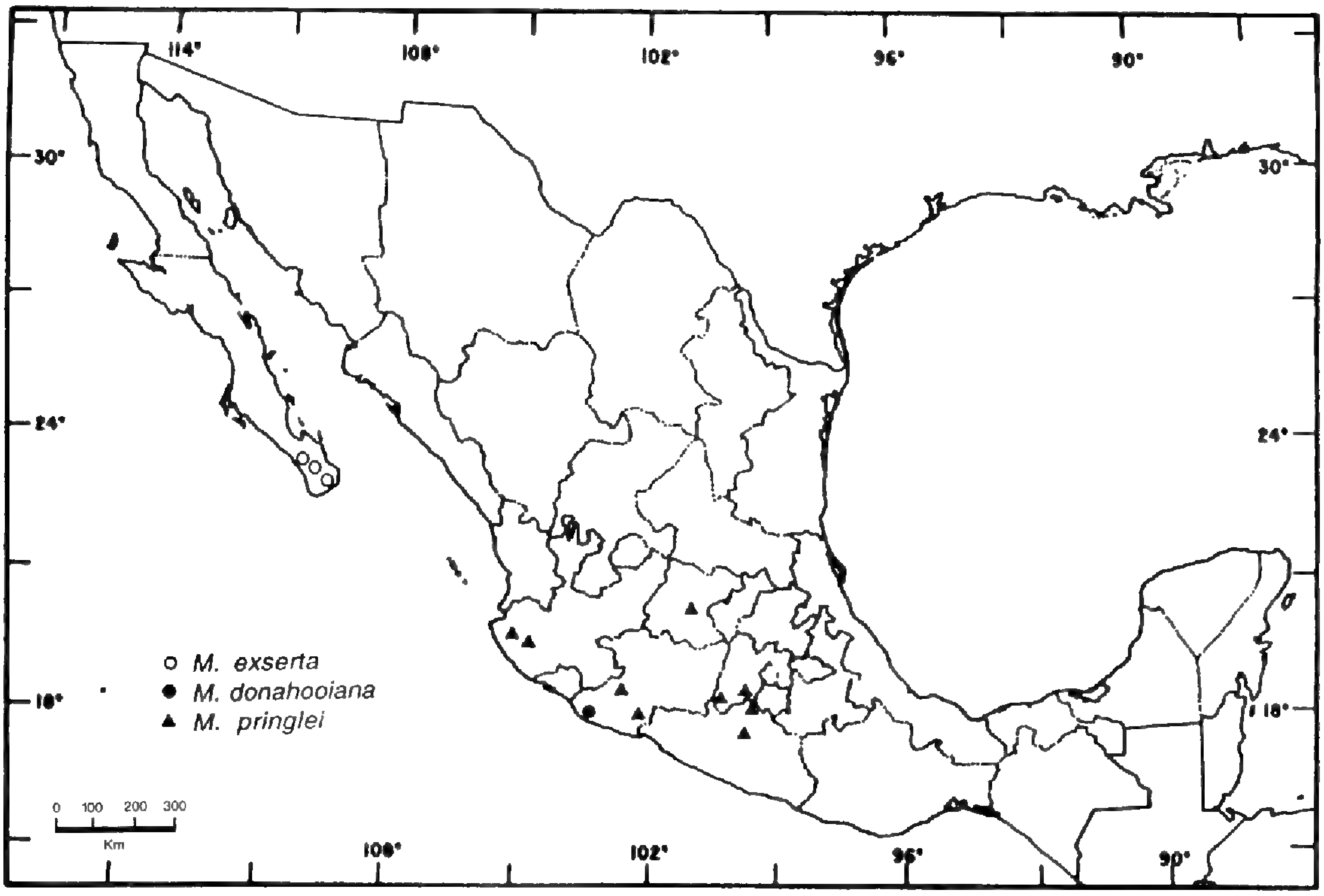

FIG. 1. Distribution of *Mirabilis exserta*, *M. donahooiana* and *M. pringlei*.

Distribution (Fig. 1).—Upper elevations of the mountains of the Cape Region, Baja California. Altitude 1700–2000 m.

Representative specimens: MEXICO. **Baja California Sur:** La. Chuparosa, *Brandegee s.n.* (F, GH); Valley (La Laguna) S of Pico La Aguja on the Sierra La Laguna, *Breedlove 43339* (MEXU); Laguna, Laguna Mts., *Jones 27304* (NY, RSA, UC); Los Limpios, Sierra la Laguna, E of Todos Santos, *Tenorio et al. 10586* (RSA).

This species closely resembles *M. pringlei* in vegetative characters. The flowers resemble those of *M. gracilis* but its stamens are more exserted. The anthocarp is unique within the section *Mirabilis*; it resembles those of section *Quamoclidion* in shape (elliptic) and having a smooth, glabrous surface with only slight indication of furrows.

3. **Mirabilis hintoniorum** Le Duc, Sida 15:53. 1992. TYPE: MEXICO. MICHOACÁN: District Coalcomán, Villa Victoria, dense woods, 11 Jul 1939, *Hinton 13909* (HOLOTYPE: TEX!; ISOTYPES: G!, MO!, UC!).

Herbaceous or suffruticose perennials(?), erect, 7–8 dm high. Stems slender, striate, nodes puberulent, otherwise glabrous. Mid-stem leaves: petiole slender 1–2 cm long; blade glabrous, 5–9 cm long, 2.0–6.5 cm wide, base broadly to narrowly ovate, asymmetrically cordate or slightly truncate, apex acuminate, margin sparsely ciliolate. Inflorescences terminal, arranged in few-flowered cymes, subtended by sessile or subsessile, ovate to ovate-lanceolate, pubescent leaves. Involucre narrowly campanulate, 2–3

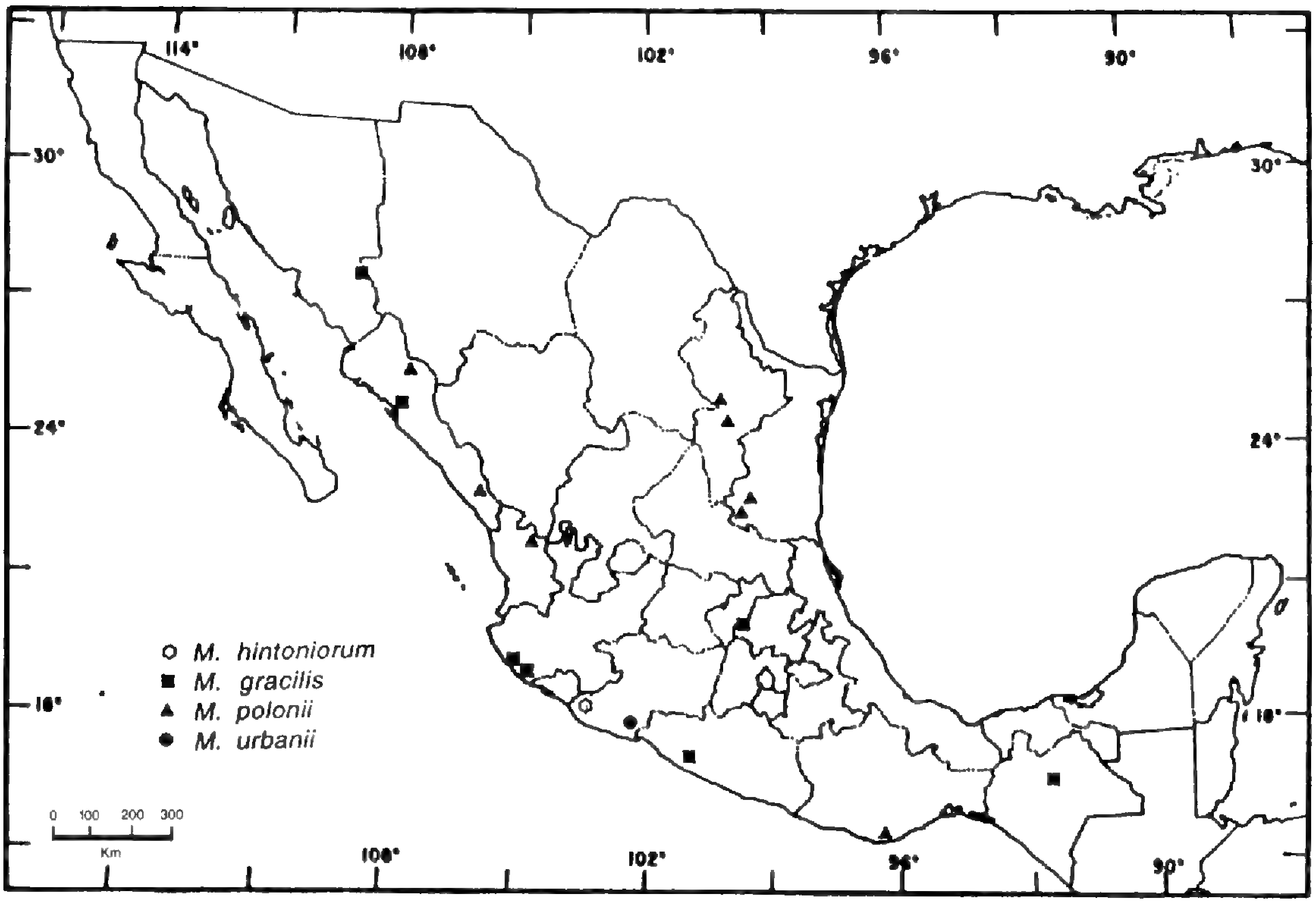

FIG. 2. Distribution of *Mirabilis hintoniorum, M. gracilis, M. polonii* and *M. urbanii.*

mm long, glabrous or slightly puberulent, lobes narrowly triangular, less than 1/2 the length of tube, margin ciliolate; ultimate peduncles 3–5 mm long, pubescent. Perianth 2.0–2.5 cm long, glabrous or nearly so, orange, tube dilated upwards, limb 5–8 mm broad, lobes obscure, ciliolate. Stamens ca. twice as long as the perianth. Anthocarp dark brown, oblong-ellipsoid, 6–7 mm long, 3 mm wide, 5-angled, the ridges tuberculate, moderately puberulent, constricted at both base and apex.

Phenology.—Flowering in July.

Distribution (Fig. 2).—Known from only type locality, in tropical deciduous forest. Altitude 700 m.

The open terminal inflorescences and ovate leaves with cordate bases of *M. hintoniorum* are most similar to those of *M. exserta* and *M. pringlei*. However, it differs in the extreme reduction of the perianth lobes, the lack of viscid-villous pubescence, and its few-flowered inflorescences. The anthocarp of *M. hintoniorum* most closely resemble those of *M. donahooiana* and *M. polonii* but also shows a resemblance to many anthocarps of *Mirabilis* section *Oxybaphus* differing from the latter in being nonmucilaginous. The flower color of *M. hintoniorum*, as noted by label data, is unusual for the genus, and might be questioned. However, I have collected *M. jalapa* with orange flowers, from a small population in the state of Mexico (*Le Duc 94* TEX), thus giving credibility to Hinton's notation.

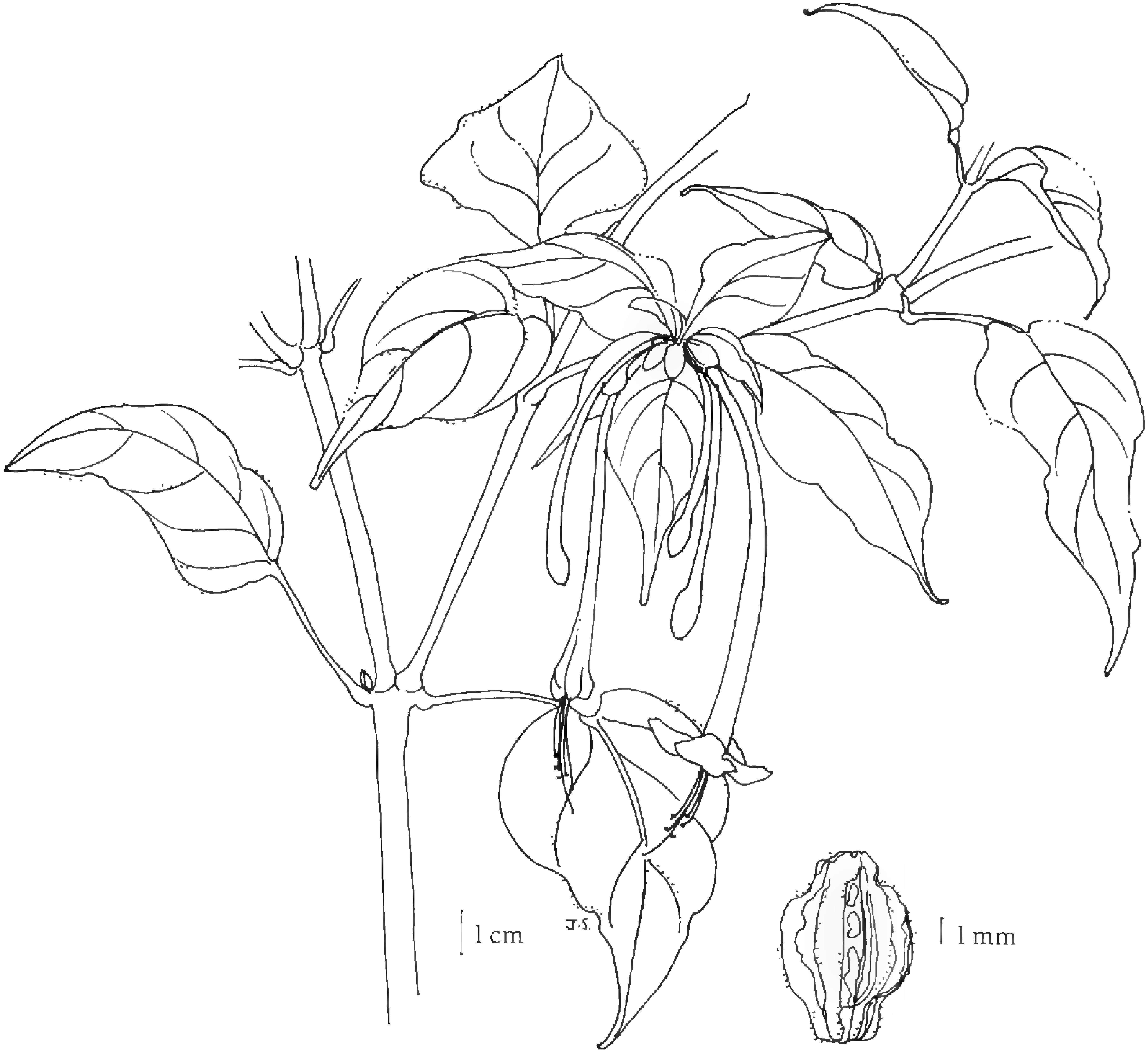

Fig. 3. *Mirabilis polonii* habit and details from holotype showing: upper leaves and flowers with an enlarged detail of the anthocarp.

4. **Mirabilis polonii** Le Duc, sp. nov. (Pl. 3-B; Fig. 3)

Mirabilis gracili (Standl.) Le Duc foliis similis, *M. hintoniorum* Le Duc morphologia anthocarpiorum similis; *M. longiflorae* L. similis perianthiis in longitudine similibus sed differt perianthiis arcuatis (deorsum curvatis), foliorum basibus truncatis, et anthocarpiorum apicibus truncatis.

Herbaceous or suffruticose perennials, erect, 7.5–10 dm high, much-branched, roots tuberous. Stems slender or stout, glabrous or with pubescence restricted to 2 longitudinal lines, internodes 7–9 cm long, nodes puberulence. Mid-stem leaves: petiole slender, 0.5–3.0 cm long; blade 7–11 cm long, 4–5 cm wide, thin, green (often reddish beneath), puberulent, broadly ovate, base asymmetrical, subtruncate or occasionally subcordate, apex attenuate, margin ciliolate. Inflorescences terminal, somewhat open, many-flowered cymes, subtended by small ovate-lanceolate leaves. Involucre slightly pinkish in age, narrowly campanulate, 8–10 mm long, slightly puberulent, lobes 4–5 mm long, lanceolate-oblong, acute, margin ciliolate;

ultimate peduncles 2–5 mm long, puberulent. Perianth 9–11 cm long, glabrate, white, fragrant, tube very elongate, curved downward, ca. 2 mm wide, limb 2.0–2.5 cm broad. Stamens exserted, slightly less than half length of tube, 11–13 cm long, lavender. Style ca. 1 mm longer than stamens. Anthocarp dark brown to brownish black, obovoid, 6–7 mm long, 4–5 mm wide, 5 angled, ridges tuberculate with warty areas between, pubescent, constricted and truncate at both base and apex.

TYPE: MEXICO. SINALOA: along Hwy 40, 3 mi SW of La Guayanera & 2 mi N of the Copolita spur, between Matzatlán and Durango, N 23° 23', W 105° 55', altitude ca. 700 m, 29 Jul 1991, *Le Duc 178* (HOLOTYPE: TEX!; ISOTYPES: MEXU!, others to be distributed).

Representative specimens: MEXICO. **Nayarit:** Mpio Nayar Cerro Cangrejo, Cañada al NE poblado Villa de Guadalupe, *Tenorio & Flores 16206* (RSA). **Nuevo Leon:** Cañón 3.6 mi SW of Los Ajuntas & 7.4 mi NE of La Trinadad, *Le Duc 259* (TEX); Cañón del Pasaje de los Osos, al Pte. de Ybanis, Santiago, *Marroquin 1330* (TEX); Trail between Potrero Redondo & Las Ajuntas, *Mueller 2990* (GH, UC). **Oaxaca:** Río Coyula a 7 km al SE de le Limón, *Refugio-Cedillo 1688* (LL, MEXU). **San Luis Potosi:** Tanjasnec, Mpio San Antonio, *Alcorn 1838* (TEX). **Sinaloa:** Mpio San Ignacio. La Cebolla ± 40 km N de San Ignacio, *Vega. R. y S. Palazuelos 781* (MEXU); 33 mi SW of Rivalcaderos, *Waterfall 12733* (TEX). **Tamaulipas:** 10 km NW of El Progresso, which is ca. 18 km NW of Ocampo, *Standford et al. 1040* (GH, MO, NY, UC).

Phenology.—Flowers from late July to September. Flowers open in the evening.

Distribution (Fig. 2).—Moist Pacific slopes of the Sierra Madre Occidental, Sierra Madre del Sur, and the Eastern protected canyons of the Sierra Madre Oriental; in tropical deciduous forest, semi to full shade, soil crumbly, igneous or limestone. Altitude 900–1500 m.

This species resembles *M. gracilis* in foliage, having thin dark green leaves with truncate bases. The anthocarp, however, is like that of *M. hintoniorum* and *M. donahooiana*. The perianth is at least 6 cm long, resembling that of *M. longiflora*, but the latter is erect while that of *M. polonii* is arching (curved downward).

The species is named in honor of David Polon, an anthropologist who worked in Mexico. Without his encouragement I would not have focused my studies on a genus from Mexico. He was very positive in his beliefs that more research was needed on the plants of Mexico.

5. **Mirabilis longiflora** L., Kongl. Svenska Vetensk. Acad. Handl. 176. t. 6. 1755. *Jalapa longiflora* (L.) Moench, Methodus 508. 1794. *Nyctago longiflora* (L.) Salisbury, Prodr. Stripium Chap. Allerton 57. 1796. TYPE: MEXICO. without specific locality or date. Illustration t. 6 adequately typifies this name. There is one specimen 240.3 LINN in the Linnean collection. No information is indicated on the sheet as to the origin of the material or if Linnaeus studied it. The only other element cited by Linnaeus is the illustration in Rerum Medicarum Novae Histpaniae Thesaurus f. 2, p. 170 by Francisco Hernández, 1651.

Herbaceous or suffruticose perennials, erect, 0.5–1.5 m high, much branched, roots tuberous. Stems slender or stout, densely viscid-puberulent or short villous, lower internodes usually longer than leaves. Mid-stem leaves: petiole slender, 2–6 cm long; blade 6–12 cm long, 3–7 cm wide, thin, bright green, densely viscid-puberulent to sparsely so, cordate-ovate to narrowly deltoid-ovate or lance-ovate, base cordate, apex acute to attenuate, margin ciliolate. Inflorescences dense, axillary or terminal, many-flowered cymes, subtended by sessile or subsessile reduced leaves. Involucre campanulate, 1.0–1.5 cm long, densely glandular-pubescent, lobes about as long as tube, triangular to narrowly triangular-lanceolate, very acute to long-attenuate, usually exceeding anthocarp in fruit, margins ciliolate; ultimate peduncles ca. 3 mm long or less, densely glandular-pubescent. Perianth 7–17 cm long, densely viscid-villous outside, white, throat tinged with pink or purplish-red, fragrant, salverform, tube very slender, ca. 2 mm in diameter, limb 2–3 cm broad, lobes broad shallow-rounded. Stamens exserted, ca. 2.5 cm beyond throat, purplish-lavender. Anthocarp dark brown, puberulent, constricted and truncate at base. Chromosome number n = 29 (Showalter 1935; Kruszewska 1961).

Inflorescence congested, glomerate, subtending leaves sessile; anthocarp obscurely 5-angled, slightly puberulent, prominent white-warty areas, the apex truncate. .... 5a. *M. longiflora* var. *longiflora*
Inflorescence open, subtending leaves short-petiolate to subsessile; anthocarp 5-angled, puberulent, warty, the apex acute. .... 5b. *M. longiflora* var. *wrightiana*

5a. Mirabilis longiflora L. var. longiflora

Phenology.—Flowering from July to September. Flowers open in the evening.

Distribution (Fig. 4).—Mostly the Trans-Mexican Volcanic Belt and Central Valleys of Mexico, growing under *Juniperus*, Magey or other similar plants, at the margins of cultivated fields. Altitude 1800–2800 m.

Representative specimens: MEXICO. **Guanajuato:** Xichú road, *Kenoyer 2298* (GH). HIDALGO: 6 km N of Pachuca, *Hernández 4346* (GH); Cerro Jazmin, 2 km NE of Apan, *West D-10* (UC). **Nuevo Leon:** Monterrey, *Orcutt 1228* (US). **Oaxaca:** Escuela Normal, Oaxaca, *Conzatti 973* (GH). **Puebla:** Santa Ana, *Nicolas 5317* (NY); ca. 2 km N of Saltillo La Fragua, Hwy 140 from Jalapa to Puebla, *Poole 1555* (TEX); San Luis Tultitlanapa, *Purpus 3374* (F, GH, MO, NY, UC, US); Mt. Orizaba, Esperanza, *Seaton 493* (F, GH). TLAXCALA: 1 km WSW Tlaxco on road to Apan, Hwy 119, *Le Duc 170* (TEX); E of Cuapiaxtla on Hwy 136, *Le Duc et al. 224* (TEX). **Veracruz:** Perote, *Balls B5518* (UC, US); Tenextepec, Mpio Perote, *Chazaro & Acosta 3739* (MICH); Cerros arriba de Santiago, *Nevling & Gomez-Pompa 1888* (CAS, GH, MEXU, RSA); near town of Alchichica, *Ramos 284* (GH, MEXU); near Rancho El Camino Totalco & La Gloria, *Ramos 226* (GH); ca. 20 air km SSW of Perote, *Turner 15209* (TEX); 3 km S of Totalco, *Vazquez 4843* (MO).

5b. Mirabilis longiflora var. wrightiana (A. Gray) Kearney & Peebles, J. Wash. Acad. Sci. 29:475. 1939. *Mirabilis wrightiana* A. Gray ex. Britton &

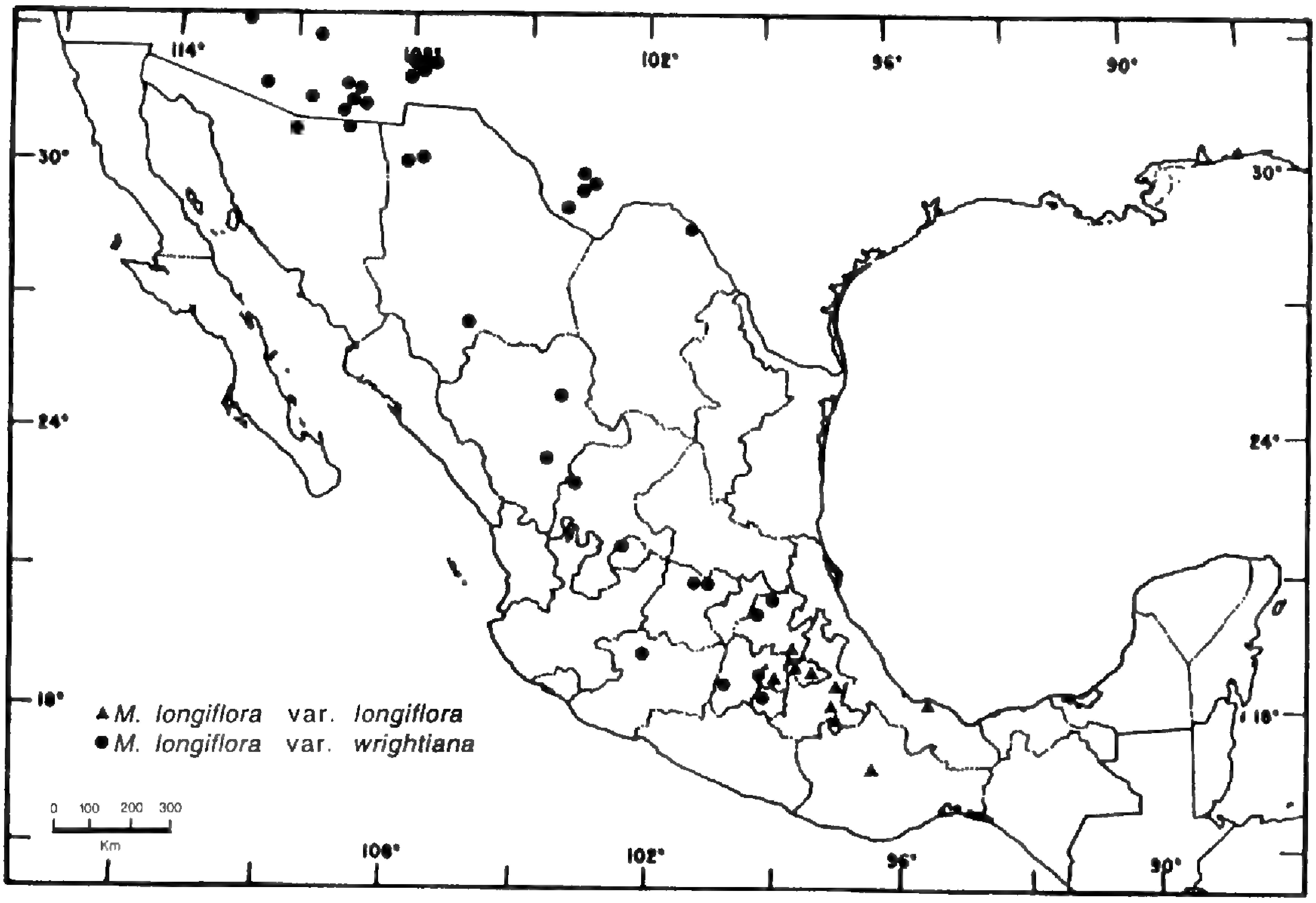

Fig. 4. Distribution of *Mirabilis longiflora* var. *longiflora* and *M. longiflora* var. *wrightiana* in Mexico and U.S.A.

Kearney, in Trans. New York Acad. Sci. 14:28. 1895. TYPE: U.S.A. New Mexico. Grant Co.: Santa Rita de Cobre, valley of the Coppermines creek, 4 Aug 1851, *C. Wright 150* (holotype: GH!; isotype: NY!). A number of specimens were distributed by A. Gray under the exsiccata number 1702. It has not been ascertained if these are all isotypes.

Mirabilis suaveolens H.B.K., Nov. Gen. Sp. 2:213.1817. Type: MEXICO. Guanajuato: vicinity of Guanajuato, Aug–Sep. 1803, *Humboldt & Bonpland s.n.* (holotype: P).

Mirabilis tubiflora Fries ex. Heimerl, Beitr. Syst. Nyctag. 20. 1897. *Mirabilis wrightiana* var. *tubiflora* (Heimerl) Heimerl, Notizbl. Bot. Gart. Berlin-Dahlem 11:450. 1932. Type: Cultivated plant, Leipzig Botanical Garden grown from seed provided by Th. M. Fries. (holotype: W, destroyed; isotype: F!). Material was destroyed in 1945, during the war, pers. comm., Harald Riedl, Director W.

Differs from *M. longiflora* var. *longiflora* in stems more slender, upper most leaves short-petiolate. Inflorescences open, involucre slightly viscid-puberulent. Stamens slightly more exserted, ca. 3 cm. Anthocarp dark brown, oblong to ellipsoid, ca. 8 mm long, ca. 5 mm wide, 5-angled, puberulent, except on swollen areas, warty, base constricted and truncate, apex acute.

Phenology. –Flowers from July to September. Flowers opening in the evening.

Distribution (Fig. 4).—Central Mexico northwards to the mountain ranges of SE Arizona, SW New Mexico, and Big Bend area of Texas, U.S.A.; usually in the shade of trees and shrubs, occasionally in open grasslands, in rocky soil. Altitude 1500–3700 m.

Representative specimens: MEXICO. **Aquascalientes:** 6 km E of Tepezalá, *Rzedowski & McVaugh 1208* (MICH). **Chihuahua:** Soldier Canyon, Sierra Madre Mts., *Jones s.n.*(RSA); NW end of Sierra del Diablo, *Stewart 960* (GH); 24 km NW of Balleza, *Tenorio,et al. 9917* (RSA, TEX); Santa Eulalia, Rosalia, *Wilkerson s.n.* (UC); Gallejo Springs, *Wislizenus 122* (MO). **Coahuila:** Cañón above Palomas, Saltillo, *Gregg 331* (GH); Mpio Villa Acuña, Hacienda Piedra, Canyon of Sentenela, *Wynd & Mueller 585* (MO, NY). **Distrito Federal:** Sierra de Guadelupe, cerro Grande 5 km al NNW of Cuautepec, *Moreno 275* (MICH); Teutli, *Ventura 1876* (NY, MEXU, RSA). **Durango:** Hwy 30 between La Zarca & La Cadera, 22 km E of Hwy 45, *Cruden 2035A* (UC); Hwy 40 at the crossing of arroyo de Los Mimbres, 5 mi W of Guadalupe Victoria, *Le Duc 180* (TEX). **Guanajuato:** Guanajuato, *Dugis s.n.*(GH); 30 mi E of San Luis de la Paz toward Xichú, *Straw & Forman 1466* (MICH). **Hidalgo:** Puerto de la Zorra NE of Jacala, *Moore 3524* (GH, UC); upper slopes of El Monte on trail from Zimapan to mines of El Monte, *Moore, Jr. 4474* (MEXU, MICH). **Jalisco:** Mpio de Zapopan, Río Caliente La Primavera, *Diaz-Luna 333* (MICH); Mpio Tlajomulco, San Lucas Evangelista, *Machuca-Nuñez 2736* (MICH). **Mexico:** Dist. Temascaltepec, Pañon, *Hinton 4412* (GH, MICH, MO, US); Dist. Temascaltepec, Salitree, *Hinton 4313* (GH, MICH, NY, RSA, US); Lomas, *Lyonnet 1560* (CAS, MEXU, UC); E of Tenango del Aire, Río Tenango, *Pineda 519* (CAS, MICH, UC); Mpio Tepatzotlán, Presa de la Concepcion, *Rzedowski 22891* (CAS, MICH, TEX). **Michoacán:** Paricutin, *Eggler 124* (MO). MORELOS: Huajojutla, *Alexander & Hernández 2017* (CAS, GH, MICH, NY, UC, US); Tepoztlan near Cuernavaca, *Le Duc, et al. 234* (TEX); Barranca near Cuernavaca, *Pringle 6377* (CAS, GH, MO, NY, UC). **Nuevo Leon:** entrance de Garcia Cave, Grutas, 32 mi NW of Monterrey, *Ward 5666* (MICH). **San Luis Potosi:** 7 km SW of Pozuelos and 22 km SW of San Luis Potosi on the hwy to Guadalajara, *Johnston et al. 12267* (CAS). **Sonora:** Imuris, *Abrams 12771* (RSA); Fronteras, *Hartman 976* (MO). **Zacatecas:** 95 mi W of Sombrerete, *Taylor 6247* (NY); 3 mi W of Villanueva, *Walker 76H48* (MO, NY).

U.S.A. **ARIZONA: Cochise Co.:** Dragoon Mts., Sorin Camp, *Daniel 3079* (MICH, NY); Huachuca Mts. Carr Canyon, *Gould et al. 2428* (UC); 1.5 mi W of Turkey Creek Ranger Station, *Holler et al. 1024* (NY); Portal, *Spellenberg et al. 2671* (NY). **Gila Co.:** Workman Creek, Sierra Ancha, *Wagner 327* (UC). **Pima Co.:** Fresnel Canyon, Baboquivari Mts., *Gilman 49* (GH, MO, NY). **Santa Cruz Co.:** Atascosa Mts. near Yanks Canyon, *Franklin 5390* (NY). **NEW MEXICO: Grant Co.:** Forest Nursery, Fort Bayard water shed, *Blumer 231* (GH, NY); Santa Rita, on dirt road called Miner's Legend, *Le Duc 185* (TEX); community of Fierro, *Le Duc 190* (TEX). **Socorro Co.:** San Mateo Springs, 10 mi W of Hwy 85, Socorro/ Sierra Co. line, *Baad 1349* (MICH); Mogollon Mts. mid fork of the Gila river, *Metcalfe 432* (GH, UC). **TEXAS: Brewster Co:** Alpine, *Stieger 240* (NY). **Jeff Davis Co.:** Limpia Creek W of Fort Davis, *Correll 33672* (GH, UC); summit of Sawtooth in Davis Mts., *Correll 34971* (NY); Limpia Canyon, Hwy 118 near Ft. Davis, *Le Duc 195* (TEX); Davis Mts., Sawtooth, *Palmer 31895* (MO); old Kent road W of Mt. Locke, *Steiger 1123* (NY); Fern Canyon, *Steiger 1256* (NY); Fern Canyon, *Warnock T634* (NY); 2 mi N of Fort Davis, *Warnock 8034* (MICH). **Presidio Co.:** Cibolo Creek, 5 mi E of Russ. Menzies ranch headquarters, *Warnock 3671* (NY); Cibolo Creek, Cieniguita, 10 mi N of Shafter, *Warnock & Hinckley 4500* (UC).

Mirabilis longiflora was cultivated by the Aztecs as an ornamental plant and, perhaps, as a medicinal herb much as it is today in parts of Mexico

(Alcorn 1984). Many of the populations in the Central Plateau valleys of Mexico show evidence of hybridization between *M. longiflora* and *M. jalapa*. Putative hybrids have also been recorded in the literature of Europe (Lepeletier 1806). The plant described by Linnaeus was probably from a European garden and its description is consistent with the numerous *M. longiflora* populations I have observed cultivated or commensal from the Central Mexican Plateau valleys to Oaxaca. Several characters seem to be shared by these various populations. The terminal glomerate many-flowered cymes characteristic of *M. jalapa* are also characteristic of *M. longiflora* var. *longiflora*. In many populations, plants with flowers resembling those of *M. jalapa* have vegetative characters resembling *M. longiflora*. *Mirabilis longiflora* var. *wrightiana* of the mountain areas of southern Arizona, New Mexico and Texas, and the northern desert regions of Mexico, differs from *M. longiflora* var. *longiflora* in inflorescence and anthocarp characters, appears to be the wild progenitor. It is possible that *M. longiflora* was not originally native to the Central plateau valleys of Mexico but was introduced from the more northern mountains in pre-Columbian times.

6. **Mirabilis urbanii** Heimerl, Oesterr. Bot. Z. 56:250. 1906. TYPE: MEXICO. MICHOACÁN: S of San Salvador, 11–12 Jul 1898, *Langlassé 240* (HOLOTYPE: W, destroyed; ISOTYPES: G! K!, P!). The holotype was destroyed during the war in 1945, pers. comm., Harald Riedl, Director W.

Herbaceous perennials, ascending or semidecumbent, 10–30 cm high, much branched, roots swollen or tuberous. Stems slender, young puberulent, mature glabrous or with pubescence restricted to 2 longitudinal lines, internodes 5–7 cm long. Mid-stem leaves: petiole slender, 1.0–1.5 cm long; blade 3.5–4.5 cm long, 2.5–3.0 cm wide, thin, bright green, puberulent, ovate-deltoid, base asymmetrical, grading into the petiole, apex attenuate or acute, veins few, weak or little branched. Inflorescences solitary in the leaf axils, or terminal and aggregate in small 2–3 (–4) flowered cymes, subtended by few small subsessile ovate-lanceolate leaves. Involucre narrowly campanulate, ca. 7 mm long, glabrate, the lobes ca. the same length as tube, lanceolate-oblong, subobtuse, the margin ciliolate; the ultimate peduncles 3–4 mm long, short-villous. Perianth 1.5–2.5 cm long, short-villous below, purplish-red to lavender-pink, tube funnelform, the limb 12–14 mm broad. Stamens slightly exserted, pink. Flowers may be cleistogamous late in season. Anthocarp brown to dark brown, oblong-ellipsoid, 6–7 mm long, 5-angled, ridges slightly tuberculate; distinct pubescence of orange-brown scalarified trichomes containing cystoliths; constricted at both base and apex.

Phenology.—Flowers from late July to September or October. Flowers open in the morning.

Distribution (Fig. 2).—Pacific slopes of the Sierra Madre del Sur in Michoacán; crumbly igneous soil. Altitude 600–900 m.

Representative specimens: MEXICO. **Michoacán:** 4.9 mi S of Puerte San Salvador, along Hwy 37, *Le Duc et al. 245* (TEX); 20 km N of Infiernillo, *Nuñez 1687* (CAS).

Mirabilis urbanii possesses several distinctive characters. Its leaves which are truncate with the blade base grading into the petiole, and the anthocarp with its distinctive bristle-like, scalarified trichomes. Because of this, the position of *M. urbanii* in section Mirabilis is somewhat questionable. It is similar to *M. sanguinea*, differing from the latter in the above mentioned leaf and anthocarp characters.

7. **Mirabilis sanguinea** Heimerl, Notizbl. Bot. Gart. Berlin-Dahlem 11:451 1932. TYPE: MEXICO. GUERRERO: Campo Morado, 14 Jun 1899, *Langlassé 1058* (HOLOTYPE: W, destroyed; ISOTYPE: F!, GH!). The holotype was destroyed during the war in 1945, pers. comm., Harald Riedl, Director W. Isotype at GH has the collection no. 1058 written in, I could not discern if this was actually Langasse's number but make the assumption that it is.

Herbaceous perennials, erect or semidecumbent, 30–40 cm high, multistemmed, roots tuberous. Stems slender, glabrous to very puberulent, internodes strongly elongate, 13–23 cm long, the nodes with lateral puberulence. Mid-stem leaves: petiole slender, usually half as long as or longer than blade; blade 60–70 mm long, 35–55 mm wide, thin, green, glabrous, rhombic-orbicular, cordate-deltoid, base cordate to subequal truncate, apex acute, margin minutely ciliolate. Inflorescences dense, terminal many-flowered cymes, subtended by small ovate-lanceolate to lanceolate leaves. Involucre narrowly campanulate, ca. 4 mm long, 2–5 mm wide, lobes slightly acute, margin ciliolate, exceeding anthocarp in fruit; ultimate peduncles 1.5–3.0 mm long, somewhat puberulent to densely puberulent. Perianth 15–35 mm long, glabrous or upper half long villous, blood red to lavender-pink, funnelform to salverform, tube narrow, ca. 0.5 mm, limb gently expanding to 13 mm broad, lobe apices obtuse. Stamens exserted, 17–37 mm long, lavender. Anthocarp brown to brownish-black, obovate-elliptic, 3.5–4.5 mm long, 2.0–2.5 mm wide, 5-angled, ridges tuberculate, hirsute, constricted near base, with nipple-shaped apex.

Perianth 20–35 mm long; flowers red .... 7a. *M. sanguinea* var. *sanguinea*
Perianth 15–20 mm long; flowers cerise to lavender-red ... 7b. *M. sanguinea* var. *breviflora*

7a. Mirabilis sanguinea Heimerl var. sanguinea

Phenology.—Flowers from July to September.

Distribution (Fig. 5).—Western slopes of the Sierra Madre del Sur, inland to mountains along the Guerrero-Mexico and Morelos state lines and south to Chiapas. Altitude 800–2500 m.

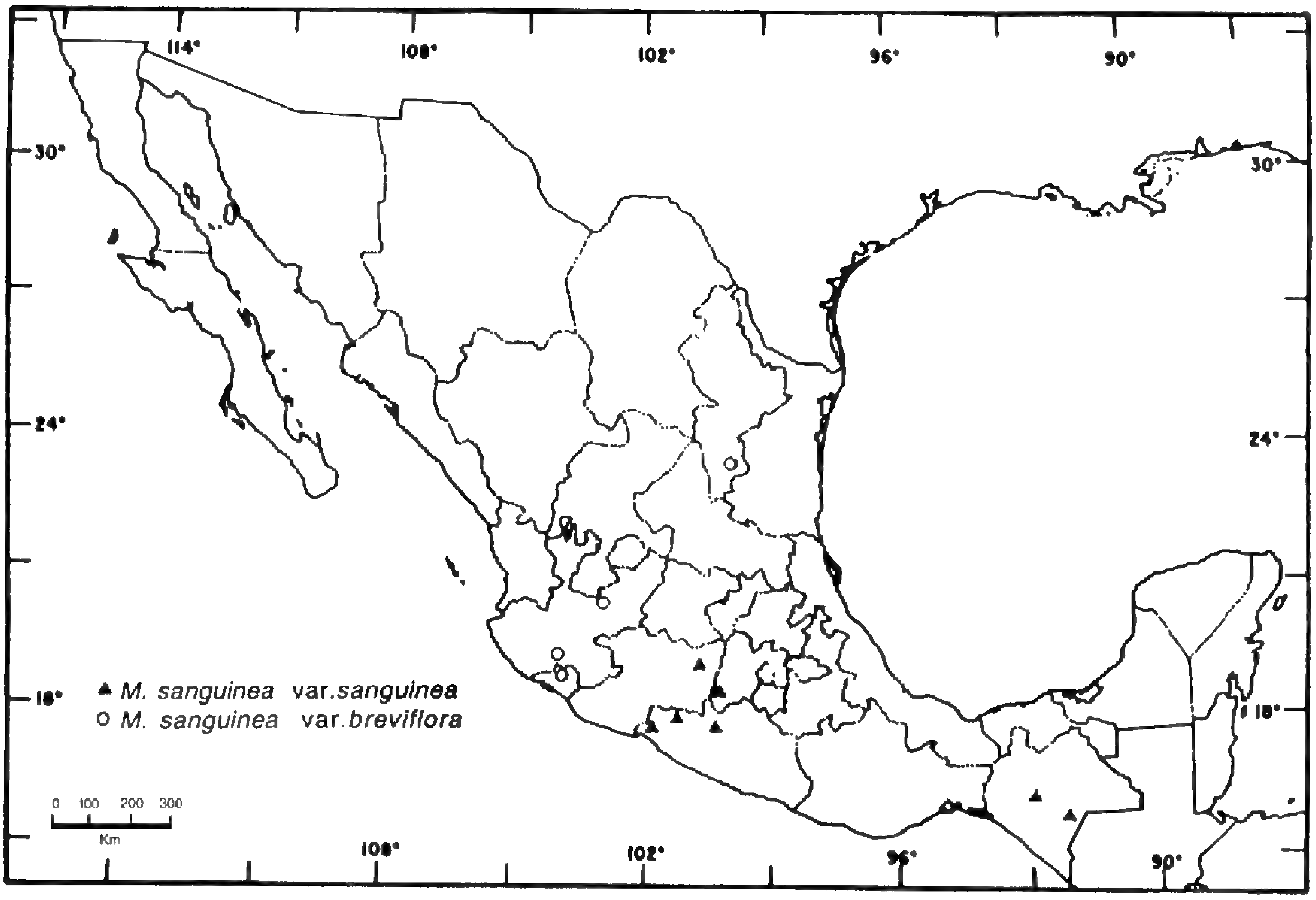

FIG. 5. Distribution of *Mirabilis sanguinea* var. *sanguinea* and *M. sanguinea* var. *breviflora*.

Representative specimens: MEXICO. **Chiapas:** Suchiapa, road to Villa Flores, *Breedlove 28076* (NY); El Chorreadero, 5.6 mi E of Chiapa de Corozo, *Breedlove 10679* (F, LL, MICH); Río Grijalva Canyon, Hwy 211 N of Amatenango de la Frontera, *Soule 2359* (TEX). **Guerrero:** Aquazarca, Mina, *Hinton 10452* (F, GH, MICH, MO, NY, RSA, TEX, UC); Campo Marado, Mina, *Hinton 14320* (F, GH, MICH, NY, RSA, UC, US). **Michoacán:** La Florida, Zitacuaro, *Hinton 11976* (F, GH, MICH, MO, NY, RSA, TEX, UC, US). **Mexico:** Nanchititla, Temascaltepec, *Hinton 4521* (MICH, UC, US).

7b. Mirabilis sanguinea var. breviflora Le Duc, var. nov. (Fig. 6)

Varietati typicae similis sed floribus perianthio breviore et limbo latiore differt.

Phenology.—Flowers from July to September.

Distribution (Fig. 5).—Western slopes of the Sierra Madre del Sur, inland to mountains along the Guerrero-Mexico and Morelos state lines north through the Sierra Madre Oriental and Sierra Madre Occidental. Altitude 800–2500 m.

TYPE: MEXICO. JALISCO: Ejido Santa Catarina Balneario, 0.9 mi N of Hwy 104 & 401 jct, 26 Jul 1991, *Le Duc et al. 251* (HOLOTYPE TEX!; ISOTYPES: MEXU!, others to be distributed).

Representative specimens: MEXICO. **Jalisco:** Road to Tapalpa, 10.6 mi from jct. of old Hwy 54, 0.8 mi from before microwave tower, *Le Duc et al. 254* (TEX). **Nuevo Leon:** 13 km al e de San Antonio Pena Nevada, Mpio Zaragoza, *Hernández S. et al. 2716* (TEX).

The entities from Jalisco and Nuevo Leon differ from *M. sanguinea* var.

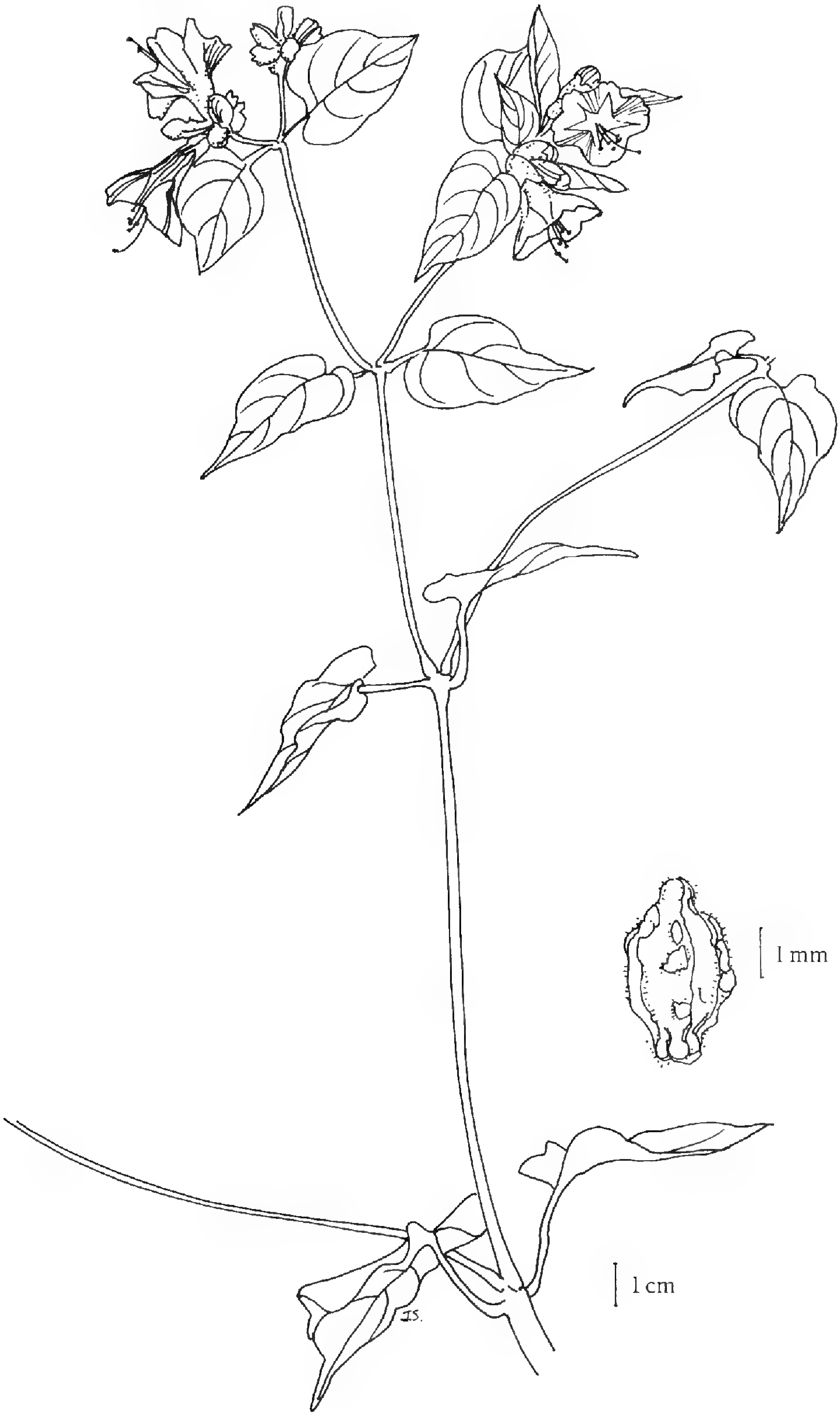

FIG. 6. *Mirabilis sanguinea* var. *breviflora* habit and details from holotype showing: upper leaves and flowers with an enlarged detail of the anthocarp.

sanguinea. They have a shorter perianth tube,15–17 mm long, which flairs more and is lavender-purple in color. The Jalisco plants, which I have observed, all bloom in the morning.

Mirabilis sanguinea is similar to speices of the section *Oxybaphus* in perianth, and in the shape and pubescence character of the anthocarp. This species differs from section *Oxybaphus* in having 1-flowered involucres that are not enlarged in fruit, and nonmucilaginous anthocarps. Within the section *Mirabilis*, *M. sanguinea* appears to be most similar to *M. urbanii*.

8. **Mirabilis donahooiana** Le Duc, sp. nov. (Pl. 3-C; Fig. 7)

Mirabili hintoniorum Le Duc ac *M. polonii* Le Duc morphologia anthocarpiorum similis; *M. jalapae* L. proprietatibus foliorum ac florum similis. Differt a *M. jalapa* morphologia anthocarpiorum, floribus matutino aperientibus, et corollarum limbo magis profunde lobo.

Herbaceous or suffruticose perennials, erect, 75–120 dm high, much branched, roots tuberous. Stems slender or stout, younger with pubescence restricted to 2 longitudinal lines, mature glabrous, internodes 7–11 cm long, nodes with lateral puberulence. Mid-stem leaves: petiole slender, 0.5–2.5 cm long; blade 2–8 cm long, 1.0–4.5 cm wide, thin, green, slightly puberulent, broadly ovate, base asymmetrical, subtruncate, apex attenuate, margin ciliolate. Inflorescences open, terminal, many-flowered, cymes, subtended by small ovate-lanceolate leaves. Involucre narrowly campanulate, 10–12 mm long, lobes 5–6 mm long, puberulent. Perianth 3.0–3.5 cm long, ca. 2 mm wide, limb 1.5–2.5 cm broad, pubescent, lavender-pink. Stamens only slightly longer than tube, lavender-pink. Style slightly longer than stamens. Anthocarp brown, oblong-obovate, 5–6 mm long, ca. 3 mm wide, puberulent, ridges tuberculate, slightly warty between ridges; constricted and truncate at both base and apex.

Phenology.—Flowering from July to September. Flowers open in the morning.

Distribution (Fig. 1).—Area around Aquila, Michoacán, Mexico, in tropical deciduous forest, in partial shade at the foot of rocky cliffs or road cuts, in crumbly igneous soil. Altitude ca. 25 m.

TYPE: MEXICO. MICHOACÁN: road to Aquila, 4.8 mi NW from jct of Hwy 200, 3.5 mi before La Joya bridge, N 18° 37' 30" W 103° 30', 8 Aug 1992, *Le Duc et al. 248* (HOLOTYPE: TEX!; ISOTYPES: MEXU!, others to be distributed).

Representative specimens: MEXICO. **Michoacán:** Aquila, Dist. of Coalcomán, *G. Hinton 16017* (LL, MICH, NY, RSA, UC); side road to Aquila, 8.3 mi NW from jct of Hwy 200, just before La Joya bridge, *Le Duc et al. 247* (TEX).

Anthocarps of this species are similar to those of *M. hintoniorum* and *M. polonii*, in other respects the species resembles *M. jalapa*. *Mirabilis donahooiana* differs from the latter in having a narrower perianth with deeply

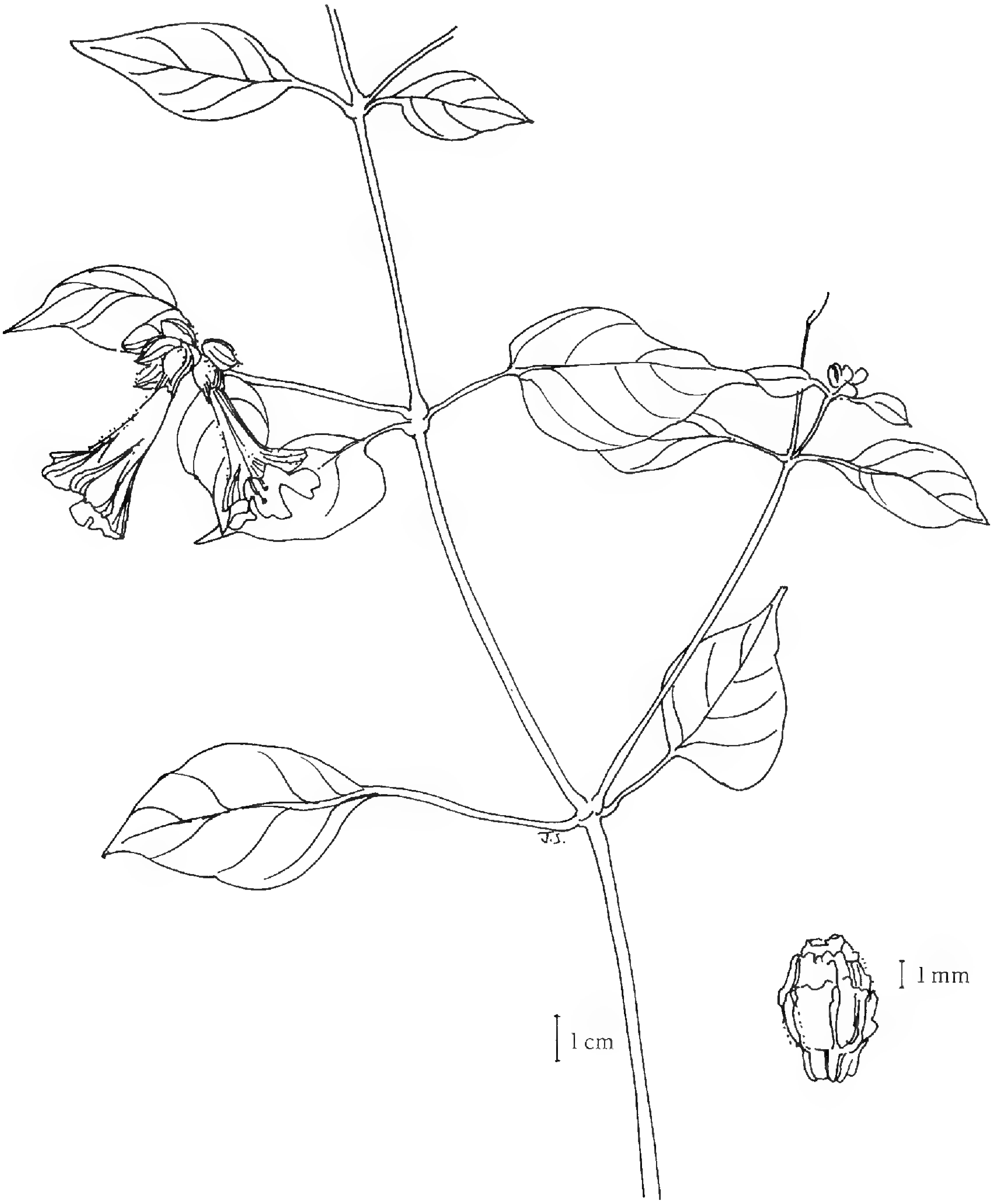

FIG. 7. *Mirabilis donahooiana* habit and details from holotype showing: upper leaves and flowers with an enlarged detail of the anthocarp.

lobed limb. It blooms in the morning, and is closed before four o'clock in the afternoon, the time when *M. jalapa* begins to bloom.

This species is named in memory of Absalom Donahoo, the author's great grandfather. Mr. Donahoo was a pioneer plantsman in Nebraska in the 1860s and 70s. It was his legacy of plant knowledge that led the author to her career in plant systematics.

9. Mirabilis gracilis (Standl.) Le Duc, comb. & stat. nov. (Pl. 3-D; Fig. 8). *Mirabilis jalapa* var. *gracilis* Standl., Contr. U.S. Natl. Herb. 12:367. 1909 TYPE: MEXICO. SINALOA: vicinity of Culiacan, 17 Sep 1904, *T.S. Brandegee s.n.* (HOLOTYPE: UC!).

Herbaceous or suffruticose perennials, erect, 75–100 dm high, much branched, roots tuberous. Stems slender or stout, glabrous or with pubescence restricted to 2 longitudinal lines, lower internodes 10–12 cm long, (occasionally 28–30 cm), the nodes ± villous. Mid-stem leaves: petiole slender, 1.5–3.0 cm long; blade 6–9 cm long, 3.0–4.5 cm wide, thin, dark green, glabrous, deltoid-ovate, ovate, base asymmetrical, truncate, apex acuminate, margin minutely ciliolate. Inflorescences terminal few-flowered cymes, subtended by short-petioled, small leaves. Involucre campanulate, 8–10 mm long, glabrous, lobes 4–5 mm long, triangular, apices acute, margin ciliolate; ultimate peduncles ca. 3 mm long, villous. Perianth 6.0–6.5 cm long, glabrous, fragrant, white, salverform, tube ca. 3 mm in diameter, limb ca. 2.5 cm broad. Stamens exserted, 8–9 cm long, lavender. Anthocarp dark brown, broadly obovoid to oval, 9–10 mm long, 4–5 mm wide, 5 angled, warty, pubescent, base constricted and truncate, apex acute.

Phenology.—Flowering from late July to October. Flowers open in the evening.

Distribution (Fig. 2).—Mostly Pacific slopes of the Sierra Madre Occidental and Sierra del Sur; Chihuahua to Michoacán, Mexico, occasionally in mts. of the Central Plateau; in tropical short tree or deciduous forest, partial to full shade, most often at the foot of a cliff. Altitude 100–2000 m.

Representative specimens: MEXICO. **Chiapas:** along Hwy 190 in Zinacantán paaje of Multajoc, Mpio Ixtapa, *Breedlove 13995* (F). **Chihuahua:** Guasaremos, Río Mayo, *Gentry 1549* (CAS, F, GH, MO, UC). **Guerrero:** Campo Morado, Otatlan, *Hinton 14489* (LL, MICH, NY, UC). **Jalisco:** 4.5 mi N of El Rincon, Hwy 80, *Le Duc & Sydor 71* (TEX); Chamela, Estación de Biologia Chamela, UNAM. *Magallanes 3822* (F, MEXU). **Mexico:** 5 mi SW of Santo Tomás de los Plátanos (19.09N, 100.2W), *G. Webster 21189* (MEXU). **Michoacán:** Huizontla, Dist. Coalcomán, *Hinton 15970* (LL, MICH, NY, RSA, UC). **Oaxaca:** Presa Temazcal, Vertederos de le presa, Distr. Tuxtepec, *Cortés, L y R. Torres 49* (MEXU). **Queretaro:** Mpio of Landa de Matamoros, Tangajo, ca. 15 km W of Santa Ines, *Fernández 3153* (NY).

This species closely resembles *M. jalapa*, but differs in the few-flowered inflorescences, the perianth slightly longer, the stamens well exserted, and lavender rather than the same color as the perianth. The large anthocarp with its unique sulptured topography is unlike any other within the section *Mirabilis*.

10. Mirabilis jalapa L., Sp. Pl. 177. 1753. *Jalapa congesta* Moench, Methodus 508. 1794. *Nyctago versicolor* Salisbury, Prodr. Stirp. Chap. Allerton 57. 1796. *Nyctago jalapae* De Candolle, Fl. Franç. 426. 1805. TYPE: locality and collector unknown, probably from cultivated material obtained originally in Mexico or the West Indies.

Fig. 8. *Mirabilis gracilis* habit and details from holotype showing: upper leaves and flowers with an enlarged detail of the anthocarp.

Herb. Clifford 53, Mirabilis 1[eta] (LECTOTYPE: BM! designated by Le Duc, in Regnum Veg. 127:67.

Mirabilis odorata L., Cent. Pl. 1:7. 1755. *Mirabilis dichotoma* L., Sp. Pl. 252. 1762. (The reference Amoen. Acad. 4:267 in the original description, is a citation of the reprint of the original description of *M. odorata*). *Jalapa dichotoma* Crantz, Inst. Rei Herb. 2:266. 1766. Crantz references the illustration on p. 90 of Clusius, Rar. Pl. Hist., pt. 2. 1601. He makes no references to specimens examined. This is possibly meant to be a nov. comb. of *M. dichotoma*. *Jalapa undulata* Moench, Methodus Suppl. 196. 1802. (Moench reference to *M. dichotoma* L.). *Mirabilis jalapa odorata* (L.) Heimerl, Bot. Jahrb. Syst. 21:616. 1896. TYPE: MEXICO. 240.1. (LECTOTYPE here designated: LINN). Original material includes the specimen 240.1 which was annotated *M. odorata* by Linnaeus. He later crossed through this annotation and added *dichotoma*, the superfluous 1762 name.

Nyctago mirabilis J.St.-Hil., Expo. Fam. Nat. 1:212, t. 37. 1805. TYPE: not located, if any. Illustration t. 37 published with the original description here designated as lectotype.

Mirabilis pedunculata Stokes, Bot. Mat. Med. 1:311. 1812. In his protologue Stokes mentions a garden grown plant and makes reference to *M. jalapa* L., Sp. Pl. 252. 1762. TYPE: cultivated garden plant, collector and location unknown.

Mirabilis divaricata Lowe, Trans. Cambridge Phil. Soc. 17. 1831. TYPE: cultivated and escaped garden plant on the islands of Madeira and Porto Santo, 1831. No collections were cited. If Lowe actually collected a voucher, then the specimen is probably at BM or K.

Mirabilis procera Bertol., Novi Comment. Acad. Sci. Inst. Bononiensis 3:15. t. 1. 1839. *Mirabilis jalapa* var. *procera* (Bertol.) Choisy in DC., Prodr. 13:428.1849. TYPE: cultivated plant (HOLOTYPE: BOLO?; LECTOTYPE here desiginated: illustration t. 1 in lieu of a specimen).

Mirabilis planiflora Trautv., Bull. Acad. Imp. Sci. Saint Petersbourg 6:216. 1840. *Mirabilis jalapa* var. *planiflora* (Trautv.) Choisy in DC., Prodr. 13:428. 1849. TYPE: cultivated plant, Kiev Botanical Garden. (HOLOTYPE: KW).

Trimista laevigata Raf., Autik. Bot. 1:12. 1840. TYPE: not located, if any. Rafinesque did not cite a specific collection. He did mention plants from Central America and "In particular one plant with characteristics that blend in with *Nyctago jalapa*." Originally published as *T. levigata*, undoubtedly a printing error.

Mirabilis ambigua Trautv., Linnaea 15: Lit. Ber. 97. 1841. *Mirabilis jalapa* var. *ambigua* (Trautv.) Choisy, in DC. Prodr. 13:428. 1849. TYPE: cultivated plant, Kiev Botanical Garden, 1840 (HOLOTYPE: KW).

Mirabilis jalapa subsp. *ciliata* Standl., Contr. U.S. Natl. Herb. 12:368. 1909. TYPE: MEXICO. OAXACA: valley of Oaxaca, 1 Oct 1894, *Smith 791* (HOLOTYPE: MO!).

Mirabilis jalapa subsp. *lindheimeri* Standl., Contr. U.S. Natl. Herb. 12:368. 1909. *Mirabilis jalapa* var. *lindheimeri* (Standl.) Standl., Rhodora 38:405. 1936 *Mirabilis lindheimeri* (Standl.) Shinners, Field & Lab. 19:173. TYPE: U.S.A. TEXAS. Comal Co.: New Braunfels, Jun 1846, *Lindheimer 158* (LECTOTYPE here designated: MO!). Several Lindheimer sheets exist at MO, some of these annotated by Standley; but these are variously dated and apparently reflect a collage of collections. I have selected one of the sheets annotated by Standley as a lectotype.

Mirabilis jalapa subsp. *volcanica* Standl., Contr. U.S. Natl. Herb. 12:367. 1909. TYPE: MEXICO. DISTRITO FEDERAL: Pedregal (lava beds), valley of Mexico, 19 Aug 1896, *Pringle 6433* (HOLOTYPE: MO!; ISOTYPES: GH!, US!).

Herbaceous or suffruticose perennials, erect, 0.5–1.0 m high, much branched, roots tuberous. Stems slender or stout, glabrous, puberulent or rarely short-villous, sometimes viscid. Mid-stem leaves: petiole slender, 0.3–5.0 cm long; blade 4–14 cm long, 2.0–8.5 cm wide, thin, bright-green, glabrous or rarely puberulent, ovate-deltoid, broadly ovate, ovate-oblong, or rarely lance-ovate, base subcordate to truncate and asymmetrical, apex acute to attenuate, margin usually ciliolate. Inflorescences terminal glomerate many-flowered cymes subtended by numerous reduced leaves. Involucre campanulate, 7–15 mm long, glabrous, puberulent, or short-villous, lobes longer than tube, linear-lanceolate to lance-ovate, acute to attenuate, margin usually ciliolate; ultimate peduncles 1–2 mm long or wanting. Perianth 3.0–5.5 cm long, purplish-red, white, yellow, orange, or variegated, glabrous or sparsely villous, tube 2–5 mm in diameter, gradually dilated upward, the limb 2.0–3.5 cm broad, lobes shallow and broadly rounded. Stamens same length as perianth or occasionally exserted 1–2 cm beyond the perianth, white or the same color as perianth. Anthocarp dark-brown or black, elliptical, obovoid, oval to round, 7–9 mm long, 5 angled, warty or rugose, glabrous or puberulent, base truncate. Chromosome number $n = 29$ (Kruszewska 1961).

Phenology.—Flowers from May to November, or year round in cultivation in areas that receive no freezing temperatures. Flowers open in the evening around 4 p.m. and close the following morning.

Distribution (Fig. 9).—In Mexico found cultivated in most villages and towns, though often seen as escaped, persisting long after abandonment. Selected strains of *Mirabilis jalapa* have become ubiquitous weeds through out the tropical and subtropical areas of the world. Altitudes mainly 100–3000 m.

Representative specimens: MEXICO. **Chiapas:** Mpio Ocosingo, ruins of Yaxchilan, on banks of Río Usumacinta, *Breedlove 33906* (TEX); San Juán Chamula, *Santiz-Ruiz 970, 829* (TEX). **Distrito Federal:** Pedregal, *Pringle 6433* (F, MEXU, NY, UC); Pedregal, *Lyonnet 129* (G, MEXU, MO, NY); Xochimilco, *Ventura 1579* (MEXU, NY, RSA). **Chihuahua:** Mojarochic, *Knobloch 5289* (F); Mpio Tuxtla Chico, Monte Grande, *Ventura & Lopez 1656* (MEXU, NY); Amatenango del Valle, *Breedlove 14444* (LL, MICH, NY); between San Richardo & Ocezucuantla, *Nelson 2987* (G). **Colima:** Rancho El Jabali 22 km NNW of Colima at Jalisco line, Hacienda San Antonio NW of Lago El Jabali, *Garcia et al. 8208* (RSA, TEX). **Durango:** vicinity of City of Durango, *Palmer 630* (F, GH, MO, NY, UC); Mpio de Santiago Papasquiaro, 3.5 km W of La Soladad, 11 km NW Santiago Papasquiaro, *Diaz 824* (NY); Mina la Amparo 6 km NW of Las Higueras, Mpio de Rodeo, *Torres et al 4225* (RSA). **Guanajuato:** near Guanajuato, *Kenoyer 1755* (G). HIDALGO: Río Tula, Ixmiquilpan, *Moore 3369* (G); Rd N of Mineral (Real) del Monte, *Straw & Gregory 1126* (MICH, RSA). **Jalisco:** Valle de Guadelupe, Hwy 80, *Le Duc & Sydor 42* (MEXU, TEX); 3 mi N of Tapalpa, *Walker 78H40* (NY); Mpio Tuxpan, near Colima, *Fuentes 551* (MICH). **Mexico:** Texcoco, *Runyon 1362* (TEX); Temple of Quetzalcoatl, *Barkley et al.*

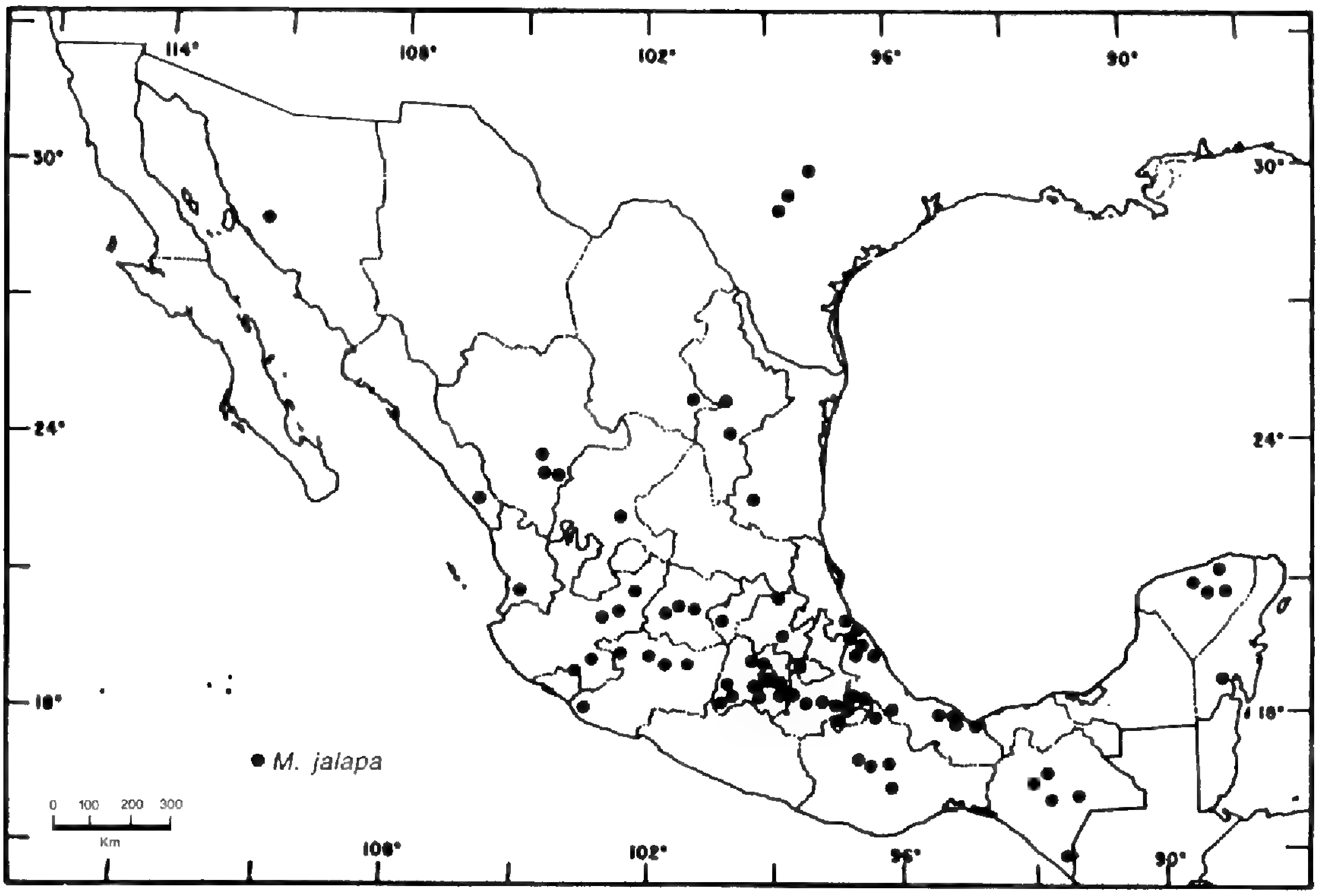

FIG. 9. Distribution of *Mirabilis jalapa* in Mexico and Texas.

7259 (TEX); Hwy 54, 6 mi N of Ixtapan del Sal, *Le Duc & Sydor 94, 96* (MEXU, TEX); Molino de la Flor, Texcoco, *Matuda 18936* (F); Mpio Temascaltepec, Tejupilco, *Hinton 4385* (G, MICH, NY). **Michoacan:** ca. 4.5 mi E of Maravato, *Soule 2472* (TEX); Patzcuaro, near Hotel Don Vasco, *Le Duc 14* (TEX); Hwy 14 Patzcuaro to Morelia, *Le Duc & Sydor 90, 91* (MEXU, TEX); 5 mi W of Cd Hidalgo, *Sauer 1110* (UC). **Morelos:** Along trail from town of Tepotzlan to ruins, *Ayers & Scott 111* (TEX); Cuernavaca, pyramids of Teopanzolco, *Leon MX001* (RSA). **Nayarit:** near Tepic, *Rose 2131* (US). **Nuevo Leon:** Hacienda Pabillo, Galeana, *Taylor 116-B, 116-a* (F, TEX). **Oaxaca:** Valley of Oaxaca, *Smith 791* (F, NY); 5.5 km adelante de San Pedro Jocotipac, Dist. Cuicatlán, *Salinas 4335* (TEX); 10 mi W of Mitla, *Rowell et al 17M485* (TEX); Hwy 175, village of Guelatao, *Le Duc & Sydor 127* (TEX); Yegul, *Le Duc & Sydor 109* (TEX); Monte Alban, in the ruins, *Le Duc & Sydor 107* (TEX); Yanhuitlán at Dominican Monastery, *Le Duc & Sydor 106* (TEX). **Puebla:** Tehuacan 4 km al E de Azumbilla, *Sanchez-Ken 252* (TEX); Meseta de San Lorenzo, *Salinas F-4010* (TEX); Puebla, *Arène s.n.* (NY); San Luis Tultitlanapa, *Purpus 3375, 3522* (UC); Tehuacán, *Chaing et al. 2364* (RSA, TEX). **Queretaro:** Querétaro, *Arsène & Agniel 10526* (F, MO). **San Luis Potosi:** Mpio San Antonio, Tanjasnec, *Alcorn 3332* (TEX); 2 mi S of rte. 70 on road to Zaragosa, *Moran 7650* (MICH, RSA). **Sinaloa:** near Mazatlán, *Rose et al. 13767* (US). **Sonora:** Las Tierritas de El Temblor, Sierra El Tigre, *White 3400* (G, MICH). **Tabasco:** Mpio Huimanguillo, El Arenal, *Ventura 20043* (GH). **Tamaulipas:** 54 mi S of Cd. Victoria, Hwy 85, *Wilson 12278* (TEX). **Tlaxcala:** Tlaxco, *Azcárraga s.n.* (TEX). **Veracruz:** Hwy 125 to Jalapa, junct. with rd to Jalcomuco, *Le Duc & Sydor 159* (TEX); Mpio Altotonga, *Dodds 48* (MICH, NY); Mpio Perote, Tolalco, *Ventura 9163* (LL, MICH); Baños del Carrizal, *Purpus B5494* (UC); Biological Stat. Los Tuxtlas, *Gomez-Pompa 4613* (G); Vista Hermosa, Jilotepec, *Ortega 579* (F); Coatepec, *Pedraza & Ortega 297* (F). **Yucatan:** Izamal, *Gaumer 548* (F); Chichen Itzá, *Steere 1479* (F, MICH); Xocén, Mpio Vallodalid, *Acosta 238* (RSA).

Zacatecas: 10 mi W of Fresnillo on rd to Valparaiso, E of Santa Cruz 15 km, *Anderson & Lskowski 3587* (G, MICH, NY,US).

U.S.A. TEXAS. **Comal Co.:** New Braunfels, *Lindheimer 1103* (TEX). **El Paso Co.:** El Paso, *White 13* (TEX). **Travis Co.:** Austin, *Ferguson s.n.* (TEX).

Mirabilis jalapa is an exceedingly variable species, typical of a horticulturally important plant. Emmart (1940) shows that *M. jalapa* was cultivated by the Aztecs for its medicinal properties and for its showy fragrant flowers, long before the Spanish conquest of Mexico. Collections of *M. jalapa* were introduced into England within 75 years of the Conquest. By the time of Linnaeus (1753, Species Plantarum), the plant had been in cultivation in Europe for about 200 years. The specimens from which the species was described were those of cultivated plants. The numerous early synonyms are a result of attempts to seggregate the various cuultivated strains. Considerable propagation of the species had been done and many plants were well established in Aztec gardens before the Conquest (i.e., prior to 1521). In all my field work in Mexico, I have never seen any population that was not in cultivated or formerly cultivated areas (herbarium collections from remote areas ascribed to *M. jalapa* have on closer examination proved to be misidentified.) It is questionable whether there is any extant population that represents a true wild progenitor. Today, distribution of the species, in Mexico, encompasses all areas which were part of the Aztec empire and sphere of influence, particularly around ancient ruins. It is also dominant in the towns and cities established by the Spanish during the colonial period.

Names applied to putative hybrids between *M. jalapa* × *M. longiflora*

Mirabilis hybrida Lepeletier, Ann. Mus. Natl. Hist. Nat. 8:481. 1806. Type: Cultivated in the garden of M. Lepeletier, 1806. Apparently no voucher collection was made. Lepeletier's plant was grown from seed received from M. Fabus d'Attichy of Champagne, France, who found a single natural hybrid in his garden in 1802.

Mirabilis jalapa var. *oaxacana* Heimerl, Notizbl. Bot. Gart. Berlin-Dahlem 11:450. 1932. Type: MEXICO. Oaxaca: ca. the city of Oaxaca, 1842, *Franco s.n.* (holotype: W destroyed, photoholotype: F!; isotype: F!). The holotype was destroyed during the war in 1945, pers. comm., Harald Riedl, Director W. There is a photograph of the holotype and fragmentary material at F. The name *Mirabilis oaxacae* Heimerl is a nomen nudum which appeared in Beitr. Syst. Nyctag. 20. 1897, and is therefore not valid.

Considering the site from which the above referenced entity was obtained, and its apparent intermediate morphology, it is presumed to be of hybrid origin. The foliage resembles *M. jalapa*, but the floral characters resemble those of *M. longiflora* var. *longiflora*. It differs from both, in having an obovoid anthocarp with prominent ridges and warty areas. The anthocarps of *M. longiflora* var. *longiflora* are warty throughout, with indistinct ridges, while those of *M. jalapa* are ovoid or elliptical.

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APPENDIX

Additional Specimens Examined

Abrigo, R. s.n.(10)
Alcorn, J. 1401, 2973(10)
Arguelles, E. 1083(5b), 1145(5b), 2648(10)
Arsène, G. s.n., 1675(10)
Ascencio, M.A. 74(10)
Avila, S. 135(10)
Balls, E. B 5494(10)
Barkley, F.A. 14/a521(5b), 16024(5b)
Barneby, R.C. 5112(5b)
Bartlett, H.H. 12381(10)
Beals, J.M. s.n. (5b)
Benito, S. 21(10)
Bingham s.n. (5b)
Blakley, E.R. B-567(5b)
Blumer, J.C. 2190(5b), 2205(5b)
Bossé, G. 7860(10)
Bonilla, R. & E. Monsalvo 30(10)
Bourgeau, M. 61(10)
Brandegee, T.S. s.n.(2)
Breedlove, D. 10439(10), 14643(10), 47494(10)
Burger, W. & T. Antinio 10939(10), 10855(10)
Bush, B.F. 1209(10)
Bustillo, S. 219(10)
Cabrera, E. & O. Tellez 2398(10)
Caec & Seler 53(10)
Caldron, S. 1800(10)
Calzada, J. 7575(10)
Calzada, J.F. et al. 6315(10)
Campos, A. & G. Toriz 3209(7a)
Carlson, M.C. 109(10)
Castrejón, J. 6(10) 23(10)
Chiang, F et. al. 12267(5b), 9551F(5b)
Conzatti 136(10)
Correll 33672(5b)
Correll, D.S. & I.M. Johnston 19952(10), 20192(5b)

Cory, V.L. 9410(5b), 52390(10)
Coues, E. & E. Palmer 168(5b)
Croat, T. 44151(10)
Crutchfield, J. R. 2120(5b)
Cruz-Cisneros, R. 722(10)
Darrow, R.A. et al. 1282(5b)
Davidson, A. 753(5b), 855(5b)
Diaz, I. 395(10)
Diego, N.P. 68(10)
Dillon, M. et al. 1833(10)
Dunn, D. et al. 23305(10)
Dziekanowski et al. 1968(10)
Edwards, & Eaton s.n.(10)
Elias, T. et al. 9060(5b)
Engelman s.n.(5b)
Epling, C. & Stewart s.n.(5b)
Ferris, R.S. & C.D. Duncan 2519(5b), 2579(5b)
Fisher, G.L. 2113(10)
Flores et al. 1713(10)
Gandara, J.M. & J. Dorantes 146(10)
Garcia, E. s.n.(5b)
García-Saucedo 2589(10), 2635(5b)
Gaumer, G.F. 1843(10), 1842(10), 1843(10), 548(10)
Genelle, P. & G. Fleming 886(10)
Gentle, P. 814, 815, 832(10)
Gentry, H.S. 212(5b), 1911, 588M(10), 672M(10), 10993(1)
Gloyd, L. 14527(5b)
Gomez-Santiz, F. 185(10)
Gonzalez, G. 15(10)
Gonzalez-Medrano 7339(4)
Gonzalez, V. 53(10)
Gooding, L. 548-58(5b); 273-62(5b)
Graham, H.W. s.n.(5b)
Grant, V. 586(10)
Greene, E.L. s.n.(5b); 12511(5b)
Greenman, J.M. & M.T. 5777(10)
Gregg, J. s.n., 344, 231(10)
Guzman, M. & D. Castro 1406(10)
Guzman, R. 881(1)
Hansen & Nee 1718(10)
Hanson, C.A. 507(5b), 503(5b)
Harde Le Sueur 613(5b)
Harker & Mellowes 168(10)
Harrison, G.J. & T.H. Kearney 5818(5b)
Heller, A.A. 1881(10)
Hernandez A. C. 621(10), 5(10)
Hernandez, C. et al. 171(10)
Hernandez, H. 28(10)
Hinkley & Warnock 46821(5b)
Hinkley s.n., 3168, 129(5b)
Hinton, G., et al. 20491(5b), 4356(1), 10297(7a)
Hinton, G.B. 4577(10), 4742(10), 1333(10), 4644(10), 6554(10), 631(10)
Holzinger, J.M. s.n.(5b)
Hood, J.T. s.n.(5b)
Hynes, M. s.n.(10)
Illescas, M. & O. Sparza 59(9)
Inzunza, F. 74(10)
Janzen, D. s.n.(10)
Jermy, G. s.n.(10)
Jimenez A., R. 0005(10), 00038(10)
Jones, M.E. s.n. (5b)
Jones, W.W. 194(5b); 386(5b); 178(5b); 256(5b)
Kelly, I. 984(10)
Kenoyer, L.A. s.n., A600(10)
King, R.M. & T. Soderstrom 4616(10)
Kunze 39(5b)
Kusche, J. s.n.(5b)
Lavin, M., et al. 4850(9)
Laughlin, R. 734, 2828(10)
Le Duc, A. & M. Sydor 75(10), 45(10), 46(10), 74(10), 158(10), 127(10), 90(10), 171(10), 42(10), 159(10), 47(10)
Le Duc, A. et al. 255(7b)
Leavenworth, W.C. 911(5b)
Lehto, E. & T. Reeves P12426(5b)
Lemmon s.n. 2867(5b)
Lindheimer 567(10)
Loew, D. s.n. (5b)
Loomis, H.F. 7267(5b); 1267(5b)
Lopez, R. & J. Villarreal 902(5b)
Lot, A. 333(10)
Luckow, M. et al. 13238(5b)
Lundell, C.L. 876(10)
Lyonnet, E. 985(5a)
Mac Daniels, L.H. 688(10)
MacDougall, T. s.n. (7a)
Mainland & Barkley 14T770(5b)
Makrinius, E. 853(10)
Martinez, E. et al. 19902(10)
Martinez-Calderon, G. 1431(10), 1758(10), 1539(10), 1531(10)
Massey, J. & W. Hess 1791(5b)
Matinez, E.M. 1287(1), 363(10)
Matuda, E. 621(10), 21086(5a)
Mayfield, M. et al. 131(5b)
Mc. Dougal, D.T. s.n.(5b)
McDowell, T. 938(10)
Mearns, E.A. 682(5b); 2359(5b), 2052(5b)
Medellin L., F. 404(10)
Medina, M. 2101(10)
Mendoza, A. s.n.(10)
Messer, E. 72/54(10)
Metcalfe 432(5b); 855(5b); 1187(5b)
Millspaugh, C.F. 36(10)

Moldenke, A.L. & H.N. 29743(10)
Montellano, H. 25(10)
Moore, R.C. 48(5b)
Moreno, P. 867(10), 6456, 6339(10), 6276(10), 4754(10), 6373(10)
Moreno G., S. 245(10)
Mulford, I. 717(5b)
Murrieta G., Y. 46(10)
Nee, M. & G. Diggs 24565(10)
Nelson, E.W. 1314(10)
Nevling & Gomez-Pompa 2212(10)
Nicolas s.n. (10)
Nuñez, J. 5262(10)
Orcutt, C.R. 4122(10)
Ortega et al. 1257(10), 1955(10)
Ortega, R.V. 579(10), 313(10), 1956(10), 1957(10), 1870(10)
Ostero, J. M 16(10)
Pachero, M. 8(10)
Palmer, E.J. 631(10)
Palmer, J. 29561a(10), 31838(5b)
Parks, H.B. Rx1315(10), 1312(10)
Parry, C. & E. Palmer 775(10)
Peebles, R.H. et al. 2641(5b); 2785(5b)
Pedraza & Ortega 297(10)
Pedraza, R.A. 284(10)
Pennell, F.W. s.n.(4)
Pennington, C.W. 184(5b), 600(5b), 63(5b)
Phelps, A. 73(5b)
Pinkava, D.H. et al. P12426(5b)
Powell, A. M. et al. 1454(5b)
Powell, A.M. & S.A. 4944(5b)
Price, W.W. s.n.(5b)
Purpus, C.A. 10584(10) 49(5a)
Ramos, C.H. 285, 108(10), 283(5a)
Rebolledo Velez, A. s.n.(10)
Reverchon, J. 1586(10)
Reyes S., J. 236(10)
Richter, L. s.n.(10)
Riskind, D.H. & T.F. Patterson 1818(5b)
Robbins, S.B. 6258(10)
Rosas, M. 875(10)
Rose, L.S. 65115(10)
Rothnoch, J.T. 359(5b)
Rowell, C.M. et al. 17M668(10)
Rubio, 330(10), 1235(9)
Runyon, R. 5743(10) s.n.(10)
Rusby, H.H. 350(5b)
Rzedowski 19082(9), 29377(5b), 19326(10), 19082(10), 25(10)
Salinas T., A 4495(10), 4743(10)
Sanders, A.C. et al. 8367(10), 8208(10)
Sandino, J.C. 328(10)
Santiz-Cruz, E. 705(10)
Sartwell s.n. (5b)
Saunders, J.L. s.n.(10)
Saynes V., A. 819(4); 430(4), 902(4)
Schery, R.W. 103(10)
Schiefer, H.P. 110(10)
Servin 462(9)
Sessé & Mociño, 5407(10), S402(1)
Setchell s.n.(5b)
Seymour, F.C. 3478(10), 3394(10)
Shelton, M.G. 107(5b)
Shreve 5023(5b)
Smith 518(5b)
Smith, C.E. & S. Kitchen 4819(7a)
Smith, L. 773(10)
Smith, J.D. 6737(10), 2019(10), 1731(10)
Smith, R.F. M563(5b)
Sohmer, S.H. 9398(10)
Solbrig & Ornduff 4514(10), 4513(10)
Solheim & Reisfield 1445(10)
Solís, F. 245(10), 27(10), 74(10), 99(10)
Soria, G. s.n.(10)
Soule, J. 2345(10)
Soya, D. & A. Grijalva 167(10)
Spellenberg, R. 3832(5b)
Spellenberg, R. & N. Zucker 8242(5b)
Standley, P.C. & E. Padilla V. 3168(10), 3750(10)
Standley, P.C. 88758(10), 70775(10), 64284(10), 64613(10), 22066(10), 23758(10), 77821(10), 76502a(10), 75427(10), 78914(10), 20584(10), 19287(10)
Stevens, W.D. & B.A. Krukoff 7026(10), 3449(10)
Stevenson, J. & T. Bradley 3354(10)
Stewart, R.S. 2501(5b)
Steyermark, J. 34449(10), 42173(10)
Streets, R.B. s.n.(5b)
Swallen, J.R. 2526(10)
Templeton, B. 8741(10)
Thurber, G. 90(5b); s.n.(5b); 212(5b)
Tlapay Ubierna 1088(10)
Ton, A.S. 2899(10)
Torres, R. 101(10)
Toumey 395(5b)
Tun Ortiz, R. 788(10)
Valerio, M. 1304(10)
Vazquez, L. 758(10)
Vazquez, M. V-1973(10)
Vazquez, T. V. 97(10)
Ventura, A. 1759(10)
Ventura, E. & Lopez 2485(10), 493(10), 1309(10), 6102(10), 6100(10)
Ventura, E. 790(10)
Ventura, F. 9854(10), 4065(10), 11844(10), 1031(10), 19188(10), 1132(10)

Vibrans, H. s.n.(10)
Vidaurri, G. 33(10)
Villarreal, J.A. & M.A. Carranza 1734(5b)
Von Rozynski, H.W. 185(10)
Warnock T. 633(5b), 2324(5b)
Waterfall, U.T. 15539(5b) 12891(5b)
Waterfall, U.T. & C.S. Wallis 13480(5b), 13760(5b)
Wagenbreth, 643(10)
Weller, S. 654(10)
West, R. H-6, I-14(10)
Whiffin, T. & E. Rodriguez. 212(10)
Wilcox, T.E. s.n.(5b)
Wieder et al. 200, 33(10)
Wilkinson, E.H. 134(10), 1900(10)
Wilson J. et al. 8566(5b)
Wilson, J. 12281(10)
Wolff, S.E. 223(10)
Wooten, E.O. s.n.(5b)
Worthington, R.D. 13439(5b)
Wright, C. s.n. (10), 408, 595(5b), 1073(5b,) 1072(5b)
Young, s.n.(5b)
Yuncker, T.G. et al. 5663(10), 8795(10)
Zelaya, H. M. 2315(10)
Zola, M.G. 548(10), 783(10), 760(10)

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THE GENUS *CLUSIA* SECTION *CRIUVA* (CLUSIACEAE) IN GUAYANA

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ABSTRACT

The genus *Clusia* section *Criuva* is revised for species within the Guayana Floristic Province. Eleven species are recognized, of which five, *Clusia grammadenioides* Pipoly, *C. multilineata* Pipoly, *C. asymmetrica* Pipoly, *C. maguireana* Pipoly, and *C. guayanae* Pipoly are described as new, illustrated, and their phylogenetic relationships are discussed. Amplified descriptions are provided for the section and each hitherto known species, along with keys to the species within the section, and citation of representative specimens. *Clusia reducta* is reduced to synonymy under *Clusia opaca* and *Clusia hexacarpa* subsp. *ptaritepuiana* is reduced to synonymy under *C. hexacarpa.*

RESUMEN

Se presenta una revisión taxonómica del género *Clusia* sección *Criuva* para las especies procedentes de la Provincia florística Guayanesa. Se reconocen once especies, dentro de las cuales hay cinco, *Clusia grammadenioides* Pipoly, *C. multilineata* Pipoly, *C. asymmetrica* Pipoly, *C. maguireana* Pipoly, y *C. guayanae* Pipoly que se describen como nuevas, se ilustran y se discute su parentesco. Se ofrecen descripciones ampliadas para la sección y especies previamente conocidas; también se presentan claves para identificar las especies dentro de la sección, y un listado de especímenes representativos. Se reduce *Clusia reducta* a la sinonímia bajo *C. opaca* y *C. hexacarpa* subsp. *ptaritepuiana* bajo *C. hexacarpa.*

INTRODUCTION

While preparing a diagnostic treatment of the genus *Clusia* L. for the *Flora of the Venezuelan Guayana* and a more comprehensive one for *Flora de Colombia*, section *Criuva* was revised. This synopsis treats the species of section *Criuva* indigenous to the Guayana Crystalline Shield (sensu Maguire 1979), and provides descriptions, synonymy, specimen citations distributions, hypotheses of phylogenetic relationships, ecology and conservation status for each Guayana species of the section.

Section *Criuva* is closely related to sections *Stauroclusia* Planch. & Triana

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and *Clusiastrum* Planch. & Triana, (Engler 1888, 1893; Vesque 1893), but easily distinguished from both by the staminodes with well-developed anthers, abruptly widened and connivent basally. While Engler (1888, 1893) felt that *Criuva* was most closely related to *Criuvopsis* Planch. & Triana, his classification was based mostly on petal number rather than on some qualitative feature. Pipoly and Graff (1995) have indicated that the most closely related group to section *Criuvopsis* is section *Brachystemon* Engler. Because the formats of the floristic treatments in preparation do not allow for complete descriptions and synonymy, the present treatment is intended to provide data for the Guayana taxa over their entire range, until a more comprehensive revision is prepared.

TAXONOMIC TREATMENT

Clusia L. section **Criuva** Planch. & Triana, Ann. Sci. Nat. sér 4, 14: 325. 1860.

Clusia sect. *Criuva* subsect. *Eucriuva* Engler in Martius, Fl. Bras. 12(1):406. 1888.
Clusia subgenus *Criuva* Benth. & Hook. section *Eucriuva* (Planch. & Triana) Engler, Pflanzenfam.3(6):225. 1895.

Free-standing terrestrial shrubs, trees or hemiepiphytes; latex creamish yellow to translucent, when translucent, oxidizing to yellow. Leaves sessile or petiolate; petioles canaliculate, marginate or trigonal. Inflorescence a terminal pyramidal panicle of cymes, a reduced compound axillary cyme or rarely, a solitary terminal flower, often subtended by foliaceous bracts; secondary inflorescence bracts carnose or cartilaginous; bracteoles 2–4(–14), coriaceous, carnose or cartilaginous. Staminate flowers with spreading perianth; sepals 4–8, coriaceous or chartaceous, the outer opposite, the inner decussate, imbricate or contorted; petals 4–6, coriaceous, carnose or cartilaginous, the outer opposite, the inner decussate, imbricate, or contorted, usually progressively smaller acropetally; androphore rectanguloid, pentagonoid or rarely cubic; stamens numerous, the filaments apically free, connate at the base, fleshy, often thickened at the base; the filaments flat, anthers muticous, rounded or emarginate, equalling or shorter than the filaments, the thecae clavate, oblong or linear, slightly longer than the connective, dehiscent by longitudinal slits; pistillode absent or rarely, vestigial, usually without resin. Pistillate flowers as in staminate; staminodia 4-numerous, free, linear,with vestigial anthers; ovary 4–8 locular, one to multiovulate, ovule placement variable; styles obsolete or equalling locules in number, free, terete or angled, thickened, radiate, stigmas subpeltate, orbicular, ovate, cuneiform or pentagonal. Fruit a dehiscent capsule, ovoid, oblongoid, prismatic or fusiform, stigma and styles persistent.

TYPE SPECIES: *Clusia criuva* Cambessèdes in A. St.-Hilaire, Fl. Bras. Merid. 1:245. 1825.

KEY TO SPECIES OF *CLUSIA* SECTION *CRIUVA*

1. Leaf blades chartaceous to subcoriaceous, dull above, pallid below, the apices acute to acuminate, bearing round, magenta glands abaxially.
  2. Apical portions of branchlets decussately alate; leaves sessile or on broadly marginate; petioles, 0.5–1.0 cm long.
    3. Leaves 1.5–4.0 cm wide, sessile; peduncle 2.0–3.5 cm long; sepal margins opaque; entire .... 1. *C. duidae*
    3. Leaves 2–6 cm wide, on broadly marginate petioles, 0.5–1 cm long; peduncle obsolete to 3 mm long; sepal margins scarious, hyaline, incised-erose .... 2. *C. grammadenioides*
  2. Apical portions of branchlets subterete to tetragonal, the corners rounded, not alate; leaves on narrowly marginate or trigonal; petioles 1–3.5 cm long.
    4. Branchlets subterete or weakly tetragonal; leaf blades symmetric, liear latex canals conspicuous; petioles marginate, thin, 1–1.5 cm long; sepals 7, without conspicuous latex canals, the outer sepals acute to acuminate apically; petals decussate, thickly carnose, suborbicular; anthers obovoid .... 3. *C. multilineata*
    4. Branchlets strongly tetragonal; leaf blades asymmetric, linear latex canals inconspicous; petioles trigonal, thick, 2–3.5 cm long; sepals 4, linear latex canals conspicuous, the outer sepals rounded apically; petals imbricate, coriaceous, obovate; anthers ovoid .... 4. *C. asymmetrica*
1. Leaf blades stiffly coriaceous to cartilaginous, nitid at least above, the apices obtuse, broadly rounded or truncate, without round magenta glands abaxially.
  5. Leaf blades coriaceous, rarely thickly so, but the secondary veins prominent above and below; inflorescence erect, the rachis flattened; bracteoles numerous, small, similar to the sepals; flowers numerous.
    6. Petioles broadly marginate, 3–10 mm long; leaf blades obovate to very widely obovate, the bases cuneate, fully decurrent to petiole base; inflorescence rachis longitudinally ribbed, not alate; stigmas on persistent styles, ca. 1 mm long; fruit ovoid at first, then fusiform at maturity .... 5. *C. melchiorii*
    6. Petioles canaliculate, 15–25(–28) mm long; leaf blades oblong, elliptic or rhombic, the bases obtuse, not decurrent on petiole; inflorescence rachis narrowly alate; stigmas sessile; fruit subglobose at first, then globose at maturity .... 6. *C. cardonae*
  5. Leaf blades thickly coriaceous to cartilaginous, the secondary veins not easily discernible without magnification; inflorescence pendent, the rachis not flattened; bracteoles few, smaller than the sepals; flowers solitary or in a few-flowered, pyramidal compound cyme.
    7. Petioles broadly marginate; flowers solitary (–3) or in reduced, 6-flowered cymes; stigmas on persistent styles; fruits ovoid to subglobose, strongly ribbed.
      8. Petioles, 6–15 mm long; flowers terminal, solitary; petals obovate to orbicular; staminodes 8–9.
        9. Leaf blades 2.5–4.5 cm wide; bracteoles 3.5–4 mm long; sepal margins not scarious; petals 6; carpels 6–8 .... 7. *C. hexacarpa*
        9. Leaf blades 5–7 cm wide; bracteoles 12–14 mm long; sepal margins scarious; petals 8; carpels 7–10 .... 8. *C. radiata*

8. Petiole obsolete to 6 mm long; flowers in an axillary, branched, 3–6-flowered cyme; petals suborbicular; staminodes 4 .... 9. *C. maguireana*

7. Petioles canaliculate; flowers in 6–18-flowered cymes; stigmas sessile to subsessile; fruits globose, smooth, without ribs.

  10. Leaf blades obtuse to broadly rounded basally; peduncle 3–5 mm long; sepals 4–6, suborbicular; petals coriaceous; staminodes numerous; stigmas orbicular, sessile. .... 10. *C. opaca*

  10. Leaf blades broadly acute to obtuse basally; peduncle 5–12 mm long; sepals 2, oblate; petals cartilaginous; staminodes 4; stigmas pentagonal, subsessile. .... 11. *C. guayanae*

1. **Clusia duidae** Gleason, Bull. Torrey Bot. Club 58:402. 1931. TYPE. VENEZUELA. AMAZONAS: Cerro Duida, slopes of ridge 25, 1,800–2,200 m, (fr), *Tate 429* (HOLOTYPE: NY!; ISOTYPE: F!).

Shrub or small tree to 4 m tall; branchlets decussately short-alate, the wings 1–1.8 mm wide. Leaves petiolate; blades chartaceous to subcoriaceous, oblong or oblanceolate, 6–8 cm long, (1.4–)2.1–4 cm wide, apex acute, base abruptly acute, symmetric, dull above, pallid and bearing round, magenta glands below, midrib slightly prominent above, prominently raised below, secondary veins numerous, prominently raised above and below, united by a submarginal collecting vein, the margin flat, entire, glabrous.; petioles obsolete. Inflorescence terminal, erect, pyramidally paniculate, 5–7(–8) cm long, 6–9 cm wide, the flowers cymose; peduncle 2.0–3.5 cm long; secondary bracts coriaceous, ovate, 2–5 mm long, apex acute, carinate; bracteoles 2, coriaceous, cordate, 2.4–2.6 mm long, 2.5–2.7 mm wide, apex acute to obtuse, base somewhat auriculate, carinate, the margin entire, opaque; not scarious; pedicels angulate, 6–12 mm long. Staminate flowers unkown. Pistillate flowers yellow; sepals 6, coriaceous, suborbicular, 4–6 mm long, 5.2–6 mm wide, apex broadly rounded, carinate, linear latex canals few, inconspicuous, the margin entire, hyaline, scarious; petals 5, coriaceous, acropetally smaller, obovate, the outer pair opposite, 4–4.5 mm long, 3–3.5 mm wide, apex broadly rounded, somewhat cucullate, linear latex canals few, inconspicuous, the margin entire, opaque, not scarious; staminodes 4, linear, 2.2–2.5 mm long, the filaments 1.2–1.5 mm long, 1.3 mm wide at base, the anthers linear, 1 mm long, apex muticous, base obtuse; pistil oblong, 3–3.5 mm long, 2–2.5 mm diam., carpels 4; styles angular, thick, ca. 3 mm long, stigmas orbicular, 1.6 mm long and wide. Fruit prismatic, 15–30 mm long, 6–8 mm wide, costate.

Distribution.—Endemic to the Guayana Crystaline Shield, Duida-Marahuaca Subprovince of Maguire (1979), at 1,225–2,200 m elevation.

Ecology and conservation status.—*Clusia duidae* occurs in mossy elfin forest formations, where it forms mats of interwoven stems. Label data indicate it is locally common, and the fact that its known range falls within national parks indicates that it is probably not threatened.

Representative specimens examined: **VENEZUELA. Depto. Atabapo:** slope of Cerro Marahuaca, upper Río Yameduaka, 03°38'N, 65°28'W, 1,225 m, 17–18 Feb 1985 (fr), *R. Liesner 17603* (BRIT, MO, VEN); Cerro Marahuaca, SE slopes, below Salto Los Monos on tributary of Río Iguapo, at headwaters, 03°35'N, 65°23'W, 1,500–1,600 m, 11 Mar 1985 (pist. fl, fr), *R. Liesner 18533* (MO, VEN), 20 Oct 1988 (fr), *R. Liesner 25135* (BRIT, MO, VEN); Cerro Marahuaca, SW-facing slopes, headwaters of Río Iguapo, S sector of the SE mountain, 03°36'00" N, 65°23'10" W, 1,560 m, 13–14 Oct 1983 (pist. fl, fr),*J. Steyermark 129648* (BRIT, MO, VEN); Cerro Huachamacari, Río Cunucunuma, vicintiy of summit camp, 1,800 m (pist. fl), *B. Maguire et al. 30017* (F, NY, US, VEN).

Clusia duidae appears to be most closely related to *C. grammadenioides*, but is easily distinguished by its sessile leaves with abruptly acute leaf bases, entire sepals, and smaller inflorescence.

2. **Clusia grammadenioides** Pipoly, sp. nov. (Fig. 1)

Ob ramulorum internodiis quadrangulatosque alatos, folia sessila atque canalis resiniferis permanifeste praeditis *C. duidae* valde affinis, sed ab ea ramulis later (non anguste) alatos, foliorum bases sensim largo decrescentes (nec abrupte acutes), petiolos late marginatos 5–10 mm longos (non obsoletos), sepalis secus marginem eroso-dentatis (nec integerrimis), promptem dignoscenda.

Hemiepiphyte, attaching to tree trunks by adventitious roots; branchlets tetragonal, broadly and decussately alate, 3–5 mm diam., the wings 2–8 mm wide, (therefore the stem appearing 8–13 cm diam.), the wings thinly cartilaginous, glabrous. Leaves petiolate; blades subcoriaceous, narrowly elliptic to obovate, (9.5–)14–19(–25) cm long, (2–)2.5–5(–6) cm wide, apically broadly to narrowly acute, basally long-attenutate, decurrent on the petiole, symmetric, bearing round magenta secretory glands below, without conspicuous latex canals, midrib raised above and below, secondary veins numerous, prominent above and below, united by a prominent submarginal collecting vein, glabrous, the margin revolute, thin, entire; petioles broadly marginate, 0.5–1 cm long, glabrous. Staminate inflorescence erect, terminal, tripinnately pyramidal paniculate, 8–9 cm long, 11–17 cm wide, the flowers cymose; peduncle obsolete to 3 mm long; bracteoles 2, coriaceous, oblate, 1.8–2 mm long, 2.3–2.5 mm wide, apex rounded to obtuse, margin scarious, the band to 0.3 mm, incised with 2–3 incisions, glabrous; pedicel tetragonal, 2.2 mm long, glabrous. Staminate flowers white, cymose; sepals 8, chartaceous, dimorphic, the outer whorl 2, opposite to the bracteoles, oblate, 2.5–2.6 mm long, 3–3.2 mm wide, apex rounded, somewhat cucullate, latex canals consipuous, linear, submarginal, the margin scarious and hyaline, variously incised-erose, appearing serrulate-dentate, the border of 0.5 mm wide, glabrous, the inner whorl 6, imbricate, chartaceous, suborbicular to oblate 3.8–4.2 mm long, 4–5.6 mm wide, apex obtuse, cucullate, the latex canals lineate, prominent, submarginal, the margin hyaline, erose-fimbriate; petals 5, contorted, coriaceous, acropetally smaller, oblong to widely ovate, 4.2–4.6 mm long, 2.4–3.4 mm

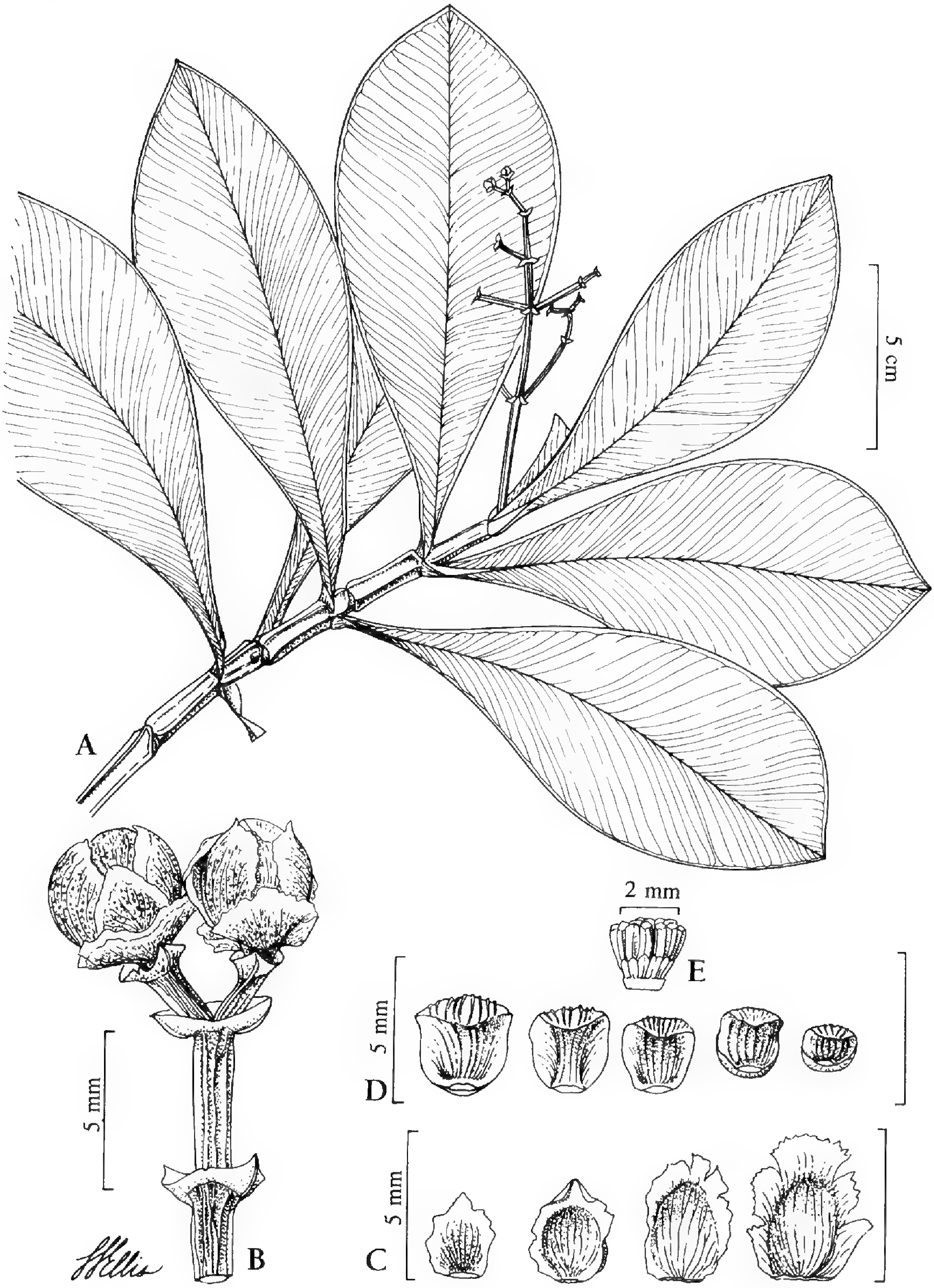

FIG. 1. *Clusia grammadenioides* Pipoly. A. Habit, showing the alate branchlets. B. 2-flowered cyme. C. Sepals, showing the scarious, hyaline, incised-erose margins. D. Petals, showing the linear latex canals, entire margins, and cucullate habit. E. Androphore, and adroecium. A-E, drawn from type.

wide, apex rounded, highly cucullate, not carinate, latex canals very prominent, marginal, the margin hyaline, ca. 0.3 mm broad, entire, glabrous; receptacle concave, without resin; androphore pentagonoid, 2 mm long, 1.5–1.7 mm tall, 1.3 mm wide; stamens 18, 1.7–1.8 mm long, the filaments flat, 0.3–0.4 mmm long, the anthers muticous, 1.4–1.5 mm long, 0.5 mm wide, the apex emarginate, base cuneate, longitudinally dehiscent entire length; the connective medially darkened on both sides; pistillode absent. Pistillate flowers unknown. Fruit unknown.

TYPE. VENEZUELA. AMAZONAS: Huachica, 11 km NE of San Carlos de Río Negro, 1°58'N, 67°03'W, 120 m, 13 Nov 1977 (stam. fl), *R. Liesner & J. Hall 3447* (HOLOTYPE: VEN; ISOTYPES: MO, 2-shts).

PARATYPES: COLOMBIA. CAQUETÁ: Araracuara, 00°37'S, 72°24'W, 10 Dec 1991 (ster.), *J. Duivenvoorden et al. 2673* (BRIT, COAH, COL); Araracuara, Villa Azul, Río Caquetá, left bank, in front of Sumaeta Island, 00°34'S, 72°08'W, 200–300 m, 4 Nov 1989 (ster.), *C. Londoño et al. 1150* (BRIT, COAH, COL, JAUM, U). VENEZUELA. AMAZONAS: 0.5–3 km NE and E of San Carlos de Río Negro, N of airstrip, 01°51'N, 67°03'W, 120 m, 22 Jan 1980 (ster.), *R. Liesner 8576* (MO, NY, VEN).

Distribution.—Amazon Basin of Venezuela and Colombia, in lowland areas of the Guayana Crystalline Shield, at 120–300 m elevation.

Ecology and conservation status.—*Clusia grammadenioides* occurs along steambanks on terraces just above floodline at forest margins on deep white sands. Because these areas are in such close proximity to major, frequently travelled river systems, this species should be considered threatened.

Etymology.—The epithet "grammadenioides" refers to the resemblence of the leaves of this species to those of several species of *Cybianthus* subgenus *Grammadenia* (Myrsinaceae).

The decussate wings of the branchlets apices and chartaceous leaves indicate a close relationship with the parapatric *Clusia duidae*. However, the broadly marginate petioles, short or obsolete peduncle, and sepals with scarious, hyaline and incised-erose margins clearly distinguish *Clusia grammadenioides* from *C. duidae*.

3. **Clusia multilineata** Pipoly, sp. nov. (Fig. 2)

Propter folia tenuiter coriacea ad apicem necnon basem attenuata, subter glandulas punctatas puniceas indura atque lineas laticiferis atras praedita, non nunquam perianthii membra cucullata carinatasque ad *C. asymmetrica* Pipoly valde affinis sed ab ea foliis symmetricis necnon ellipticis (non asymmetricis necnon oblanceolatis), petiolis tenuis 1–1.5 (nec crassis 2–3.5) cm longis, denique cyma a eas ter (nec quater) ramificantibus facile cognoscitur.

Tree 3 m tall; branchlets subterete to weakly tetragonal, the corners rounded, not alate, 3–3.5 mm diam., subterete with age, glabrous. Leaves petiolate; blades chartaceous, elliptic, 8–13 cm long, (4.0–)5–5.5(–6.2) cm wide, apex and base acute, the base decurrent on the petiole, symmetric,

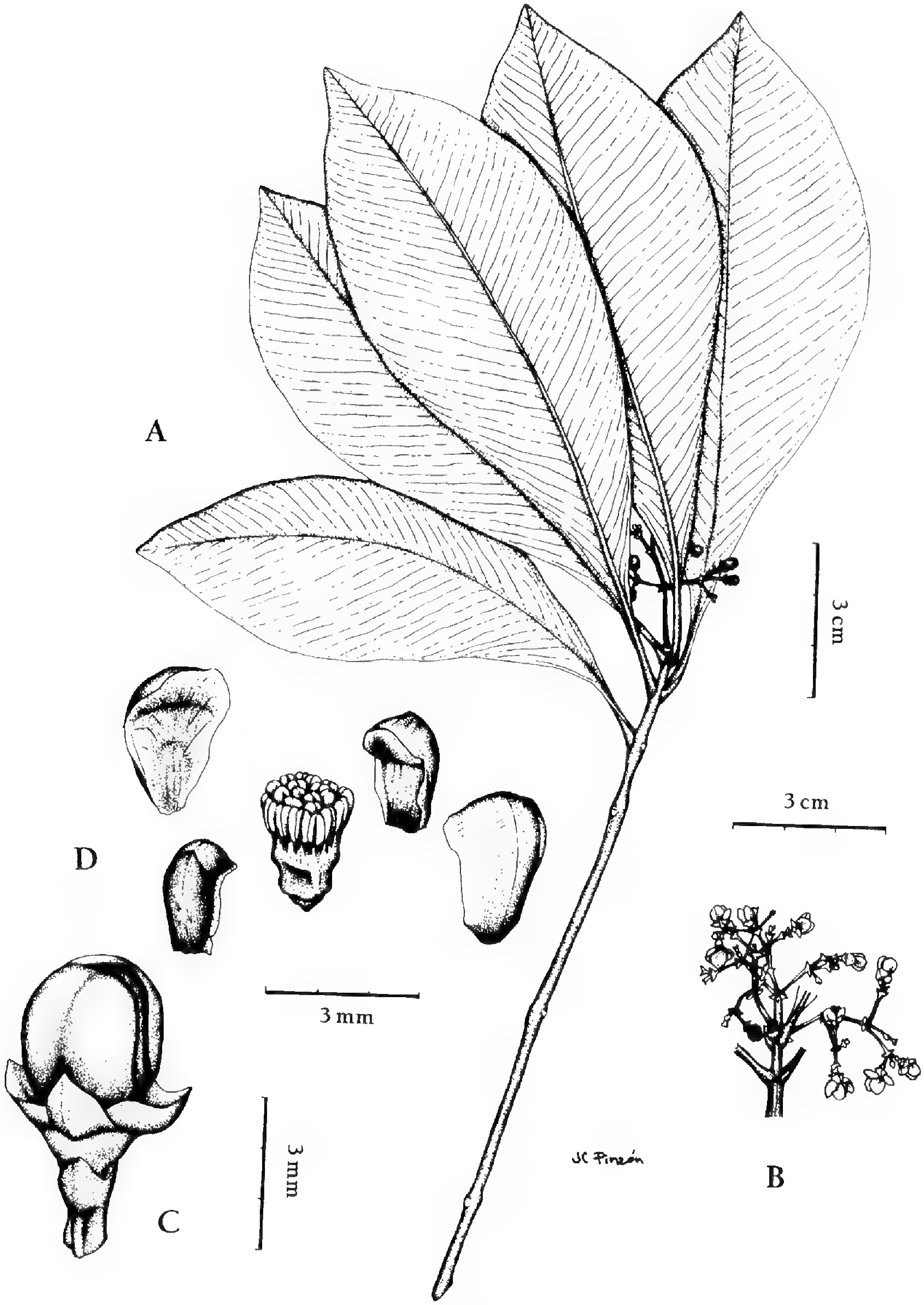

FIG. 2. *Clusia multilineata* Pipoly. A. Habit. B. Inflorescence. C. Staminate flower buds. D. Petals and androecium. A-E, drawn from type.

bearing round magenta secretory glands and numerous, conspicuous linear latex canals below, glabrous, midrib raised above and below, secondary veins numerous, prominent above and below, united by a submarginal collecting vein, the margin entire, revolute; petioles marginate, ligulate, thin, 1–1.5 cm long, glabrous. Staminate inflorescence terminal, erect, pyramidally paniculate, trichasial, 2.5–5 cm long, 3–7 cm wide, the flowers cymose; peduncle 0.5–1.0 cm long; bracteoles 2, opposite, cartilaginous, ovate, 1.5–1.6 mm long, 2–2.4 mm wide, apex acute to acuminate, carinate, w/o conspicuous latex canals, the margin scarious, entire, the border less than 0.1 mm wide, glabrous; pedicels 2–4 mm long, tetragonal. Staminate flowers greenish-white; sepals 7, the lower 4 decussate, the upper 3 contorted, chartaceous, suborbicular, more or less equal in size, 2.2–2.4 mm long, 2–2.2 mm wide, apex obtuse, rugose medially toward the apex, slightly carinate, the margin scarious, entire, the border to 0.2 mm wide; petals 4, decussate, thickly carnose, without conspicuous latex canals, suborbicular, slightly carinate, the outer pair 4.0–4.2 mm long, 3.2–3.4 mm wide, apex rounded, cucullate, the margin entire, revolute, the inner pair 2.9–3.1 mm long, 2.0–2.2 mm wide, apex rounded, strongly cucullate, the margin entire, strongly revolute; receptacle concave, without resin; androphore rectanguloid, 0.8–1.1 mm high, 1.4–1.5 mm long, 1.1–1.2 mm wide; stamens 22–24, 1.1–1.3 mm long, the filaments free, clavate, 0.3–0.4 mm long, broadly conic at base, the anthers muticous, obovoid, 0.8–0.9 mm long, 0.4–0.5 mm wide, apex emarginate, base obtuse, dehiscent by longitudinal slits for entire length; pistillode absent. Pistillate flowers unknown. Fruit unknown.

TYPE: VENEZUELA. AMAZONAS. Depto. Río Negro: Cerro de la Neblina, Camp IV, 15 km NNE of Pico Phelps; 0°51N, 65°57'W, 780 m; 15–18 Mar 1984 (stam. fl), *R. Liesner 16649* (HOLOTYPE: VEN; ISOTYPES: BRIT, MO, US).

Distribution.—Presumably endemic to Cerro de la Neblina, Amazonas, Venezuela, 780 m, known only from the type.

Ecology and conservation status.—*C. multilineata* is restricted to river canyons of Cerro de la Neblina. Cerro de la Neblina is very remote and lies within a national park and thus, is protected.

Etymology.—The specific epithet refers to the numerous, conspicuous linear latex canals of the leaf blades, which appear translucid upon drying.

Clusia multilineata is closely related to *C. asymmetrica* Pipoly of Cerros Marahuaca and Aracamuni, but can immediately be recognized by its elliptic and symmetric leaves, thin petioles, and 3-branched inflorescences.

4. **Clusia asymmetrica** Pipoly, sp. nov. (Fig. 3)

Species notabilis haec en *C. multilineata* diagnosem antequam referantur ad illa foliis asymmetricis necnon oblanceolatis (non symmetricis necnon ellipticis), petiolis crassis

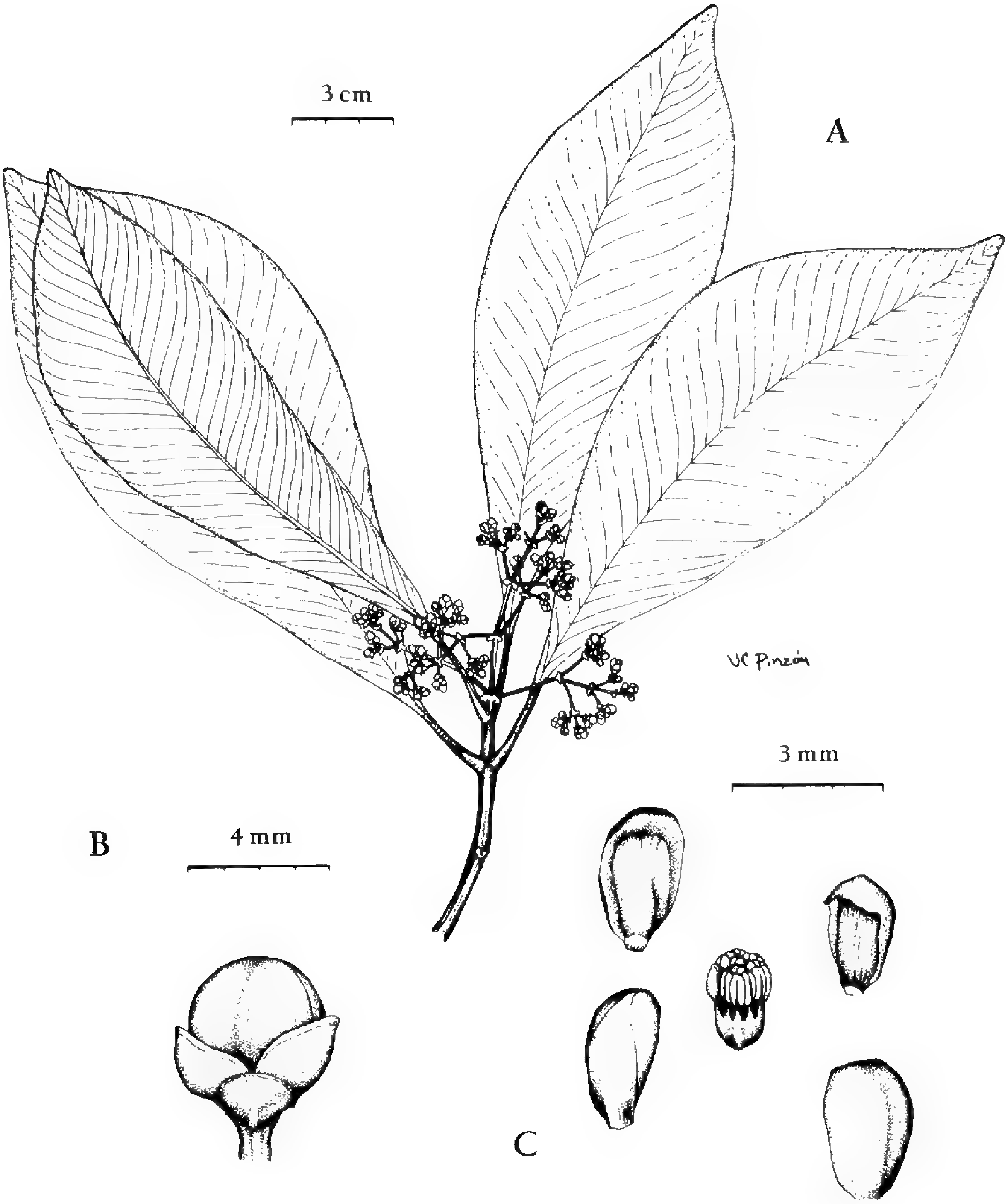

FIG. 3. *Clusia asymmetrica* Pipoly. A. Habit. B. Staminate flower bud. C. Petals and androecium. A-E, drawn from type.

2.0–3.5 (nec tenuis 1.0–1.5) mm longis, denique cyma a eas quater (non ter) ramificantibus statim separabilis.

Tree 6 m tall; branchlets tetragonal, the corners not alate, 4–6 mm diam., remaining angular with age, glabrous. Leaves petiolate; blades thinly coriaceous, oblanceolate, (12–)15–20(–22) cm long, (4.8–)5–8(–9) cm wide, apex and base acute, the base decurrent on the petiole, asymmetric, bearing round magenta secretory glands and conspicuous linear latex canals below, glabrous, the margin entire; petioles trigonal, ligulate, thick, 2.0–3.5 cm long, glabrous. Staminate inflorescence terminal, pendent, pyramidally paniculate, 4-branched, 3–7 cm long, 7–10 cm wide, the flowers cymose; peduncle 0.3–1 cm long long; bracteoles 2, opposite, thickly cartilaginous, very broadly ovate, 3.6–3.8 mm long, 5–5.2 cm wide, apex rounded, medially rugose and prominently carinate, w/o conspicuous latex canals, the margin scarious, irregularly incised, the border ca. 0.4 mm wide, glabrous; pedicels 1 mm long, tetragonal. Staminate flowers white; sepals 4, chartaceous, orbicular, more or less equal in size, 4.0–4.2 mm long and wide, apex rounded, carinate and cucullate, rugose medially toward the base, the margin scarious, irregularly incised, the border to 0.4 mm wide, glabrous; petals 4, imbricate, coriaceous, obovate, 4.8–5 mm long, 3–3.2 mm wide, apex rounded, latex canals numerous, conspicuous, the margin entire, flat; receptacle concave, without resin; androphore rectanguloid, 1.4–1.6 mm high, 3.8–4.1 mm long, 1.8–2 mm wide; stamens 18, 3.2–3.3 mm long, the filaments basally connate forming a non-resinous mass of tissue 1.8–2.1 mm tall, apically free 1.4–1.6 mm, subclavate, 0.4–0.5 mm long, terete at base, the anthers muticous, ovoid, 0.8–1 mm long, 0.5–0.6 mm wide, apex rounded to subemarginate, base acute, dehiscent by longitudinal slits for entire length, the connective not darkened; pistillode highly reduced, sparingly resiniferous, with hollow ovary and 5 styles and reduced stigmatic areas. Pistillate flowers and fruit unknown.

TYPE: VENEZUELA. AMAZONAS. Depto. Atabapo: Cerro Marahuaca, "Sima" area, 03°43'N, 65°30'W, 1200 m, 16 Oct 1988 (stam. fl), *R. Liesner 24972* (HOLOTYPE: VEN; ISOTYPES: BRIT, MO).

PARATYPES: VENEZUELA. AMAZONAS. Depto. Río Negro: Cerro Aracamuni, 01°39'N, 65°40'W, 250 m, 4 Nov 1987 (stam. fl bud), *R. Liesner & G. Carnevali 22797* (MO, VEN). Depto. Atabapo: affluent of Caño Negro at junction with Río Cunucunuma, water source from Cerro Marahuaca, 1,000–1,200 m, 19 Oct 1988 (stam. fl), *H. Rodríguez 2875* (MY, NY).

Distribution.—Endemic to southern Amazonas of Venezuela, on Cerro Marahuaca and Cerro Aracamuni, at 250–1,200 m elevation.

Ecology and conservation status.—*Clusia asymmetrica* occurs in the "sima" areas (sinkholes) of the upper plateaus of Cerro Marahuaca and the open "lajas" of Cerro Aracamuni. "Simas" have low-level light regimes, high level moisture, but are shielded from the strong winds of the open areas on the tepui summits. The "laja" formations described on the label of *Liesner & Carnevali 22797* are protected from winds by tall forests which surround them. While the environment on the tepuis is a fragile one, the southern tepuis are within national parks and therefore, are protected. Despite the fact that this species is known from two very different elevational ranges, it is possible that exposure to wind, alternating periods of high humidity and aridity, concomitant with nutrient poverty are critical factors in determining the species' success.

Etymology.—The specific epithet refers to the asymmetric leaves, unique within the genus *Clusia.*

Within *Clusia* section *Criuva* (*sensu stricto*), *C. asymmetrica* is easily distinguished by its long, trigonal petioles and asymmetric leaves. The 4-branched cymes wider than tall are also distinctive.

5. **Clusia melchiorii** Gleason, Bull. Torrey Bot. Club. 58:403. 1931. TYPE. VENEZUELA. AMAZONAS: Cerro Duida, Desfiladero, 1,850 m, *G. Tate 705* (HOLOTYPE: NY!; ISOTYPE: US!).

Clusia melchiori Gleason, orth. var., ibid.

Terrestrial, free-standing shrub or small tree to 4 m tall; branchlets subterete, angulate, (3–)7–12 mm diam., not alate, glabrous. Leaves petiolate; blades coriaceous or rarely thickly coriaceous, obvate to widely obovate, rarely oblong, (6.5–)8–10(–17) cm long, (2.8–)5.5–8(–11) cm wide, apex broadly rounded to truncate, base cuneate, fully decurrent to petiole base, symmetric, without round magenta glands, linear latex canals inconspicuous, nitid above, pallid below, midrib prominently raised above and below, secondary veins numerous, united by a submarginal collecting vein, the margin revolute, entire, glabrous; petiole broadly marginate, 3–10 mm long, glabrous. Inflorescence terminal, erect, pyramidally paniculate, (4.5–)8–11(–19) cm long, (4.2–)6–11 cm wide, the flowers cymose, in 7–9's; peduncle flattened, (2–)3.5–4.5 cm long, longitudinally ribbed, not alate, subtended by 2 reduced leaves similar to vegetative leaves but 6–8 cm long, 2–3.5 cm wide; secondary inflorescence bracts cartilaginous, oblate, 2–5 mm long, 6–8 mm wide, apex broadly rounded, strongly carinate, the margin opaque, scarious, entire, glabrous; secondary peduncles similar to basal one, 5–10 mm long; bracteoles (4–)6–12(–14), decussate, coriaceous, oblate, 2.5–3.5 mm long, 3.5–4.5 mm wide, apex obtuse, the margin entire, hyaline, scarious, glabrous; pedicels tetragonal, 1–3 mm long. Staminate flowers yellowish-white; sepals 4, decussate, the outer coriaceous, oblate, 3.5–4 mm long, 4–4.5 mm wide, apex obtuse, carinate, the margin hyaline, scarious; petals 4–6, carnose, obovate, 3–3.5 mm long, 2.5–3 mm wide, apex broadly rounded, linear latex canals inconspicuous, the margin entire, opaque, not scarious, glabrous; androphore rectanguloid; stamens numerous, ca. 3–3.5 mm long, the filaments flat, 2.8–3 mm long, the anthers muticous, oblong, ca. 0.5 mm long, 0.2 mm wide, apex rounded, base fused to filament, the connective not darkened. Pistillate flowers (bud) as in staminate, sepals identical; petals unknown; staminodes 4, linear, 1–1.5 mm long, the filaments 1–1.3 mm long, the anthers muticous, oblong, 02–0.5 mm long, 0.1–0.2 mm wide, apex rounded, base fused to filament; pistil oblong to obovoid, 1.5–3 mm long, 2–4 mm wide; carpels 4; styles 4, erect, connivent, 2–2.4 mm long; stigmas cuneiform, subpeltate, 0.6–

0.8 mm long and wide; ovules 4 per locule. Fruit ovoid, then fusiform at maturity, 10–13 mm long, 3–8 mm wide.

Distribution.—Amazonian Colombia and Brazil, eastward to Surinam on sandstone mountains of the Guayana Crystalline Shield and its satellites, 1,200–3,000 m.

Ecology and conservation status.—*Clusia melchiorii* occurs in elfin forests, often dominated by *Bonnetia* species, where it is a conspicuous element of the vegetation along margins of the forest on rockly slopes. It is a common species throughout its range and is not threatened at this time.

Specimens examined. **VENEZUELA. Amazonas:** Caño Verada, Campo M. Pérez to Camp Verada, 900–1,100 m, 30 Jan 1951 (fr), *B. Maguire et al. 31665* (NY, US, VEN); Cerro Duida, Cerro Culebra, 1,500 m, 22–24 Apr 1949 (fr), *B. Maguire & B. Maguire, Jr. 29124* (NY, VEN), Culebra Valley, Río Cunucunuma, 1,500 m, 19 Nov 1950 (fr), *B. Maguire et al. 29535* (NY, US, VEN); Cerro Guanay, ridge and savanna, W camp, 1,800 m, 4 Feb 1951 (fr), *B. Maguire et al. 31746* (NY, VEN); Cerro Moriche, Río Ventuari, Amazonas, 1,500 m, 15 Jan 1951 (fr), *B. Maguire et al. 30927* (NY, VEN), Cerro de la Neblina, Río Yatua, 2–8 km S of Camp 3, 1,000 m, 24 Dec 1953 (fr), *B. Maguire et al. 36905* (NY, US, VEN), cumbre between Cumbre Camp and N escarpment, 1,700–1750 m, 13 Jan 1954 (pist. fl), *B. Maguire et al. 37248* (NY, US, VEN), trail from camp to N escarpment, 1,800–1,900 m, 17 Nov 1957,(fr), *B. Maguire et al. 42124* (NY, US, VEN), upper basin of Cañon Grande, above Salto Grande, 1,900–2,000 m, 13 Dec 1957 (fr), *B. Maguire et al. 42731* (NY, US, VEN), E escarpment of Upper Caño Grande Basin, 2,000 m, 13 Dec 1957 (fr), *B. Maguire et al. 42377* (NY, US, VEN), talus forest between Camps 3 and 4, 700–1,300 m, 1 Jan 1958 (fr), *B. Maguire et al. 42758* (NY, US, VEN), headwaters of Caño Grande, SW portion, 1,900 m, 16–17 Oct 1970 (stam. fl), *J. Steyermark 103992* (NY, VEN); Planicie de Zuluoaga, Río Titirico, 2,300 m, 10–15 Oct 1970 (stam. fl), *J. Steyermark 103847* (NY, VEN); Neblina Massif, Camp 2, 2.8 km NE of Pico Phelps, 00°49'N, 65°59'W, 15 Apr 1984 (fr), *B. Stein & A. Gentry 1535* (BRIT, MO, NY, US, VEN); Sierra Parima, 02°27'24" N, 63°56'W, along Venezuelan-Brazilian border, 45 km NW of headwaters of Río Orinoco, 1,300 m, 18–23 May 1972 (stam. fl), *J. Steyermark 105958* (NY, VEN); Serranía Parú, Río Parú, Caño Asísa, Río Ventuari, 6 km along W rim, 2,000 m, 4 Feb 1951 (stam. fl), *R. Cowan & J. Wurdack 31224* (NY, US, VEN), (stam. fl), *R. Cowan & J. Wurdack 31257A* (NY, US, VEN), (fr), *R. Cowan & J. Wurdack 31258* (NY, US, VEN); Cerro Sipapo (Paráque), SE peak, W Mountain, 2,000 m, 20 Dec 1948 (stam. fl), *B. Maguire & L. Politi 27781* (NY, US, VEN), N escarpment, 1,400 m, 23 Dec 1948 (stam. fl), *B. Maguire & L. Politi 27894* (NY, US, VEN), Caño Grande, 1 km NW of Campo Grande, 1,400 m, 28 Dec 1948 (fr), *B. Maguire & L. Politi 28014* (NY, US, VEN); Caño Profundo, 1,400 m, 12 Jan 1949 (stam. fl), *B. Maguire & L. Politi 28302* (NY, US, VEN), 1 km above Intermediate Camp, 600 m, 6 Feb 1949 (fr), *B. Maguire & L. Politi 28797* (NY, US, VEN); Cerro Yapacana, Río Orinoco, summit, 1,200 m, 2 Jan 1951 (fr), *B. Maguire et al. 30642* (NY, US, VEN), broken cumbre at 1,200 m, 5 Jan 1951 (fr), *B. Maguire et al. 30740* (NY, US, VEN), summit, 03°45'N, 66°45'W, 1,000–1,200 m, 5–7 May 1970 (fr), *J. Steyermark 103159* (NY, VEN); Sierra Maigualida, NW sector, small valley along an upper tributary of Caño Iguana, 05°30 N, 65°15'W, 2,000 m, 28 Feb-3 Mar 1991 (fr), *P. Berry et al. 4886* (BRIT, MO, VEN); *P. Berry et al. 4926* (MO, VEN); Serranía de Tapirapeco, Campo Tamacuari, stream trail from camp, 01°14'N, 64°40'W, 1,300 m, 10 Feb 1989 (fr), *H. Beck et al. 938* (BRIT, NY, VEN); Cerro Yaví, 2,000–2,300 m, 1–3 Mar 1947 (stam. fl), *K. Phelps & C. B. Hitchcock 78* (NY, VEN), Valley of Río Coro-

Coro, W of Serranía de Yutajé, plateau W of river, 5°42'N, 66°10'W, 1,300 m, 7 Mar 1987 (fr), *B. Holst & R. Liesner 3387* (MO, VEN); Serranía Yutajé, Río Manipiare, NW ridge, 1,400 m, 11 Feb 1953 (fr), *B. Maguire & C. Maguire 35174* (NY, VEN). **Bolívar:** Distrito Piar, Auyán-tepuí, N portion of S section, W division of mountain, along Río Churún, betwen N and S camp at foot of "second wall", 1,600 m, 14 May 1964 (fr), *J. Steyermark 93881* (NY, VEN), S-central region, headwaters of Río Churún, 05°51'N, 62°32'W, 200 m, 30 Mar 1987 (stam. fl bud), *B. Holst 3784* (MO, VEN), summit of central part of NW arm, W division of mountain, along small creek S of the Jimmy Angel airplane, 1,800 m, 7 May 1964 (fr), *J. Steyermark 93538* (NY, VEN); Chimantá Massif, Central Section, NNW of Summit Camp, 1,970 m, 19 Feb 1955 (fr), *J. Steyermark & J. Wurdack 942* (NY, VEN), Toronó-tepuí, N-facing slopes on summit above valley of Caño Mojado, 2,030–2,150 m, 21 Feb 1955 (stam. fl), *J. Steyermark & J. Wurdack 1017* (NY, VEN), Vicinity of Bluff Camp, at base of W-facing bluffs of Toronó-tepuí, 1,700 m, 2–4 Jun 1953 (fr), *J. Steyermark 75625* (NY, VEN); Abacapá-tepuí, NW part of summit, 2,000–2,125 m, 14 Apr 1953 (fr), *J. Steyermark 75005* (NY, VEN), Sarvén-tepuí, between Camp 4 & 5, 1,500–1,750 m, 8 Jan 1953 (stam. fl), *J. Wurdack 34092* (NY, VEN), Cerro Guaiquinima, Río Paragua, slopes below W escarpment, 1,600 m, 31 Dec 1951 (fr), *B. Maguire 32891* (NY, VEN), summit, NE section, near cliffs, near headwaters of Río Carapo, 05°59'N, 63°25'W, 1,490–1,500 m, 25 May 1978 (fr), *J. Steyermark et al. 117320* (NY, VEN); Meseta de Guaiquinima, S section, along Río Carapo, 8 km N of Salto Carapo, 05°51'N, 63°33'W, 900 m, 6 Dec 1987 (fr), *O. Huber 12437* (MYF, NY, VEN); Alto Río Paragua, Río Guaña (Merevarí), near Brazilian frontier, 20 Oct 1943 (pist. fl, fr), *F. Cardona 1036* (US, VEN); Meseta de Jaua, Cerro Jaua, summit of CW portion, 04°45" N, 64°26'W, 60 km NW of the Sanitary camp of the mission of Río Kanarakuni, 1,922–2,100 m, 22–27 Mar 1967 (stam. fl), *J. Steyermark 98144* (NY, VEN), summit, 04°48'50" N, 64°34'10 W, SW part, along tributary of Río Marajano, 1,750–1,800 m, 22–28 Feb 1974 (stam. fl), *J. Steyermark et al. 109363* (NY, VEN), E of camp, E of Río Marajano, 1,810–1,880 m, 28 Feb -5 Mar 1974 (stam. fl), *J. Steyermark et al. 109654* (NY, VEN); Summit of SE-facing escarpment , E of Cerro El Picacho, N of Las Nievers and Las Chicharras, 45 km N of Tumeremo, vicinity of Deborah, Altiplanicie de Nuria, 600–650 m, 5–8 Feb 1961 (fr), *J. Steyermark 89049* (NY, VEN), NW slopes of Ptari-tepuí, 1,600–2,000 m, 17 Dec 1952 (fr), *B. Maguire & J. Wurdack 33905* (NY, VEN), "moss forest" cumbre, N valley, 1,700 m, 4 Jan 1952 (fr), *B. Maguire 32990* (NY, VEN), along base of S-facing bluffs, 2,410 m, 6 Nov 1944 (pist. fl), *J. Steyermark 59903* (F, NY, US, VEN); Ilu-tepuí, vicinity Camp No. 1, 1,500 m, 13 Mar 1952 (fr), *B. Maguire 33391* (NY, VEN); Uaipan-tepuí, W peak, 1,930 m, 4 Mar 1967 (stam. fl), *T. Koyama & G. Agostini 7482* (NY, VEN); Sierra Pakaraima, headwaters of Río Paragua, along Venezuelan-Brazilian border, No. 15, 03°40'N, 63°00'W, 1,400 m, 4–5 May 1973 (stam. fl), *J. Steyermark 107282* (NY, VEN); Cerro Roraima, SW-facing slopes between Rondón Camp and base of bluffs, 2,040 2,225 m, 30 Sep 1944 (stam. fl), *J. Steyermark 58945* (F, NY, US, VEN), SW-facing slopes, Jan 1939 (fr), *A. Pinkus 161* (NY, VEN). **GUYANA**. **Mazaruni-Potaro Region:** Upper Mazaruni River Basin, Pakaraima Mts., along Karowrieng River, unnamed peak NW of Maipuri Falls, 05°43'N, 60°08'W, 1,385 m, 13 Jun 1986 (fr), *J. Pipoly & K. Alfred 7711* (BRG, NY, US), Headwaters of Karowrieng River, 06°12'N, 60°07'W, 712 m, 15 Jun 1986 (bud), *J. Pipoly & K. Alfred 7789* (BRG, NY, US); N of Imbaimadai airstrip, 05°43'N, 60°18'W, 511 m, 15 Jun 1986 (fr), *J. Pipoly & K. Alfred 7821* (BRG, NY, US). **Cuyuni-Mazaruni Region:** Chi-Chi Mts., 4 km W of Chi-Chi Falls, on tributary leading N from Mazaruini River, 05°34'N, 60°15'W, 450 m, 18 Feb 1987 (fr), *J. Pipoly et al. 10293, 10330* (FDG, NY, US). **Upper Potaro-Siparuni Region:** summit of Mt. Wokomung, 05°05'N, 59°50'W, 1,650 m, 7 Jul 1989, (pist. fl bud), *B. Boom & G. Samuels 9120* (BRG, BRIT, NY);1,530 m, 13 Jul 1989 (stam. fl bud), *B. Boom & G. Samuels 9201* (BRG, BRIT, NY); Mt. Wokumung, central summit plateau, 0.5–1 km S, 1–2 km E along creek area and ridge, 05°04'N, 59°52'W, 1,500–1,530 m, 22 Feb 1993 (fr), *T. Henkel et al. 1535* (BRG, US). **Upper Takatu-Upper Essequibo Region:** S. Pakaraima Mts., 5 km E of Tipuru Village, Ureisha Mt summit, 04°11'N, 59°31'W, 994 m, 4 Mar 1992 (fr), *B. Hoffman et al. 1184* (BRIT, BRG, US); NW Kanuku Mts., summit of Nappi Mt., 12 km S of Nappi Village, 03°18'N, 59°33'W, 750–950 m, 8 Feb 1993 (fr), *B. Hoffman & R. Foster 3567* (BRG, US); S Pakaraima Mts, Kopinang Falls and Savanna, 900 m, 29 Aug 1961 (stam. fl), *B. Maguire et al. 45986A* (FDG, K, NY, US), 31 Aug 1961 (stam. fl), *B. Maguire et al. 46038a* (FDG, K, NY, US), 3 Sep 1961 (stam. fl),. *B. Maguire et al. 46081A* (FDG, K, NY, US); Kanuku Mts., Nappi Mt. 03°19'N, 59°34'W, 960 m, 11 Nov 1987 (fr), *M. Jansen-Jacobs et al. 875* (NY, U, US). **SURINAM.** Wilhelmina Gebergte, Juliantops, 1,200 m, 3 Aug 1963 (stam. fl), *J. Schulz 10303* (BBS, NY, US), 3 Aug 1963 (pist. fl), *J. Schulz 10296* (BBS, NY, US); Juliana Top, 15 km N of Lucie River, 03°36'-03°41'N, 56°30'-56°34'W, 1,000–1,230 m, 18 Aug 1963 (stam. fl), *H. Irwin et al. 54864* (BBS, NY, U, US); Tafelberg, escarpment 2 km S of East Ridge, 1 Sep 1944 (stam. fl), *B. Maguire 24585a* (BBS, NY, US), 1 Sep 1944 (pist. fl), *B. Maguire 24585* (BBS, NY, US), between Savanna VIII and SW escarpment, 5 Sep 1944 (fr), *B. Maguire 24641* (BBS, NY, U, US); Bakhuis Mts, along Kabalebo and Coppenhame Rivers, 800 m, 25 Feb 1965 (fr), *P. Florschütz & P. Maas 3040* (NY, U). **FRENCH GUIANA.** Saül, S of Mt. Galbao, 13 Dec 1976 (fr), *J.J. de Granville 5401* (CAY, NY, P); Mont Galbao, 14 Dec 1976 (fr), *S. Mori et al. 8770* (CAY, NY, P); Mont Galbao, SE peak, 03°35'N, 53°16'W, 700 m, 13 Sep 1994 (stam. fl bud), *B. Boom 10863* (CAY, NY); Mont Galbao, E sector, 03°36'N, 53°17'W, 650 m, 15 Jan 1986 (fr), *J. J. De Granville 8761, 8762* (CAY, NY, P). **BRAZIL. Amazonas:** Platô da Serra Aracá, SE portion of Serra Norte, 00°51'N, 63°22'W, 1,150–1,250 m, 15 Feb 1984 (fr), *I. do Amaral. J. Pipoly et al. 1593* (BRIT, INPA, MG, NY), 24 Feb 1984 (fr), *A. S. Tavares et al. 139* (INPA, MG, NY), Plateau of northern massif of Serra Aracá, 01°51–57'N, 63°21–22'W, N part of N slope, 1,400 m, 21 Feb 1984 (fr), *G. Prance, J. Pipoly et al. 29209* (INPA, MG, NY), W slope of southern massif, 00°40'N, 63°18'W, 1,000 m, 21 Mar 1984 (stam. fl), *J. Pipoly & G. Samuels 6864* (INPA, MG, NY, US); 0–3 km N of km 211 of Perimetral Norte Hwy, Pico Rondon, ca. 01°32'N, 62°48'W, 3 Feb 1984 (fr), *J. Pipoly et al. 6614* (INPA, MG, NY). **Terr. Roraima:** Serra Sebang, Vista General, 1,525 m, 16–18 Dec 1954 (fr), *B. Maguire 40308* (NY).

Because of the unique flattened inflorescence rachis and peduncle, numerous flowers and numerous bracteoles similar to the sepals, *C. melchiorii* is most closely related to *C. cardonae*, but readily separated from it by the broadly marginate petioles, obovate to very widely obovate leaf blades with cuneate bases fully decurrent to the petiole base, and fruit ovoid at first, then fusiform at maturity.

6. **Clusia cardonae** Maguire, Mem. New York Bot. Gard. 9:483. 1957. TYPE. VENEZUELA. BOLÍVAR: Uaipán-tepuí, Río Caroní, 1,700 m, 1–15 Feb 1948 (stam. fl), *K. Phelps & C.B. Hitchcock 412* (HOLOTYPE: NY!; ISOTYPE: VEN).

Trees to 4 m tall; latex yellow, copious; branchlets 5–8 mm diam., acutely tetragonal, the corners sharp, upon drying appearing narrowly alate, the wings less than 0.5 mm wide. Leaves petiolate; blades stiffly coriaceous, oblong, elliptic, or rhombic, (5.5–)7–9(–11) cm long, (4–)6–8(–9.5) cm wide, apex obtuse to broadly rounded, base obtuse, not decurrent on the petiole, symmetric, nitid above, pallid or rarely nitid below, without magenta glands, midrib elevated above and below, the secondary veins numerous, conspicuous above and below, united by a submarginal connecting vein, linear latex canals inconspicuous, numerous, the margin revolute, entire, glabrous; petioles canaliculate 15–25(–28) mm long, glabrous. Staminate inflorescence terminal, erect, pyramidally paniculate, 7–9(–11) cm long, (5–)6–8 cm wide, the flowers cymose; peduncle obsolete; subtended by two reduced leaves similar to vegetative leaves but obovate spathulate, 2.5–2.8 mm long, 1.2–2 mm wide; secondary inflorescence bracts carnose, widely ovate, 2–2.5 mm long, 2.3–2.5 mm wide, apex obtuse, medially carinate, the margin entire, opaque, not scarious, glabrous; bracteoles 4–8, decussate, coriaceous, ovate, similar in size and shape to the bracts; pedicels tetragonal, 2–3.5 mm long, glabrous. Staminate flowers yellow; sepals 4, decussatate, carnose, oblate to suborbicular, 2–2.3 mm long, 2.2–2.4 mm wide, apex broadly rounded, subcucullate, the margin entire, opaque, not scarious, glabrous; petals 4–5, the outer pair opposite, the inner decussate or imbricate, coriaceous, suborbicular, 5–6 mm long and wide, apex broadly rounded, cucullate, linear latex canals inconspicuous, the margin entire, opaque, not scarious, glabrous; androphore pentagonoid; stamens numerous, 2–3.5 mm long, the filaments flat, 1–2 mm long, the anthers ovate, 0.8–1 mm long, apex rounded, the connective slightly exceeding the thecae, base cordate, the connective medially darkened; pistillode absent. Pistillate inflorescence as in staminate but pedicels 2–3 mm long; sepals 2–2.5 mm long, 2.4–2.7 mm wide; staminodes numerous, 1–1.5 mm long, the filaments 0.9–1.2 mm long, broadly triangular at base, connivent, the anthers ovoid to oblong, ca. 0.3–6 mm long, apex broadly rounded, base obtuse, fused to filament apex; pistil subglobose, 2.5–3 mm long and in diam.; styles obsolete; stigmas narrowly cuneiform, 1–1.5(–2) mm long, 0.5–0.8 mm wide, subpeltate, convex. Fruit subglobose, at first, then globose, yellowish-green, 5–9 mm long and in diam.

Distribution.—Endemic to the Guayana Crystalline Shield, *Clusia cardonae* is known from the state of Bolívar, Venezuela and nearby Guyana, at 920–1,825 m elevation.

Ecology and conservation status.—*Clusia cardonae* is a rare species, occurring on summits of tepuis which experience very little disturbance. It is locally common, and therefore is not likely to be threatened.

Representative specimens examined: **VENEZUELA. Bolívar:** Dtto. Piar: Chimantá-Massif, Aprada-tepuí, 1,400–1,500 m, Aug 1950 (stam. fl), *L. Bernardi 931* (MER, NY, VEN); savanna at foot of Aprada-tepuí, 05°23'N, 62°27'W, 1,200 m, 5 May 1987 (stam. fl), *O. Huber 12098* (MYF, NY, VEN); Camarcaibarai-tepuí, SW-facing shoulder, 05°52'N, 62°01'W, 1,800–1,825 m 22–24 May 1986 (fr), *J. Steyermark et al. 131998* (MO, VEN); Cerro Amuray-tepuí, W division of Los Hermanos range, summit, 05°55'N, 62°15'W, 1,030 m, 27 May 1986 (fr), *J. Steyermark 132175* (MO, VEN); Ilú-tepuí, ridge E of Mesa Grande, 1,650 m, 9 Mar 1952 (pist. fl), *B. Maguire 33318*, (stam. fl), *B. Maguire 33319* (NY, VEN); mesa S of Terekeyuren-tepuí, 40 km NE of the Kamarata Mission, 05°51'N, 62°03'W, 1,780 m, 15 Jan 1986 (fr), *O. Huber & S. Gorzula 11135* (MYF, NY, VEN); 25 km N of Luepa, along El Dorado-Luepa road, 05°55'N, 61°25'W, 1,350 m, 2 Sep 1986 (stam. fl), *O. Huber & L. Hernández 11721* (MYF, VEN); Uaipán-tepuí, Río Caroní, 2,700 m, 26 Nov 1946 (stam. fl), *F. Cardona 2064* (NY, VEN), summit of W peak, 1,980 m, 4 Mar 1967 (stam. fl), *G. Agostini & T. Koyama 7458* (NY, VEN), between the W and E peaks of Uaipán, 1,500 m, 4 Mar 1967 (stam. fl), *T. Koyama & G. Agostini 7473* (NY, VEN); Uei-tepuí, between SE slope and summit, between Luepa and Cerro Venamo, vicinty of km 125, S of El Dorado, 1,100–1,300 m, 7 Mar 1962 (stam. fl), *J. Steyermark & L. Aristeguieta 22* (NY, VEN); vicinity of km 129–130, S of El Dorado, NE of Luepa, 800–1,200 m, 6–11 Mar 1962 (fr), *J. Steyermark & L. Aristeguieta 90* (NY, VEN); Cerro Venamo, along Guyana border, 1,400–1,500 m, 1 Jan 1964 (fr), *J. Steyermark et al. 92502* (NY, VEN), NW slopes, between road to campamento 125 and forest above waterfall, 1,100–1,300 m, 14 Apr 1960 (fr), *J. Steyermark & S. Nilsson 112* (NY, VEN); ridge of Fila de La Danta, between campamento 125 and km 127, between Luepa and Cerro Venamo, 1,200 m, 15–17 Apr 1960 (fr), *J. Steyermark & S. Nilsson 204* (NY, VEN). **GUYANA. Upper Mazaruni River Region:** Karowtipu Mountain, between camp and peak on W side of mountain, 05°45'N, 60°35'W, 920–1,180 m, 24 Apr 1987, *B. Boom & D. Gopaul 7705* (BRIT, BRG, NY). **Cuyuni-Mazaruni Region:** Pakaraima Mountains, Kurupung River, top of Kamarau Falls, 06°06'N, 60°21'W, 350 m, 19 Jul 1992 (pist. fl, fr), *B. Hoffman 2086* (BRG, BRIT, NY, US); Pakaraima Mountains, NE plateau of Mt. Ayanganna, 05°23'N, 59°58'W, 1,500 m, 30 Oct 1992 (pist. fl), *B. Hoffman 3104* (BRG, BRIT, US; Mt. Ayanganna, easternmost peak, 05°25'N, 59°57'W, 1,350–1,380 m, 11 Mar 1987 (fr), *J. Pipoly et al. 11102* (FDG, NY, US).

The coriaceous leaf blades with prominent secondary veins, erect, pyramidally paniculate inflorescence, flattened inflorescence rachis, and numerous, small bracteoles similar to the sepals serve to indicate that *Clusia cardonae* is most closely related to *C. melchiorii*. However, *C. cardonae* is readily separated by its canaliculate petioles, oblong, elliptic or rhombic leaves not decurrent on the petiole, sessile stigmas and globose fruits.

7. **Clusia hexacarpa** Gleason, Bull. Torrey Bot. Club 58:403. 1931. TYPE: VENEZUELA. Amazonas: Cerro Duida, streamside at Central Camp, 1,800 m (pist. fl), *G. Tate 565* (HOLOTYPE: NY!).

Clusia hexacarpa var. *ptaritepuiana* Steyerm., Fieldiana, Bot. 28:387. 1952. syn. nov. TYPE. VENEZUELA. Bolívar: Ptari-tepuí, S-facing slopes, vicinity of "Cave Rock," 1,800 m, 4 Nov 1944 (pist. fl), *J. Steyermark 59866* (HOLOTYPE: F!; ISOTYPES: NY!, VEN).

Free-standing shrub to small tree, to 8 m tall; branchlets tetragonal, 5–7 mm diam, the angles acute to obtusish when dry, glabrous. Leaves petiolate; blades cartilaginous, elliptic, 4–7 cm long, 2.5–4(–4.5) cm wide, broadly rounded at summit, obtuse at base, not decurrent on the petiole, symmetric, subnitid above, pallid and without round magenta glands below, midrib flat to slightly impressed above, prominently raised below, the secondary veins very inconspicuous, numerous, united by a very obscure submarginal connecting vein, the margin entire, scarious, opaque, glabrous; petioles broadly marginate, 6–15 mm long, glabrous. Staminate inflorescence a single, terminal, pendent flower; peduncle 8–15 mm long; subtended by two reduced leaves, the leaves coriaceous, obovate, 1.5–2.5 cm long, 1.5 cm wide, apex obtuse to rounded, base obtuse; bracteoles 2, cartilaginous, suborbicular, 3.5–4 mm long and wide, apex broadly rounded, carinate, the margin entire, opaque, not scarious, glabrous. Staminate flowers (immature bud) white, suffused with pink; sepals 4, decussate, stiffly coriaceous, the outer pair suborbicular, 6–7.5 mm long and wide, apex broadly rounded, linear latex canals numerous, conspicuous, the margin entire, opaque, not scarious, glabrous, the inner pair 5–6.5 mm long, 4.5–5.5 mm wide, apex broadly rounded, linear latex canals moderate, conspicuous, the margin entire, opaque, not scarious, glabrous; petals 6, the outer two opposite, cartilaginous, obovate to obovate-spathulate and somewhat clawed, 6–9 mm long, 3.5–5 mm wide, apex broadly rounded, cucullate, linear latex canals sparse, inconspicuous, the margin opaque, entire, not scarious, the inner 4 imbricate, like the outer ones but progressively smaller, to 4.5–5 mm long, 2.5–3 mm wide; androphore pentagonal; stamens numerous, ca. 3.5–4.5 mm long, the filament fleshy, flattened, ca. 2 mm long, broadly triangular and connivent at base, the anther linear, ca. 1.5–2 mm long, 0.3–0.5 mm wide, triangular in cross section, apically truncate , basally obtuse, fused with filament; pistillode obsolete. Pistillate flowers as in staminate, but peduncle 15–20 mm long; bracteoles 1.6–2 mm long; sepals cartilaginous, oblate, 8–10 mm long, 10–12 mm wide, apex broadly rounded, the margin scarious; persistent; petals cartilaginous, obovate-spathulate to somewhat clawed, apex broadly rounded, linear latex canals numerous, highly conspicuous, (12–)14–18 mm long, 0.6–0.8 mm wide; persistent in fruit; staminodes 9, rectangular in outline, flattened, 2.8–3.5 mm long, 1–1.5 mm wide, apex truncate, acute, with vestigial anthers; carpels 6(–8); styles 1–2 mm long; stigmas carnose, subpeltate, deltate, 3–3.5 mm long and wide in flower, 4.8–5 mm long and wide on mature fruit, ovules numerous, horizontal. Fruit ovoid, (2.5–)3–3.5 cm long, 1.5–2.5 cm diam.

Distribution.—Endemic to southern tepuis of Amazonas and Bolívar, Venezuela, at 1,400–1,800 m elevation.

Ecology and conservation status.—*Clusia hexacarpa* is common in *Clusia* scrub forests on outcrops and expose, steep slopes of tepuis, and as such, is not threatened. It is found with numerous Cyclanthaceae, at the junction of the scrub forests with seepage areas, such as the Bromeliaceae patches which form colonies in poorly drained areas over rocks. It is not considered threatened or endangered.

Specimens examined: **VENEZUELA. Amazonas:** Cerro Aracamuni, summit, Proa Camp, 01°32'N, 65°49'W, 1,400 m, 26 Oct 1987 (pist. fl, fr), *R. Liesner & G. Carnevali 22489* (MO, VEN), 28 Oct 1987 (fr), *R. Liesner & G. Carnevali 22575* (MO, VEN); Cerro Huachamacari, Río Cunucunuma, Left fork, Caño De Dios, 1,800 m, 8 Dec 1950 (pist. fl), *B. Maguire 30028, 30033, 30179* (NY, VEN), (stam. fl), *B. Maguire 30029* (NY, VEN), Depto. Río Negro; Cerro de la Neblina, 6.5 km SSW of base camp, S extension of range, 00°47'N, 66°11'W, 1,600 m, 18 Apr 1984 (fr), *B. Stein et al. 1651* (BRIT, MO, VEN); Cerro de la Neblina, S-face of Pico Phelps Massif, 00°48'N, 66°00'W, 1,550–1,650 m, 13 Apr 1984 (fr), *A. Gentry & B. Stein 46596* (MO, VEN); escarpment above Camp IV, 1,650–1,750 m, 30 Dec 1953 (fr), *B. Maguire et al. 36990* (NY, VEN), NW cumbre, 1,950 m, 30 Dec 1953 (pist. fl, fr), *Maguire et al. 37003 , 37022* (NY, VEN), vicinity Cumbre Camp, 1,800 m, 10 Jan 1954 (stam.fl), *B. Maguire et al. 37144* (NY, VEN), NW Camp, 1,800 m, 12 Jan 1954 (fr), *B. Maguire et al. 37247* (NY, VEN), trail immediately below N escarpment, 1,850 m, 17 Nov 1957 (stam. fl), *B. Maguire 42132* (NY, VEN), escarpment above Cañon Grande, E of Cumbre Camp, 1,800 m, 22 Nov 1957 (pist. fl), *B. Maguire et al. 42169* (NY, VEN), headwaters of Cañon Grande, SE portion, 1,900 m, 16–17 Oct 1970 (stam. fl), *J. Steyermark 103973* (NY, VEN), (pist. fl), *J. Steyermark 103975* (NY, VEN); Serranía Parú, Río Parú, Caño Asísa, SW escarpment, 1,850 m, 17 Dec 1950 (fr), *B. Maguire et al. 33283* (NY, VEN), summit, W rim, 2,000 m, 2 Feb 1951 (fr), *R. Cowan & J. Wurdack 31198* (NY, VEN); Serranía Yutajé, Río Manipiare, NW ridge, 1,500 m, 23 Feb 1953 (fr), *B.& C. Maguire 35393* (NY, VEN), 1,400 m, 1 Mar 1953 (fr), *B. & C. Maguire 35419* (NY, VEN), Coro-Coro Drainage, 1,500 m, 2 Mar 1953 (fr), *B. & C. Maguire 35500* (NY, VEN). **Bolívar:** Chimantá-Massif, Chimantá-tepuí, C section, above summit camp, 1,940 m, 4 Feb 1955 (stam. fl), *J. Steyermark & J. Wurdack 412* (NY, VEN), bordering zanjon above summit camp, between Middle and Upper Falls of Río Tirica, 1,925–1,940 m, 4 Feb 1955 (pist. fl), *J. Steyermark & J. Wurdack 592, 593* (NY, VEN), summit, along Caño Mojado, 1,985–1,910 m, 23 Feb 1955 (fr), *J. Steyermark & J. Wurdack 1107* (NY, VEN); NW slopes of Churí-tepuí (Murú-tepuí), 25 Jan 1953 (pist. fl, fr), *J. Wurdack 34198* (NY, VEN); Uaipán-tepuí, 1,900 m, 1–15 Feb 1948 (fr), *K. Phelps & C. B. Hitchcock 394* (NY, VEN).

Clusia hexacarpa is closely related to *C. radiata*, but easily distinguished by the larger bracteoles, fewer sepals and petals, and most notably, the perianth persistent in fruit. The type of subsp. *ptaritepuiana* Steyermark is notable only for its rose markings on the petals and purple stigmas. In other species of *Clusia* I have seen in the field, stigmas are often more purple when exposed to the sun.

Maguire had intended to describe another subspecies of *C. hexacarpa*, bearing the subspecific epithet "*octocarpa*", and several specimens were distributed bearing that epithet. However, Maguire never published the name, and study of those specimens indicate that population differs from others only in having eight instead of six carpels. Many more specimens were available to me than were to Maguire, showing that floral merosity can change significantly even within populations.

8. Clusia radiata Maguire & Phelps, Bot. Soc. Venez. Cienc. Nat. 14. 1952. Type. VENEZUELA. Amazonas: Cerro Guanay, SE escarpment, 1,800 m, 4 Feb 1953 (pist. fl, fr), *B. Maguire, D. Phelps, C. B. Hitchcock & G. Budowski 31758* (holotype: NY!; isotypes; F!, VEN).

Free-standing shrub to small tree to 5 m tall. Branchlets tetragonal, 6–8 mm diam., the angles obtuse, not alate. Leaves petiolate; blades cartilaginous, widely obovate, widely elliptic to suborbicuar, 6–10 cm long, 5–7 cm wide, apex and base widely rounded, base not decurrent on the petiole, symmetric, nitid above, pallid and without magenta glands below, midrib slightly elevated above, prominently elevated below, the secondary nerves barely distinguishable above, numerous, united by a submarginal collecting vein, linear latex canals inconspicuous, the margin entire, opaque, somewhat scarious, glabrous; petioles broadly marginate, 6–10 mm long, glabrous. Staminate inflorescence unknown. Pistillate inflorescence a single (rarely 3) terminal, pendent flower(s); peduncle angulate, 1.5–3 cm long, subtended by 2 small leaflike bracts 1.5–5 cm long, 1.2–3.5 cm wide; bracteoles 2, carnose, oblate, 12–14 mm long, 7–9 mm wide, apex broadly rounded, carinate, the margins entire, opaque, scarious. Pistillate flowers white; sepals 4, decussate, carnose, very widely ovate, 12–14 mm long, 7–9 mm wide, apex broadly rounded, linear latex canals inconspicuous, prominently carinate, the margin opaque, scarious, entire, glabrous; petals 8, cartilaginous, the outer and inner identical in shape, progressively smaller acropetally, the outer 4 decussate, the inner 4 imbricate, very widely obovate, 20–25 mm long, 16–20 mm wide, apex broadly rounded, linear latex canals few, moderately conspicuous, the margin entire, opaque, not scarious; staminodes numerous, 3.8–4 mm long, the filaments flat, 3–3.5 mm long, the anther linear, 0.3–0.5 mm long, apex truncate, base not distinguishable from filament, the connective darkened; pistil globose; carpels 7–10; styles minute, 0.8–1.0 mm long; stigmas carnose, cuneiform, subpeltate, 3–4 mm long and wide in fruit. Fruit ovoid, 3.5–4 cm long, 3.0–4.0 cm diam.

Distribution.—Endemic to Cerro Guanay, Amazonas, Venezuela, at 1,800–2,000 m elevation.

Ecology and conservation status.—*Clusia radiata* occurs on rocky outcrops along steep slopes. Cerro Guanay is a remote mountain and although nothing is known of the population biology of the species, it is likely that it is not threatened.

Representative specimen examined: **VENEZUELA. Amazonas:** Cerro Guanay, summit, 2,000 m, 4 Feb 1953 (fr), *B. Maguire et al. 31749* (NY).

Clusia radiata is most closely related to *C. hexacarpa*, but is easily distinguished from it by the wider leaves, longer bracteoles, uniform and more numerous sepals, and more numerous petals.

9. **Clusia maguireana** Pipoly, sp. nov. (Fig. 4)

Quoad petiolos late marginatos, flores solitarios vel 3, fructum ovoideum, laminas cartilagineas *C. hexacarpae* valde affinis, sed ab ea petiolis obsoletis vel 6 (non 6–15) mm longis, floribus 3–6 (nec 1–3), axillaribus (nec terminalibus), petalis suborbicularibus (nec orbicularibus vel obovatis) denique staminodiis 4 (non 8–9) praeclare distinguitur.

Shrub to small tree to 4(–10) m tall; branchlets tetragonal, strongly ridged but not winged, (4.5–)5–9 mm diam., glabrous. Leaves sessile; blades cartilaginous; very widely obovate, or rarely oblong, (3.5–)5–7(–10.2) cm long, (2.3–)3–5(–8) cm wide, apex rounded to truncate, base obtuse, not decurrent on the petiole, symmetric, nitid above, pallid and without magenta glands below, midrib raised above and below, secondary veins 20–30 pairs, not or barely visible, glabrous, w/o visible latex canals, the margin thick, opaque, revolute, entire, glabrous; petioles obsolete to 7 mm long, deeply canaliculate, ligulate, glabrous. Staminate inflorescence axillary, pendent, a twice-branched cyme, 2.5–3 cm long, the peduncle 5–7 mm long, the pedicels tetragonal, 5–7 mm long, glabrous; bracteoles 2, cartilaginous, suborbicular to oblate, 4–4.2 mm long, 4.5–4.7 mm wide, apex rounded, basally rugose, carinate, slightly cucullate, the margin entire, thick, opaque, glabrous; sepals 2, decussate to bracteoles, thinly coriaceous, oblate, 6.3–6.5 mm long, 7–7.2 mm wide, apex rounded, cucullate, the latex canals obscure, marginate, the margin chartaceous, ca. 0.7 mm wide, opaque, entire, glabrous; petals 4, decussate in pairs and to the sepals, thickly carnose, dimorphic, latex canals conspicuous the outer pair sublinguiculate, 5.2–5.9 mm long, the claw 0.7–1 mm long, 2.1 mm wide, the limb oblate, 4.5–4.9 mm long, 5.7–5.9 mm wide, apex broadly rounded, the margin thick, opaque, entire, glabrous, the inner pair unguiculate, 4–4.3 mm long, the claw 1–1.1 mm long, 1.3–1.4 mm wide, the limb oblate, 3–3.2 mm long, 3.5–3.7 mm wide, apex broadly rounded, the margin undifferentiated, opaque, entire, glabrous; receptacle convex, cubic, 1.6–1.8 mm high, 1.1–1.2 cm long and wide, without resin; androphore cubic, stamens 26, equal in size, free, 1–1.1 mm long, the filaments fleshy, flattened, free, 0.2–0.3 mm long, the anthers oblong, 0.9–1 mm long, ca. 0.5 mm wide, apex emarginate, base deeply cordate, the connective darkened, glabrous, longitudinally dehiscent over entire length; pistillode absent. Pistillate inflorescence pendent, a reduced cyme, 1.5–2(–2.5) cm long, the peduncle 2–3(–5) mm long, the pedicels tetragonal, 2–3 mm long, glabrous; bracteoles 2, cartilaginous, suborbicular to oblate, 2.1–2.2 mm long, 2.4–2.5 mm wide, apex obtuse, basally rugose, carinate, slightly cucullate, the margin entire, thick, opaque, glabrous; sepals 2, decussate to bracteoles, thinly coriaceous, orbicular, 6.4–6.6 mm long, and wide, apex rounded, cucullate, the latex canals obscure, marginate, the margin chartaceous, ca. 0.7 mm wide, opaque, entire or sparsely incised, glabrous; petals 4, decus-

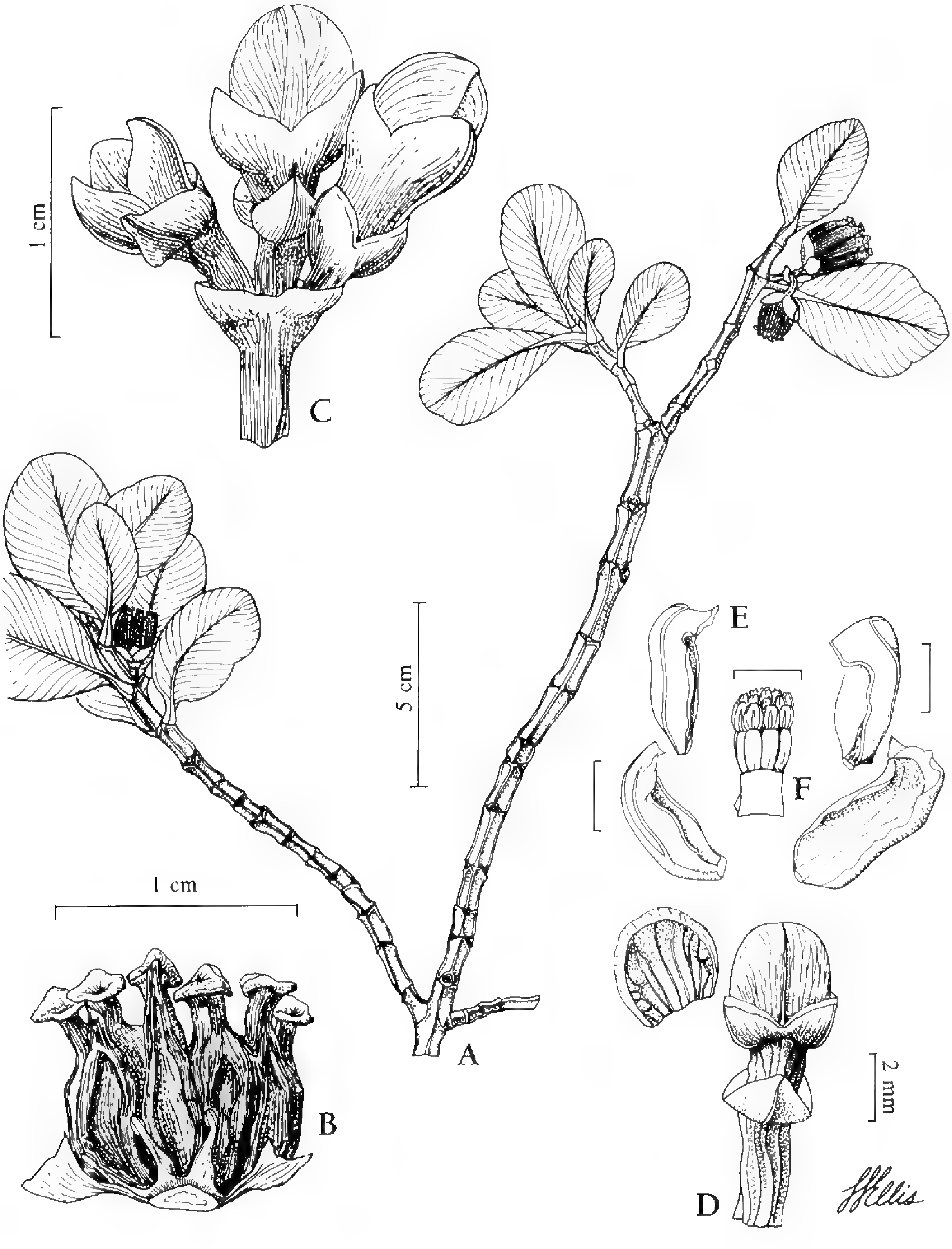

FIG. 4. *Clusia maguireana* Pipoly. Habit. B.Fruit. C. Pistillate cyme. D. Staminate pedicel, and separated sepal, showing scarious margin. E. Petals and androecium. A-C, drawn from type; D-E, drawn from *Steyermark 93542*.

sate in pairs and to the sepals, thickly carnose, dimorphic, latex canals conspicuous, the outer pair suborbicular, 4.5–4.9 mm long and wide, apex broadly rounded, the margin thick, opaque, entire, glabrous, the inner pair suborbicular, 4.2–4.3 mm long and wide, apex broadly rounded, the margin undifferentiated, opaque, entire, glabrous; staminodes 4, resembling stamens, 2–2.4 mm long, the filaments flattened, 1.4–1.6 mm long, broadly expanded at base, the sterile anthers orbicular, ca. 0.7 mm long and wide; pistil 10–carpellate, strongly ribbed, subglobose, 6–6.3 mm long, 5.6–5.8 mm diameter, styles obsolete, stigmas attached apically and basally, cuneiform, 2–2.1 mm long, 1.4–1.6 mm wide, persistent. Fruit subglobose, 1.7–2 cm long, 1.4–1.6 cm wide at maturity, strongly ribbed.

Type:. VENEZUELA. Bolívar: Dtto. Piar, Macizo del Chimantá, sector N-central of Chimantá-tepuí, eastern headwaterscabeceras of Caño Chimantá, 5°18'N, 62°09'W, 2,000 m, 26–29 Jan 1983 (pist. fl, fr), *J. Steyermark 127980* (holotype: VEN; isotypes: BRIT, F, MO-2 shts, US).

Paratypes: VENEZUELA. Bolívar: Saddle between Terekeyuren and Murisipan-tepuí, 1,650 m, 22 Mar. 1987 (fr), *B. Holst 3469* (BRIT, MO, US, VEN); Dtto. Piar, central & W part of saddle between Camarcaibarai-tepuí and Tereké-Yurén-tepuí, 1,800–1,900 m, 05°52'N, 62°01'W, 23 May 1986 (fr) *R. Liesner et al. 21006* (BRIT, MO, US, VEN); Auyán-tepuí, summit of central portion of NE arm (W range), between "Drizzly Camp" and "Río Lomita Camp," 1,800–1,850 m, 5 May 1964 (pist. fl, fr), *J. A. Steyermark 93442* (F, NY, US, VEN), same general area, woods beside small creek among savannas S of Jimmy Angel crash site, 1,800 m, 7 May 1964 (stam. fl), *J. A. Steyermark 93542* (NY, US, VEN); central-NW section of E arm, Auyán-tepuí, 05°57'N, 62°25'W, 1,950 m, 27 Aug 1983 (stam. fl), *O. Huber et al. 8096* (MYF, NY, VEN); Uei-tepuí, between SE slope and summit, between Luepa & Cerro Venamo, vic. of km. 125, S of El Dorado, 1,100–1,300 m, 7 Mar. 1962 (fr), *J. A. Steyermark & L. Aristeguieta 20* (F, US, VEN); Macizo del Chimantá, Dtto. Piar, central-southern section, wide valley between NE border of Torono-tepuí and central section of Chimantá-tepuí, S drainage, 5°16'N, 62°09'W, 2,100 m, 11–15 Feb. 1985 (stam. bud), *J. Pipoly et al. 7261* (MYF, NY, MO, VEN), (pist. fl, fr), *O. Huber. J. Pipoly et al. 10171* (MYF, NY, VEN), (stam. fl), *O. Huber. J. Pipoly et al. 10219* (MYF, NY, VEN); central-NW section of Chimantá-tepuí, E headwaters of Caño Chimantá, 05°18'N, 62°09'W, 2,000 m, 26–29 Jan 1983 (pist. fl, fr), *O. Huber & J. Steyermark 6934* (MYF, NY, VEN), (pist. fl, fr), *J. Steyermark et al. 127980* (NY, VEN); Abácapa-tepuí, *Bonnetia* forest, NW part of summit, 2,125–2,300 m, 13 Apr. 1953 (fr), *J. A. Steyermark 74861* (F, US, VEN); Abácapa-tepuí, above 1st line sandstone bluffs, 2,000–2125 m, 14 Apr. 1953 (fr), *J. A. Steyermark 75002* (BRIT, F, MO, US, VEN); Apácara-tepuí, elfin forest formation on plateau of SE-facing upper shoulder of Apácara-tepuí, 2,000 m, 19 June 1953 (fr), *J. A. Steyermark 75717* (F, NY, US, VEN); Agparaman-tepuí, SE-facing forested slopes below escarpment, 1,880–1,955 m, 26 Feb. 1955, *J. A. Steyermark & J. J. Wurdack 1166* (pist. fl, fr), (F, NY, US, VEN). **GUYANA. Potaro-Siparuni Region:** Kaieteur National Park, N of Menzie's Landing, 05°N, 59°29'W, 400 m, 26 Jan 1987 (fr), *J. Pipoly & G. Gharbarran 10029* (BRIT, BBS, CAY, FDG, K, NY, P, U, US); Pakaraima Mts., Mt. Wokumung, summit ridge of Kamiewah Pinnacle NE to S Pinnacle, "Little Ayanganna," 05°04'N, 59°52'W, 1,550–1,650 m, 17 Nov 1993 (pist. fl), *T. Henkel et al. 4495* (BRG, BRIT, US).

Distribution.—Endemic to the eastern tepuis of the state of Bolívar, Venezuela, and adjacent Guyana, at (400–)1,100–2,300 m elevation.

Ecology and conservation status.—*Clusia maguireana* is restricted to rocky outcrops, usually on overhanging ledges, and is subject to high winds and driving rains. I observed small patches of this species on the Kaieteur Plateau, but most of them were not fertile. It appears that the species has a considerable range, and because it occurs in a very hostile habitat, it is most likely not threatened.

Etymology.—It is with great pleasure that I dedicate this species to the late Bassett Maguire, prodigious fieldworker, student of neotropical Clusiaceae and the flora of the Guayana Highland during his long career at the New York Botanical Garden. He conducted many expeditions to the most remote localities of the Guayana Highland, where he collected excellent specimens despite the harsh field conditions.

Clusia maguireana is most closely related to *Clusia hexacarpa*, but may be distinguished from it by the axillary inflorescence with greater number of flowers, the subsessile leaves, suborbicular petals and fewer staminodes.

10. Clusia opaca Maguire, Bot. Mus. Leafl. 15:62. 1951. TYPE: BRAZIL. Amazonas: Path between headwaters of Ira-Igarapé and headwaters of Igarapé Abiú, affluent of Rio Taraira, 4–6 Jul 1948 (stam. fl), *R. E. Schultes & F. López 10192* (HOLOTYPE: NY!; ISOTYPE: GH).

Clusia reducta Steyerm., Fieldiana, Bot. 28:391. 1952. syn. nov. TYPE. VENEZUELA. Amazonas: Caño San Miguel, above mouth of Ichana, Guainía, 125 m, 26 Mar 1942 (pist. fl, fr), *Ll. Williams 14898* (HOLOTYPE: F!; ISOTYPE: US!).

Free-standing shrub to tree 6 m tall; branchlets subterete, 3–4 mm diam., sparsely longitudinally ribbed, glabrous. Leaves petiolate; thickly coriaceous, oblong or elliptic, (4.5–)7–9 cm long, 2.5–3.5(–5) cm wide, apex and base broadly rounded, the base not decurrent on the petiole, symmetric, nitid above, pallid and without magenta glands below, midrib impressed above, prominently raised below, the secondary veins numerous, inconspicuous, united by a submarginal nerve, linear latex canals inconspicuous, the margin revolute, entire, glabrous; petiole canaliculate, (0.6–) 1–1.5 cm long, glabrous. Staminate inflorescence terminal, pendent, a compact compound cyme, 6–18-flowered, 1.5–2 cm long, and wide; subtended by a pair of leaflike bracts, 1.5–4 mm long, 0.7–1.2 cm wide, apex broadly rounded, base obtuse, the margins revolute, entire; peduncle ca. 3 mm long, subterete, glabrous; bracts carnose, oblate, 1.8–2.2 mm long, 2–2.4 mm wide, apex rounded, carinate, the margin entire, opaque, not scarious, glabrous; bracteoles 4, decussate, oblate, carnose, 1.8–2.2 mm long, 2–2.5 mm wide, apex obtuse, carinate, the margin entire, opaque, scarious, glabrous; pedicels angulate, 3–7 mm long, glabrous. Staminate flowers white; sepals 4–5(–6), the outer opposite, decussate to the bracts, membranaceous, orbicular, 3–5 mm long, and wide, apex broadly rounded, linear latex canals few, conspicuous, the margin entire, hyaline, scarious, glabrous, the inner ones imbricate, 3.8–4.2 mm long and wide, apex broadly rounded, the margin entire, hyaline, scarious; petals 4–5, coriaceous, oblong, the outer ones opposite, the inner imbricate, all similar in shape, acropetally decreasing in size, 4–6 mm long, 3.8–4.5 mm wide, apex broadly rounded, cucullate, the linear latex canals obscure, margins entire, opaque, not scarious, glabrous; androphore pentagonoid, concave; stamens numerous, 0.9–1.5 mm long, the filaments flattened, connate basally, the distal ones 0.2–0.3 mm long, the interior 0.5–0.7 mm long, the anthers linear, oblong, 0.7–1 mm long, 0.2–0.3 mm wide, apex rounded, base obtuse; pistillode obsolete, not resiniferous. Pistillate inflorescence as in staminate, but bracteoles 2–2.5 mm long, 2.3–2.5 mm wide. Pistillate flowers as in staminate, but sepals 4–6, 4–4.5 mm long, 4.5–5 mm wide, petals 4–5 mm long, 3.3–4 mm wide; staminodia numerous, 0.8–1.2 mm long; filaments flat, linear, anthers barely differentiated, ca. 0.2 mm long, apex rounded, base not differentiated; pistil subglobose, 3–5 mm long and wide; carpels 5; styles subobsolete; stigmas sessile, orbicular, ca. 1 mm diam., ovules numerous. Fruit globose, 1.2–1.5 cm long and in diam.

Distribution.—Western Amazon Basin of Brazil, Venezuela and Colombia, at 80–160 m elevation.

Ecology and conservation status.—*Clusia opaca* is endemic to "Amazonian caatinga," campinas, and "Bana" formations, all of which are lowland subxeric areas of deep white sands, often near black water rivers, but not subject to inundation (Macedo & Prance 1978; Prance 1979; Prance & Schubart 1978). These environments all share essentially the same nutrient cycling regime, and vary only in terms of local species composition. The white sands are coarse in texture, extremely well-drained, and derived from eroded tepuis. *Clusia opaca* is locally common, and because it occurs near the major black water rivers of the Amazon Basin, which support relatively heavy river traffic, it should be considered threatened.

Common names.—"Pai-nan-ge" (Brazil, Makú language); "copei," "upihi," "baniha," "cupi" (Venezuela).

Specimens examined: **COLOMBIA. Caquetá:** Araracuara, sandstone plateau behind military camp, 00°37'S, 72°24'W, 18 Oct 1990 (fr), *J. Duivenvoorden & A. Cleef 314* (BRIT, COL, U). **VENEZUELA. Depto. Atabapo:** SE bank of the middle part of Caño Yagua at Cucurital de Yagua, 03°36'N, 66°34'W, 120 m, 8 May 1979 (fr), *G. Davidse et al. 17361* (MO, MYF, NY, VEN); El Almidón, limit of Depts. of Atabapo and Casiquiare, Río Atacavi, slope 2, 03°04'N, 67°06'W, 80 m, Nov 1989 (fr), *J. Velazco 869* (BRIT, PORT, VEN); Near San Antonio, Alto Orinoco, along Río Orinoco, 120 m, 15 Aug 1982 (pist. fl), *T. Ruíz et al. 3964* (MY, VEN); Río Guainía, 14 Apr 1953 (pist. fl), *B. Maguire & J. Wurdack 35642* (F, MO, NY, US, VEN); savanna 5 km E of Maroa, 130 m, 6 Oct 1957 (stam. fl), *B. Maguire et al. 41705* (F, NY, US, VEN), (pist. fl bud), *B. Maguire et al. 41706* (F, NY, US, VEN) Maroa-Yavita road, between Río Guainía and Caño Pimichín, ca. 2 km beyond Maroa airport, 02°43'N, 67°38'W, 8 Oct 1978 (pist. fl, fr), *H. Clark 6863* (MO, NY, US, VEN); Maroa, Río Guainía, 127 m, 1942 (fr), *Ll. Williams 14254* (F, US); Pimichín, 128 m, 2 Jul 1942 (fr), *Ll. Williams 14183* (F, US); savanna 0.5–1.5 km N of Puerto Colombia, opposite Maroa, Colombia, 130 m, 12 Oct 1957 (fr), *B. Maguire et al. 41843* (F, NY, VEN); Depto. Casiquiare, Río Casiquiare, 40 km beyond the mouth and 5 km NE of camp, 28 Jan 1991 (fr), *M. Colella et al. 1610* (BRIT, NY, VEN); Río Casiquiare, 162 kms from the mouth, 3 Feb 1991 (fr), *M. Colella et al. 1752* (BRIT, NY, VEN)[mixed collection with *C. gaudichaudii* Choisy ex Pl. & Tr]; Caño San Miguel, sector "Las Tinajas," 02°39'N, 66°45'W, 160 m, 25 Apr 1991 (fr), *G. Aymard 9237* (BRIT, PORT, VEN).

Clusia opaca is most closely related to *C. guayanae*, burt easily distinguished by the obtuse to broadly rounded leaf bases, the shorter peduncle, suborbicular sepals, coriaceous petsls, numerous staminodes and sessile, orbicular stigmas.

11. **Clusia guayanae** Pipoly, sp. nov. (Fig. 1)

Species haec quoad petiolos canaliculatos, flores 6–18 in cyma insidens, fructus globosum, laevem, non costatoque, *C opacae* valde arcte affinis, sed ab ea laminis ad basem obtusis vel late rotundatis (non acutis vel obtusis), pedunculis 5–12 (non 3–5) mm longis, sepalis 2 (non 4 6), oblatis (nec suborbicularibus), petalis cartilaginosis (non coriaceis), staminodiis 4 (non numerosis), denique stigmatibus pentagonis (non orbicularibus) perspicue recedit.

Shrub to 2 m; branchlets tetragonal, 3.5–5 mm diam., glabrous; latex white. Leaves petiolate; blades coriaceous, oblanceolate to obovate or rarely suborbicular, (3–)4–6(–7) cm long, (1.5–)2–3.5(–4) cm wide, obtuse to truncate, base obtuse to rounded, nitid above, pallid and without magenta glands below, glabrous, midrib slightly raised above, prominently raised below, secondary veins numerous, at a steep angle from midrib to a large submarginal collecting vein, ca. 0.3 mm from margin; petiole canaliculate, 3–5 mm long, with a deep channel at base. Staminate inflorescence terminal, a pendent panicle, 2–3 cm long, 2–3 cm wide, the branches cymose, in sets of 3; peduncle squarrose 5–8(–12) mm long; secondary branch bracts 2, carnose, depressed ovate, 1.8–2 mm long, 2.1–3 mm wide, apex broadly rounded, glabrous, margins entire, opaque; bracteoles 4, decussate, carnose, depressed ovate, 2.2–2.4 mm long, 2.6–2.8 mm wide, apex broadly rounded, glabrous, margins entire, opaque; sepals 6, coriaceous, decussate, the outer 2, depressed-ovate cucullate, carinate, 4–4.5 mm long, 5–5.5 mm wide, apex broadly rounded, margins entire, opaque, glabrous, the inner ones oblong, cucullate, 5–5.3 mm long, 4–4.5 mm wide, apex truncate to widely rounded, the margin scarious, entire; petals 4, cartilaginous, oblong to widely oblong, cucullate, apex obtuse to truncate, 3.5–5 mm long, 2–3 mm wide, margin irregular, opaque, thick; androphore concave, cuadrate, 0.8–1 mm long, 1.4–1.6 mm diam.; stamens 8, oblong, muticous, filaments and anthers undifferentiated, 0.8–1 mm long, 0.3–0.4 mm wide, apex rounded; pistillode absent. Pistillate inflorescence as in staminate, but 1.5–2 cm long, 1.5 cm wide, secondary branch bracts 2, as in staminate; bracteoles 4, decussate, as in staminate flowers; sepals 6, decussate, depressed ovate, the outer ones sepals 3.8–4 mm long, 4.2–4.5 mm wide, inner ones 4.8–5 mm long, 4–4.2 mm wide, coriaceous, cucullate, carinate, apex broadly rounded, the margin scarious; petals deep pink, 4–5,

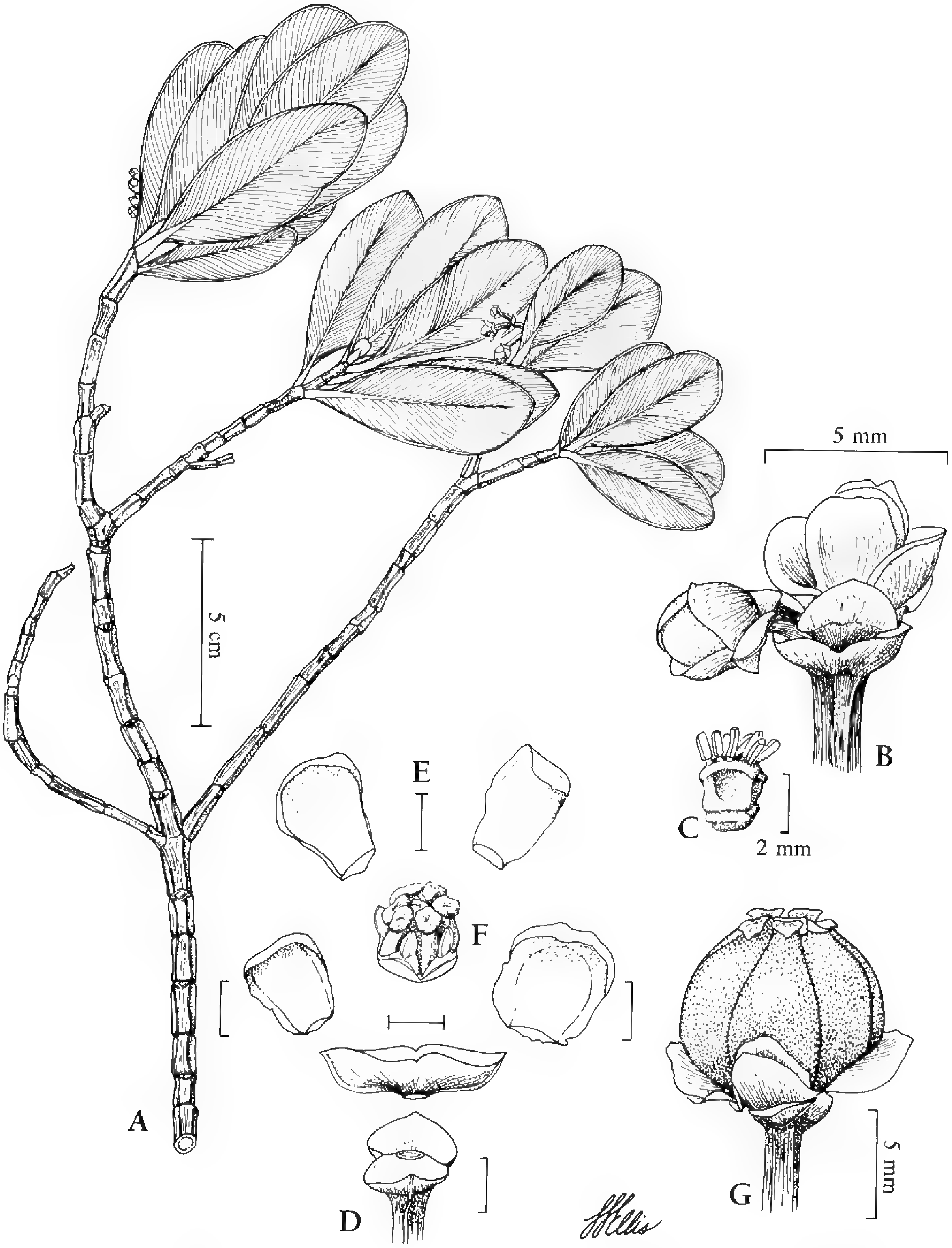

FIG. 5. *Clusia guayanae* Pipoly. A. Habit. B. Immature inflorescence. C. Androphore and androecium. D. Bracts and sepals. E. Corolla. F. Staminodia and ovary. G. Fruit. A-C, drawn from *Steyermark & Holst 20984*; D-G, drawn from *Huber 9330*.

cartilaginous, oblong, 5–7 mm long, 2–3 mm wide, cucullate, apex broadly rounded; staminodes 4, 1.8–2.2 mm long, thin, strap-like, bases united by a flat tube 0.2 mm long, the filaments 1–1.2 mm long, broadly ovate, the anthers widely oblong, 0.8–1 mm long, 0.6–0.8 mm wide, apex muticous, with narrow longitudinal slits; pistil 5-carpellate, subglobose, 2.7–3 mm long and diam., the stigmas peltate, subsessile, pentagonal. Fruit depressed-globose, 0.8–1 cm long, 1–1.2 cm diam., pinkish yellow.

Type. GUYANA. Cuyuni-Mazaruni Region: Mt. Ayanganna, E side on steep slopes, 5°27'N, 59°57'W, 1,250–1,300 m, 12 Mar 1987 (pist. fl), *J. Pipoly, G. Gharbarran, G. Samuels, J. Chin 11162* (holotype: FDG; isotypes: BRIT, NY, US,).

Paratypes. **VENEZUELA.** Bolívar: Dtto. Heres; Macizo del Guaiquinima, central-NE section, slope draining S; 5°54'N, 63°42'W; 1,350 m, 1 Apr. 1984 (pist. fl, fr), *O. Huber 9330* (MYF, NY, VEN); Dtto. Piar, Central and western part of saddle between Camarcaibarai-tepuí and Tereké-Yurén-tepuí, 05°52'N, 62°01'W, 1,800–1,900 m, 23 May 1986 (stam. fl), *R. Liesner, et al. 20984* (MO, US, VEN); Camarcaibarai-tepuí, shoulder of W slope, easternmost tepuí of Aparamán-tepuí range, 05°52'N, 62°01'W, 1,800 m, 24 May 1986 (pist. fl, fr), *B. Holst et al. 2887* (MO, VEN); Auyán-tepuí, summit, south-central region, headwaters of Río Churún, 05°51'N, 62°32'W, 1,700 m, 29 Mar 1987 (fr), *B. Holst 3738* (MO, VEN); plain in westernmost section of W arm of Auyán-tepuí, 25 km SE of Canaima, 06°06'N, 62°43'W, 1,650 m, 13 Nov 1984 (stam. fl), *O. Huber 9728* (MYF, NY, VEN).

Distribution.—Endemic to the easternmost tepuis of Bolívar state, Venezuela, and their satellites, at 1,250–1,900 m.

Ecology and conservation status.—*Clusia guayanae* occurs in low, scrub cloudforest formations along edges of sandstone bluffs, dominated by *Clusia melchiorii*, *Clusia crassifolia* Planch. & Triana, *Bonnetia* spp., numerous Myrtaceae and Rubiaceae. Its habitat has a hostile climate, with strong winds and rains. Because this species appears to inhabit the most inhospitable of climates, it is not considered threatened.

Etymology.—The specific epithet, "guayanae" is in the Latin locative, for this member of the autochthonous flora of the Guayana Highland.

With canalicuate petioles, flowers in 6–18-flowered cymes, and smooth, globose fruits without ribs, *C guayanae* is most closely related to *C. opaca*. However, *C. guayanae* is easily separated from *C. opaca* by the broadly acute to obstuse leaf bases, longer peduncle, fewer, oblate sepals, cartilaginous petals, 4 staminodes and pentagonal stigmas on styles.

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NUMERICAL LIST OF TAXA

1. Clusia duidae Gleason
2. Clusia grammadenioides Pipoly
3. Clusia multilineata Pipoly
4. Clusia asymmetrica Pipoly
5. Clusia melchiorii Gleason
6. Clusia cardonae Maguire
7. Clusia hexacarpa Gleason
8. Clusia radiata Maguire & Phelps
9. Clusia maguireana Pipoly
10. Clusia opaca Maguire
11. Clusia guayanae Pipoly

LIST OF EXSICCATAE

The figures in parentheses refer to the numbers from the numerical list of taxa.

Agostini, G & T. Koyama 7458 (6). Amaral, I. do; J. Pipoly et al. 1593 (5). Aymard, G. 9237 (10).

Beck, H. et al. 938 (5). Bernardi, L. 931 (6). Berry, P. et al. 4886 (5); 4926 (5). Boom, B.10863 (5). Boom, B. & G. Samuels 9120 (5); 9201 (5). Boom, B. & D. Gopaul 7705 (6).

Cardona, F. 2064 (5); 1036 (5). Clark, H. 6863 (10). Collela, M. et al. 1752 (10); 1610 (10). Cowan, R. & J. Wurdack 31257A (5); 31258 (5); 31244 (5); 31198 (7).

Davidse, G. et al. 17361 (10). Duivenvoorden et al., J. 2673 (2); 314 (10).

Florschütz, P. & P. Maas 3040 (5).

Gentry, A. & B. Stein 46596 (7). Granville, J. J. De 5401 (5); 8762 (5); 8761 (5).

Henkel, T. et al. 4495 (9); 1535 (5). Hoffman, B. et al. 3104 (6); 3567 (5); 2086 (6); 1184 (5). Holst, B. 2887 (11); 3469 (9); 3738 (11); 3784 (5); 3387 (5). Huber, O. et al. 9728 (11); 9330 (11); 11135 (6); 8096 (9); 12437 (5); 12098 (6). Huber, O., J. Pipoly et al. 10171 (9); 10219 (9). Huber, O. & L. Hernández 11721 (6). Huber, O. & J. Steyermark 6934 (9).

Irwin et al., H. 54864 (5).

Jansen-Jacobs, M. 875 (5).

Koyama, T. & G. Agostini 7473 (6); 7482 (5).

Liesner, R. et al. 8576 (2); 16649 (3); 17603 (1); 18533 (1); 20984 (11); 21006 (9); 24972 (4); 25135 (1). Liesner, R. & G. Carnevali 22489 (7); 22575 (7); 22797 (4). Liesner, R. & R. Hall 3447 (2). Londoño, C. et al. 1150 (2).

Maguire, B. et al. 24585 (5); 24585A (5); 24641 (5); 29124 (5); 30028 (7); 30033 (7); 30179 (7); 30642 (5); 30740 (5); 29535 (5); 30017 (1); 30029 (7); 30927 (5); 31578 (8); 31665 (5); 31746 (5); 31749 (8); 32990 (5); 33283 (7); 33318 (6); 33319 (6); 33391 (5); 36905 (5); 36990 (7); 37003 (7); 37022 (7); 37144 (7); 37247 (7); 37248 (5); 41705 (10); 41706 (10); 41843 (10); 42132 (7); 42169 (7); 42377 (5); 42731 (5); 42758 (5). Maguire, B. & C. Maguire 35174 (5); 35419 (7); 35500 (7); 35393 (7). Maguire, B. & L. Politi 27781 (5); 27894 (5); 28014 (5); 28302 (5); 28797 (5); 32891 (5); 40308 (5); 45986A (5); 46038A (5); 46081A (5). Maguire, B. & J. Wurdack 33905 (5); 35642 (10). Mori, S. et al. 8770 (5).

Phelps, K. & C. B. Hitchcock 78 (5); 394 (7); 412 (6). Pinkus, A. 161 (5). Pipoly, J. et al. 6614 (5); 7261 (9); 10293 (5); 10330 (5); 10330 (5); 11102 (6). Pipoly, J. & K. Alfred 7711 (5); 7821 (5); 7789 (5). Pipoly, J. & G. Gharbarran 10029 (9). Pipoly, J. & G. Samuels 6864 (5). Prance, G., J. Pipoly et al. 29209 (5).

Rodríguez, H. 2875 (4). Ruíz. T. et al. 3964 (10).

Schultes, R. E. & F. López 10192 (10). Schulz, J. 10303 (5); 10296 (5). Stein, B. & A. Gentry 1535 (5); 1651 (7). Steyermark, J. et al. 58945 (5); 59866 (7); 59903 (5); 74861 (9); 75002 (9); 75005 (5); 75717 (9); 89049 (5); 93442 (9); 93542 (9); 92502 (6); 93538 (5) 93881 (5); 98144 (5); 103992 (5); 103159 (5); 103847 (5); 103973 (7); 103975 (7); 105958 (5); 107282 (5); 109363 (5); 109654 (5); 117320 (5); 127980 (9); 129648 (1) 131998 (6); 132175 (6). Steyermark, J. & L. Aristeguieta 20 (9); 22 (6); 90 (6). Steyermark, J. & S. Nilsson 112 (6); 204 (6). Steyermark, J. & J. Wurdack 412 (7); 592 (7); 593 (7); 942 (5); 1017(5); 1107 (7); 1166 (9).

Tate, G. 429 (1); 705 (5). Tavares, A. S. et al. 139 (5).

Velazco, J. 869 (10).

Williams, Ll. 14183 (10); 14254 (10); 14898 (10). Wurdack, J. 34198 (7); 34092 (5).

TAXONOMY OF *CYPHOMERIS* (NYCTAGINACEAE) BASED ON MULTIVARIATE ANALYSES OF GEOGRAPHIC VARIATION

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ABSTRACT

The two species of *Cyphomeris* (Nyctaginaceae) occur in arid regions of central southern North America. Historically, *C. gypsophiloides* (Mart. & Gal.) Standl., the more widespread, consisted of two subspecies. The other, *C. crassifolia* (Standl.) Standl., is restricted to the eastern margin of the range of the genus. A survey of herbarium specimens reveals considerable variation particularly in fruit characteristics, leaf shape, and foliar pubescence and some intergradation in these features among populations. We used 114 specimens and 29 population samples to examine relationships of 14 vegetative and 10 fruit characters. Cluster analysis, principal components analysis, discriminant analysis, and multivariate analysis of variance indicate the presence of two morphological groups that correspond roughly to the species-level taxa of previous authors, groups that can be separated by morphology, geography, and ecology. These two species are maintained. The sole infraspecific taxon, *C. gypsophiloides* var. *stewartii* I. M. Johnst., is noted to be an extreme and geographically restricted form intergradient with nearby populations and is not recognized taxonomically.

RESUMEN

La variación geográfica de macromorfologia de *Cyphomeris*, un género pequeño de Nyctaginaceae de zonas áridas de la parte sur-centro de Norte América, fue examinada mediante el uso de métodos estadísticos multivariantes. Autores anteriores reconocieron dos especias, una [*C. gypsophiloides* (Mart. & Gal.) Standl.] con dos subespecias, y la otra [*C. crassifolia* Standl.] restringida a la parte este del área del género. Usamos 114 muestras y ejemplares de 29 poblaciones para revisar las afinidades de 14 caracteres vegetativos y 10 caracteres de los frutos. Los datos fueron analizados por análisis de agrupación, análisis de componentes principales, análisis discriminante, y análisis de multivariante. Los resultados indican la presencia de dos grupos morfológicos que se corresponden aproximadamente con los taxa delnivel de especie de los autores anteriores; que pueden ser separadas por su morfología, geografía, y ecología. Unicamente no se reconoce el taxon infraespecifico, *C. gypsophiloides* var *stewartii* I. M. Johnston, pero es considerado como una forma extrema, intermedia con poblaciones más o menos aisladas en las montañas próximas.

INTRODUCTION

Cyphomeris Standl. (Nyctaginaceae) is a small genus of perennial herbs distributed in arid and semi-arid regions of northern Mexico and the southwestern United States. It has been considered a subgenus of *Boerhavia* L.

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(Fosberg 1978). Standley (1911) and Reed (1970) recognized two species, *C. gypsophiloides* (Mart. & Gal.) Standl. and *C. crassifolia* (Standl.) Standl., distinguished by leaf shape, leaf pubescence, and features of the fruit, each having a geographic range more or less exclusive of the other. I. M. Johnston (1944) described a third taxon, *C. gypsophiloides* var. *stewartii*, from La Sierra el Diablo in southeastern Chihuahua, noting its robust habit and glandular hairs. He refrained from describing it at specific rank because he thought collections of *C. gypsophiloides* var. *gypsophiloides* from extreme southwestern Coahuila were transitional to it.

The two species of *Cyphomeris* are not completely distinguishable morphologically. There is a wide range of variation (Fig. 1) within and between species, some apparently more or less continuous, other clearly discontinuous. The geographic limitation of the genus to an ecologically definable region and fragmentation of populations according to available habitat allows an assessment of relationships of morphological variation to geography and topography throughout the range of the genus. These results were used to examine the significance of the characters used by previous authors in the delimitation of species of *Cyphomeris,* and to aid in our own taxonomy of the genus.

CHARACTERISTICS OF POPULATIONS AND POLLINATION

Throughout much of its range, and particularly west of the Sierra Madre Oriental, *Cyphomeris* often exists in small groups of 20–30 individuals confined to rocky soils of road cuts, washes, and other rough terrain, generally separated from other such groups by large distances. Thus, the overall population is highly subdivided and the majority of outcrossing probably occurs between genetically related individuals. In addition, moderate to high levels of self fertilization also occur. Monitoring of a natural population of *Cyphomeris* in southern New Mexico indicates that plants produce fruits from all or mostly cleistogamous flowers during the dry months (typically May–July) of the growing season (Fig. 2). After the onset of summer rains (typically July–September) plants produce mostly or all chasmogamous flowers. In each of two growing seasons mean percentage of cleistogamous flowers began at 100%, their relative frequency decreasing as the season progressed, corresponding to an increase in precipitation. Pooled data (across years) reveals a significant correlation (r = -0.74, $P < 0.05$) between the mean percentage of cleistogamous flowers and cumulative rainfall.

Chasmogamous flowers, about a centimeter across and varying from deep to pale pink or rarely nearly white, are visited by small bees, flies, and butterflies during early morning hours. Insects tend to move from flower to flower on the same plant, afterward moving to a nearby plant where the pattern of intraplant visitation often is repeated. Whether or not a flower is

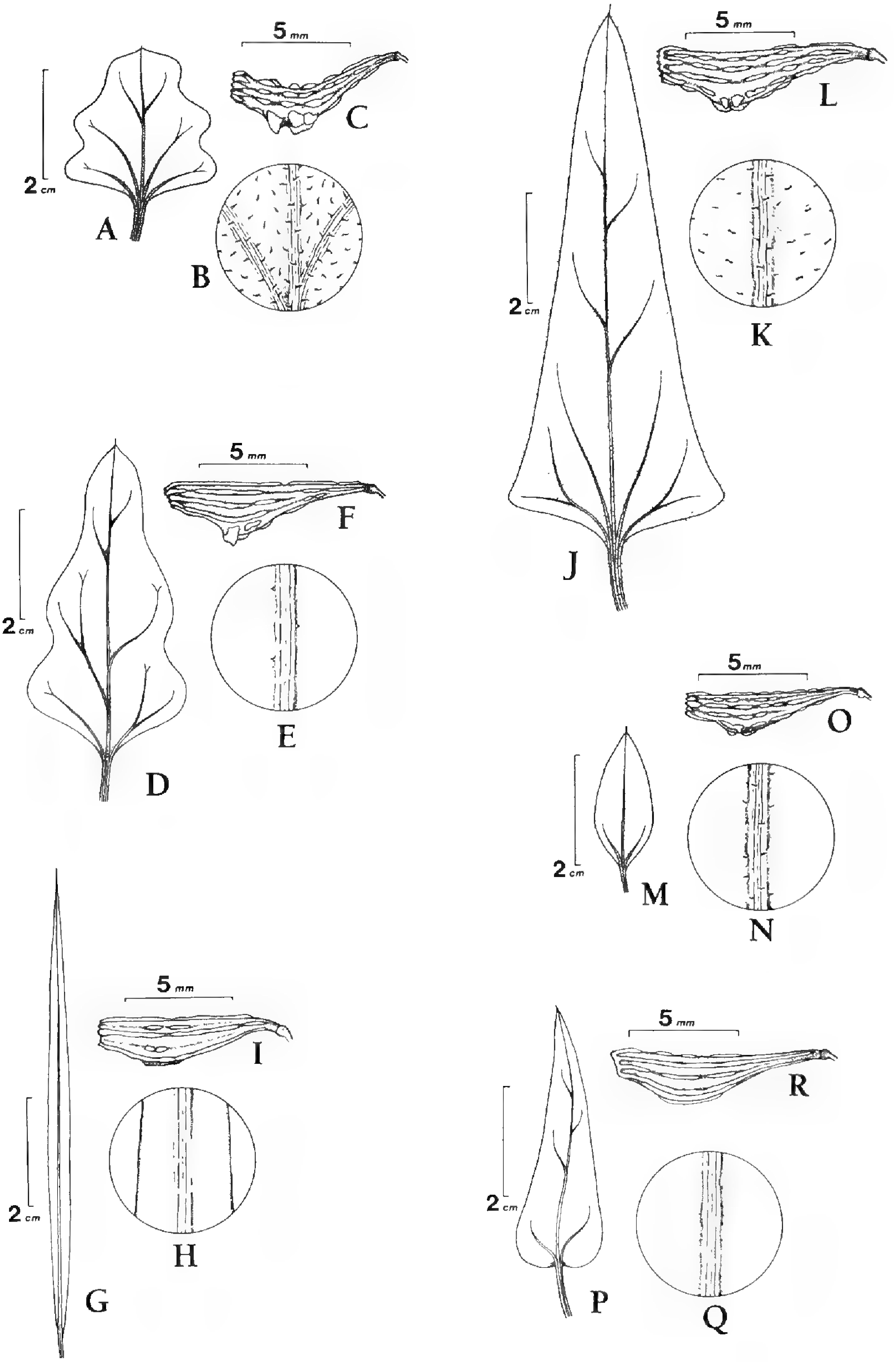

FIG. 1. Leaves and anthocarps of *Cyphomeris*. Figures in circles show abaxial leaf surface at 40. Sample numbers are given in parenthesis and associate drawings with vouchers listed in Appendix A and localities on map (Fig. 4); (a-c) *C. crassifolia* (17), (d-f) intergrade from western Texas (8), (g-i) linear-leaved example of *C. gypsophiloides* (24), (j-l) *C. gypsophiloides* var. *stewartii* (25), (m-n) intergrade from central San Luis Potosi (20), (p-r) *C. gypsophiloides* (29).

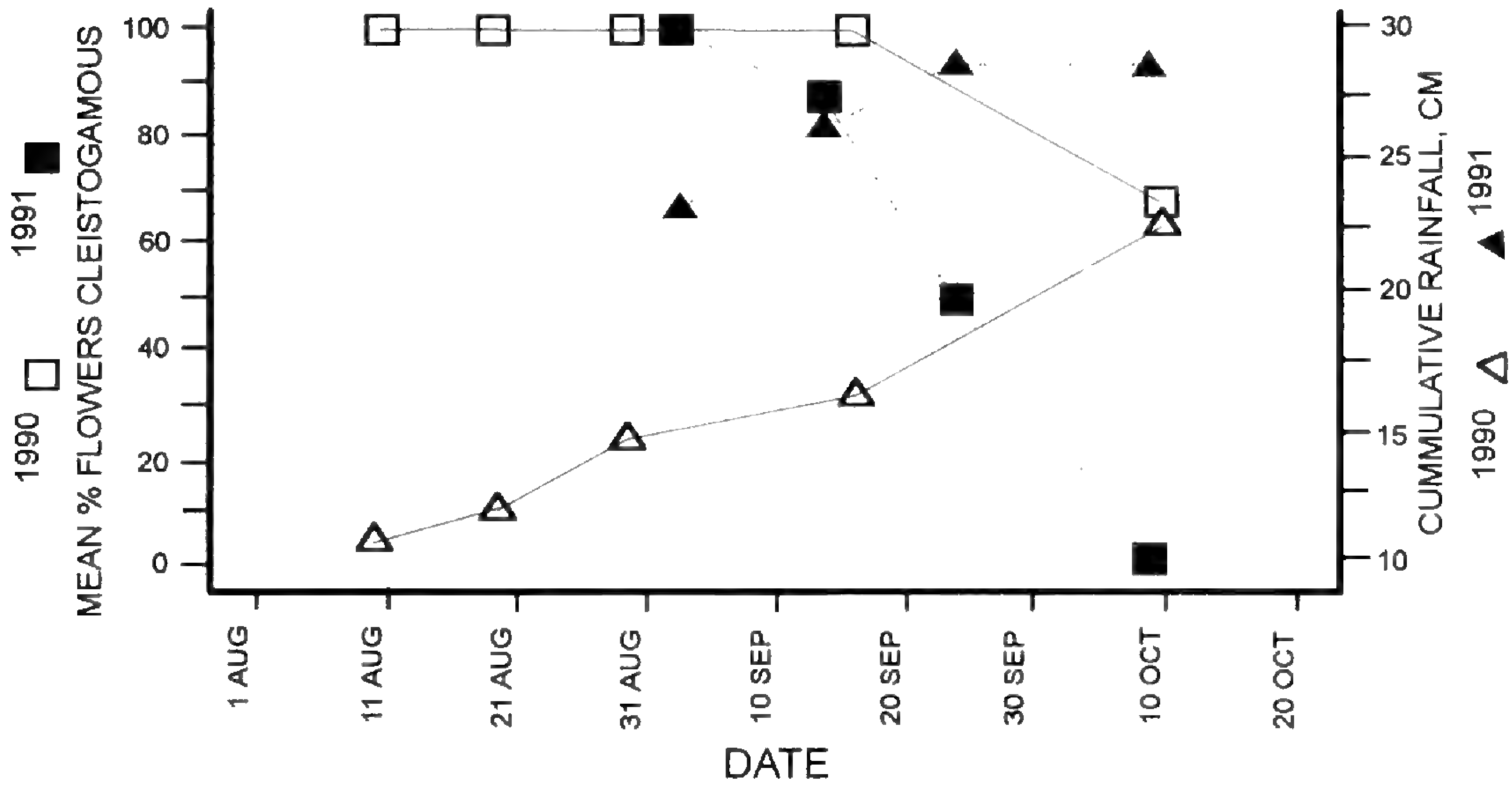

FIG. 2. Plots showing the relationship between the mean percentage of flowers that are cleistogamous (squares) and cumulative rainfall (triangles) in a population of *Cyphomeris gypsophiloides* located along the W slope of the Organ Mountains, approximately 16 km E of Las Cruces, New Mexico.

visited , the stamens of chasmogamous flowers curl over the style and stigma by late morning. This process has been described for similar flowers in the nyctage genera *Acleisanthes* and *Ammocodon* (Spellenberg and Delson 1977), *Boerhavia* (Chaturvedi 1989), and *Mirabilis* (Cruden 1973; Hernandez 1990). It results in self-pollination and seed set in all species examined in these genera that have cleistogamous flowers. We have no reason to suspect otherwise for *Cyphomeris*.

Such observations suggest that selfing often constitutes a major mode of reproduction in *Cyphomeris*, particularly in dry years or areas of low annual rainfall. As a result, the level of inbreeding is likely higher than that implied by population substructure, a situation conducive to rapid and local differentiation by the combined action of genetic drift and selection (Wright 1938, 1940, 1943).

MATERIALS AND METHODS FOR MULTIVARIATE ANALYSES

Data for numerical analyses were obtained from two sources. The first consists of 297 collections from 15 herbaria, including all holotypes. Of these specimens, 114 represented the genus well geographically, possessed complete location data, and exhibited all characters selected for analyses. Only these specimens (OTU's) were measured (Mahrt 1993).

In addition to the herbarium specimens, 29 population samples were collected from most of the range of the genus (Appendix A). Each collection represents a distinct locality and consists of 6–10 branches, each broken at the base of a different plant. Vouchers are at NMC, with duplicates variously distributed to ARIZ, ASU, BRIT, CIIDIR, ENCB, F, IBUG, IEB, MEXU, MO, MT, NMC, NY, SLPM, TEX, UC, US (Holmgren et al. 1990).

Data were taken on 14 vegetative and 10 fruit characters (Appendix B). Characters included those considered diagnostic by previous authors as well as those known to exhibit geographic variation. Although statistical problems are known to occur with their use (Phillips 1983), two ratios (MLR and ULR) were included since they provided the best measure of important aspects of leaf shape. Each character was measured an average of three times at different locations on each specimen and a set of character means was computed for each specimen. These were used for all numerical analyses. Character measurements were confined to mature organs that did not represent infrequent extremes for a specimen. Characters were measured with an ocular rule of 100 units in a dissecting microscope at 10–40. Hair densities (HD and GHD) were the number of hairs occurring in 1.5 x 2 mm rectangle. Data were not transformed since a preliminary analysis of residuals revealed reasonably normal distributions for all characters (including ratios and meristic characters).

OTUs were first assigned to one of three *a priori* categories based on Reed's (1970) taxonomy: 1) *C. gypsophiloides*; 2) *C. crassifolia*; and 3) intergrade. Three OTUs of *C. gypsophiloides* var. *stewartii*, a taxon outside the range of Reed's treatment, were assigned to category one. We use these categories throughout the following analysis.

Data from the 114 herbarium specimens were analyzed in three steps. First we examined relationships among OTUs by centroid hierarchical cluster analysis (CL) of all 24 characters. Next we employed a principal components analysis (PCA) of the character correlation matrix. Finally, we performed an *a posteriori* multivariate analysis of variance (MANOVA) on selected phenetic assemblages (exposed by CL) to identify their distinguishing characters.

Data from the 29 populations were analyzed initially with a procedure outlined by Zimmerman and Ludwig (1975). This procedure employs discriminant analysis (DA) to detect clusters of related sample populations by identifying pairs for which the Mahalanobis distance (D^2) is non-significant. For each pairwise comparison between populations, DA constructs a discriminant function, calculates D^2, and computes an F statistic that tests if D^2 is significantly greater than zero. Population localities then are plotted on a map and pairs for which D^2 is non-significant are connected with lines. Aggregates of associated populations can then be visualized.

Complimentary to DA, a MANOVA was conducted, followed by a multivariate "means separation" technique developed by Smith et al. (1993). In this technique, the population multivariate sample means first are standardized and subjected to a CL. Then a "group" variable is created, each group now treated as a single sample unit. Next, a MANOVA is run to determine if there are significant differences between groups. If differences exist, the CL is consulted and the closest groups (those joined first) are combined into a super group. A nested MANOVA with super groups, and groups within super groups, is then conducted and the significance levels of the resulting tests compared. The test for super groups should indicate significant differences whereas the test for groups within super groups may be either significant or non-significant. If the test is significant, then that is an indication the joining of the most recently combined groups was inappropriate. If the test is not significant, then the super groupings to this point are reasonable and one may proceed to the next joining as indicated by the CL. The end result of this process is the formation of groups of sample populations whose members are homogeneous, but for which there are significant differences between groups.

Analyses were performed using the Statistical Analysis System (SAS) on the mainframe computer of New Mexico State University. Cluster analysis, PCA, DA, and MANOVA were conducted using the CLUSTER, PRINCOMP, DISCRIM, and GLM procedures respectively (SAS Institute 1990). Standardization of sample population means was accomplished using IML (SAS Institute 1989).

RESULTS

The CL of herbarium specimens, using 24 characters, resulted in three major groups of OTUs (Fig. 3, branches A, B, and C). Clusters were arbitrarily defined at approximately 0.90 on the distance scale. One minor cluster (branch D) and four ungrouped specimens are also present at this level. Branch B constitutes a nearly homogenous collection of OTUs of *C. crassifolia*. Branch A contains the majority of *C. gypsophiloides* specimens, but with a mixture of *a priori* classified OTUs from *C. crassifolia* and intergrades. Branch A-1 is mostly OTUs of *C. gypsophiloides* from northern and western areas (Fig. 4, black stars). Branch A-2 is mostly OTUs of intergrades and *C. crassifolia* that are largely southern and eastern in distribution (Fig. 4, open stars). Branch C consists of seven OTUs of linear-leaved forms of *C. gypsophiloides*. Of the three OTUs assigned to *C. gypsophiloides* var. *stewartii,* two from La Sierra el Diablo in southeastern Chihuahua) remain distinct, whereas the third, from the nearby La Sierra el Rosario in northeastern Durango, is grouped with the majority of specimens representing *C. gypsophiloides* (branch A-1).

A dendrogram (Fig. 5) from the CL of standardized population means reveals a pattern similar to that of the CL of herbarium specimens (Fig. 3). Two major clusters and six distinct populations are defined at 0.60 on the

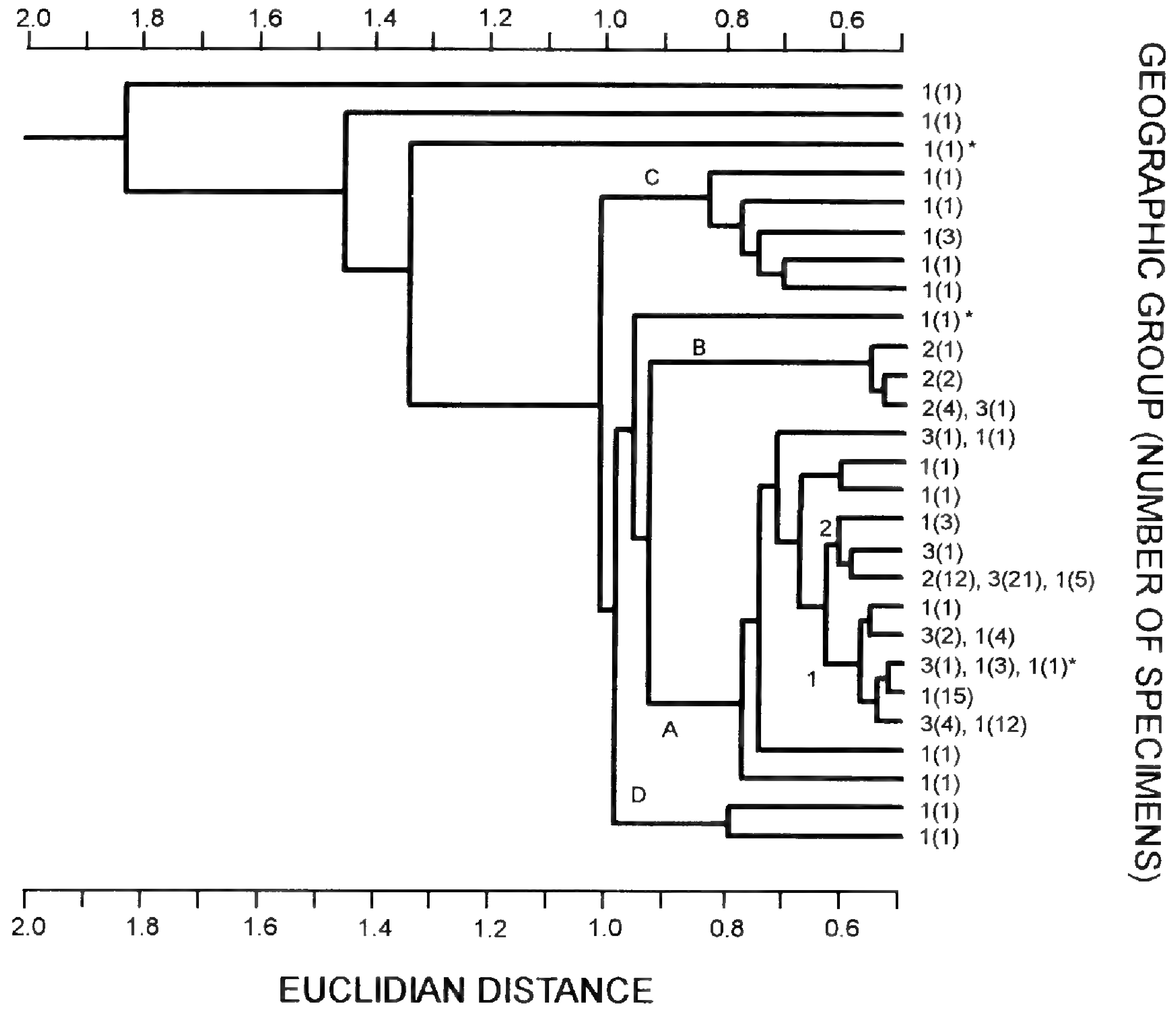

FIG. 3. Partial dendrogram from the cluster analysis of herbarium specimens. Values along the horizontal axis signify the normalized euclidian distance between cluster centroids (SAS Institute 1989). Numbers at the tip of each branch indicate the composition of the specimens contained therein. The first digit refers to *a priori* group (1 = *C. gypsophiloides*, 2 = *C. crassifolia*, 3 = intergrade). The value in parentheses gives the number of specimens belonging to that group on that branch. Clusters discussed in the text are identified by capital letters and arabic numerals near the base of each cluster. An asterisk at the end of a branch signifies an OTU identified as *C. gypsophiloides* var. *stewartii*.

distance scale. Branch A has two subgroups: A-1 has four *C. gypsophiloides* samples, all northern; A-2) has 14 intergrade populations and a single sample representing *C. gypsophiloides* var. *stewartii*. Four samples of *C. crassifolia* comprise branch B. Three unclustered populations of linear-leaved *C. gypsophiloides* form branch C at 0.90 on the distance scale, implying a loose but explicit morphological relationship. The remaining samples, one each of *C. gypsophiloides*, *C. crassifolia*, and *C. gypsophiloides var. stewartii,* join after the major branches A, B, and C have combined. Thus, they have little morphological affinity among themselves or with any of the other populations.

Results from PCA are summarized in Table 1. The first three principal components account for 58.6% of the total sample variance (Component 1

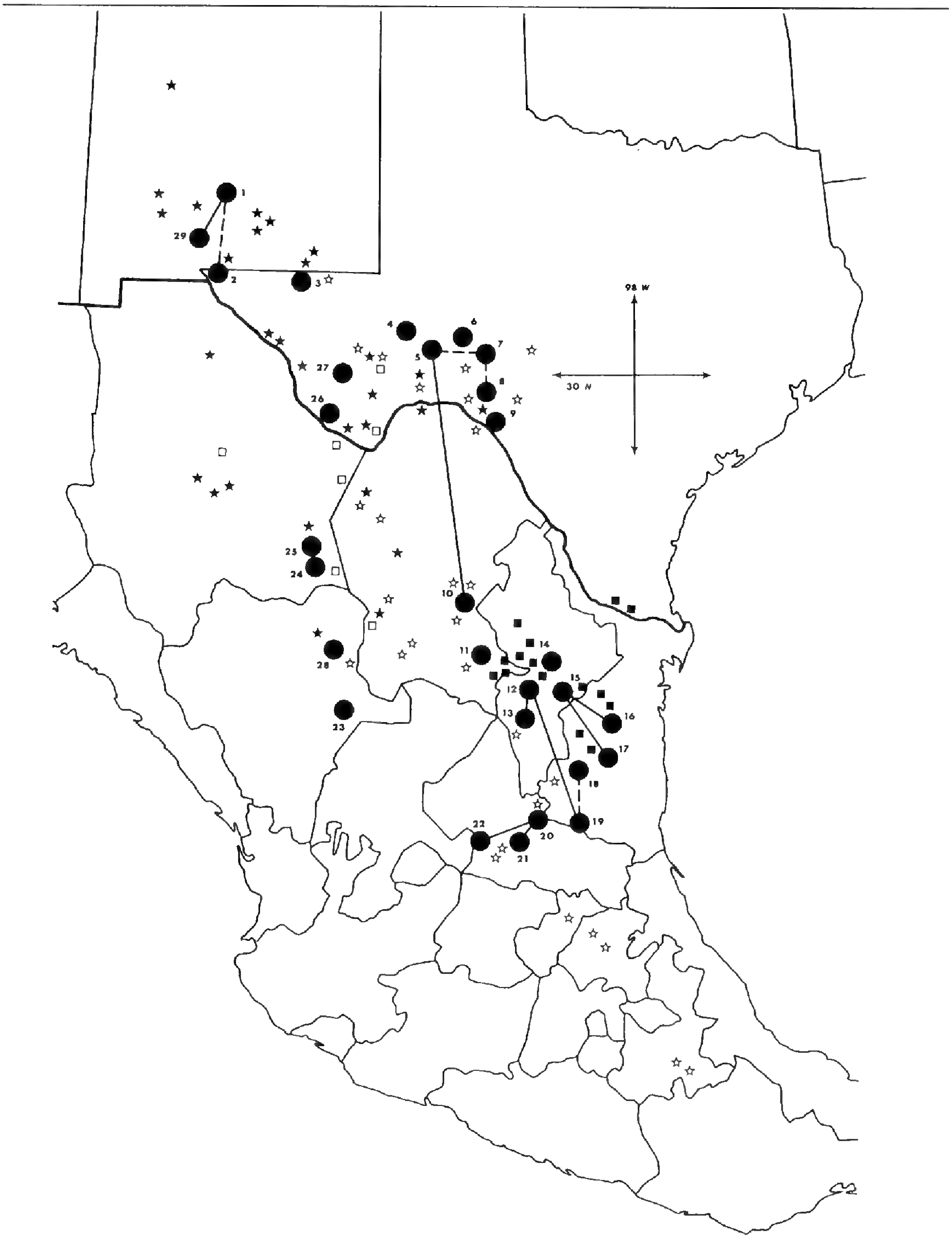

FIG. 4. Map showing the geographic range of *Cyphomeris* and the results of DA. Small symbols represent the locations of selected herbarium specimens and the *a priori* taxonomic group to which they were assigned (see methods). BLACK STARS designate *C. gypsophiloides*. BLACK SQUARES denote *C. crassifolia*. OPEN STARS indicate plants that are more or less intermediate, particularly in leaf width and leaf pubescence. In the north these may be intergrades; in the south they may represent ancestral types. OPEN SQUARES indicate linear-leaved forms of *C. gypsophiloides*. Large BLACK CIRCLES mark the locations of sample populations (Appendix A). Pairs of localities connected by a solid line have values of D^2 that are nonsignificant at $P = 0.05$. Those connected by a dotted line have values that are significant at $P = 0.05$ but not at $P = 0.01$ (see methods).

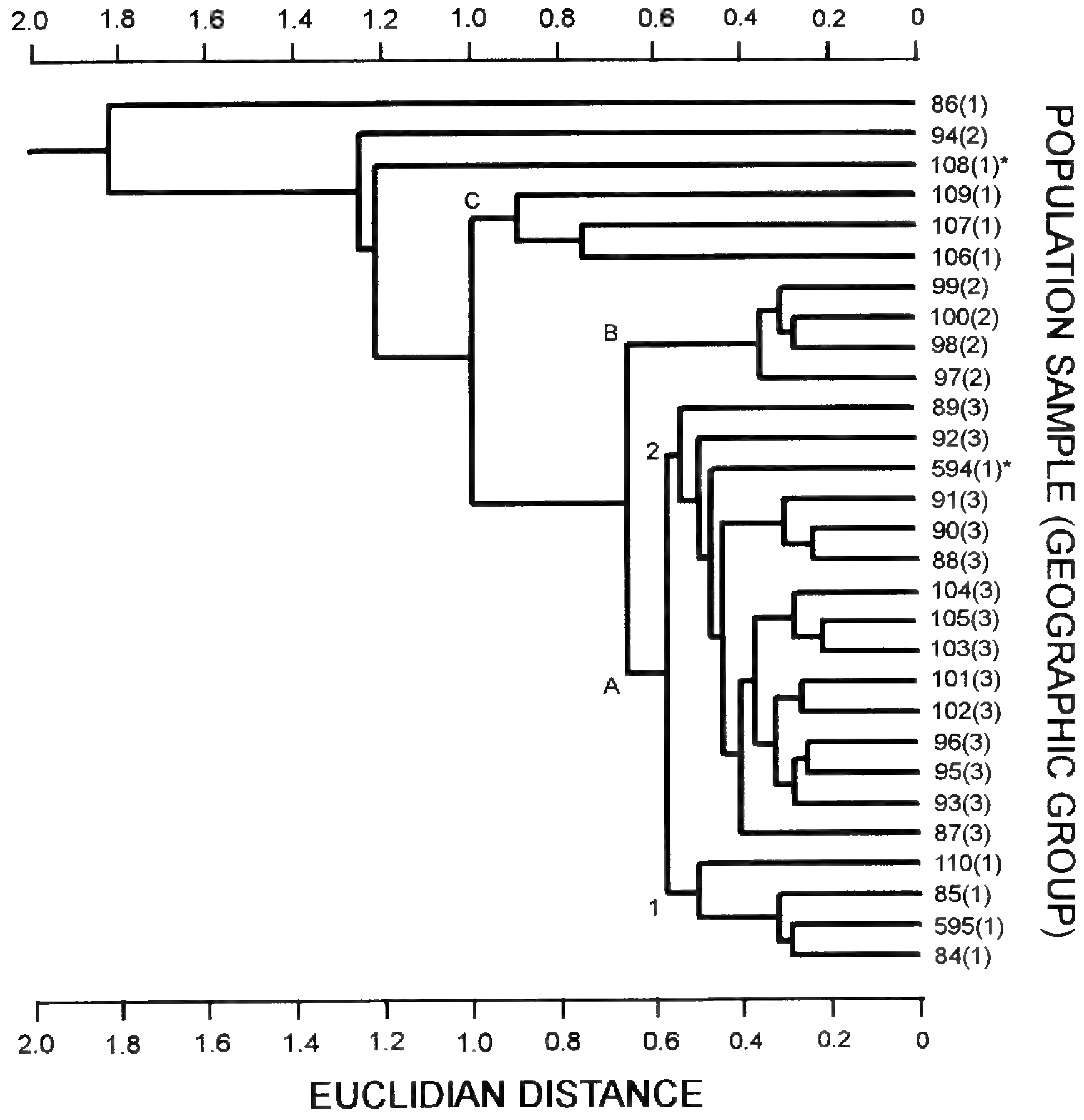

Fig. 5. Dendrogram from the cluster analysis of population samples. Values along the horizontal axis signify the normalized euclidian distance between cluster centroids (SAS Institute 1989). Population localities are identified by the number at the tip of each branch (Appendix A). The values in parentheses indicate the *a priori* group (see caption, Fig. 3) to which each sample was assigned. Clusters discussed in the text are referred to by capital letters and arabic numerals near the base of each cluster. An asterisk at the end of a branch signifies an OTU identified as *C. gypsophiloides* var. *stewartii.*

accounting for 31.5% of the total). The remaining 21 each contribute 7% or less. Eleven characters (ULW, UND, UDP, MLW, HTW, MLR, ULR, PLB, PLW, and HD [Appendix B]), summarizing leaf shape, leaf pubescence, and wartiness of the fruit, load more or less equally on Component 1. Six characters (SLL, PLL, FL, PLW, ULP, and MLP) have high loadings on Component 2. The first four describe overall fruit length; the last two measure petiole length. Aspects of leaf length and width (ULL, MLL, MLPR, ULPR, and MLW) have high loadings on Component 3.

TABLE 1. Character loadings for the first three principal components. The proportion of the total variance accounted for by each component is given in parentheses.

	Loadings		
Character	Component 1 (31.5%)	Component 2 (15.1%)	Component 3 (12.1%)
MLL	-0.2	0.09	0.42
*MLW	0.27	0.14	0.24
MLP	0.21	0.26	0.16
MLPR	-0.19	0.12	0.37
*UND	0.29	-0.04	0.13
*UDP	0.28	0.01	0.16
ULL	-0.17	0.14	0.43
*ULW	0.29	0.12	0.17
ULP	0.22	0.28	0.07
ULPR	-0.14	0.24	0.36
*HD	0.22	-0.16	0.01
GHD	0.1	-0.11	0.08
FLA	-0.14	0.35	-0.15
FDA	0.13	0.15	0.1
FAA	-0.09	-0.17	0.07
*PLL	-0.09	0.35	-0.17
*PLW	-0.23	0.28	-0.12
*PLB	0.23	-0.18	0.06
SLL	0.06	0.37	-0.21
SLW	-0.08	0.21	-0.12
SLB	0.18	0.09	-0.1
*HTW	0.27	-0.04	0.12
*MLR	-0.25	-0.21	0.13
*ULR	-0.26	-0.2	0.16

* Denotes character discussed in the text (see Materials and Methods).

A plot of OTUs of components 1 and 2 reveals three fairly well defined groups (Fig. 6) primarily separated by Component 1; characters UND, UDP, MLW, ULW, HTW, HD, and PLB contribute most. OTUs of *C. crassifolia* form a small cluster to the right of a larger cluster of *C. gypsophiloides* and intergrade OTUS. In comparison to *C. gypsophiloides* OTUs of *C. crassifolia* have leaves that are shorter, wider, more undulate, and more pubescent, and fruits that are shorter and distinctly warty, characters used by Standley (1911) to distinguish the species. OTUs of intergrade and *C. gypsophiloides* var. *stewartii* overlap extensively with OTUs of *C. gypsophiloides* but mostly are distinct from those of *C. crassifolia*. The third cluster (lower left corner of Fig. 6) exhibits a high degree of separation on both components. This group consists of *C. gypsophiloides* OTUs that separate as a result of high values for MLR and ULR combined with low values for MLP and ULP. Little else distinguishes these plants, which occur in widely scattered locations throughout the central Chihuahuan Desert (Fig. 4, open squares). A single outlier, an OTU from the Guadalupe Mountains of western Texas,

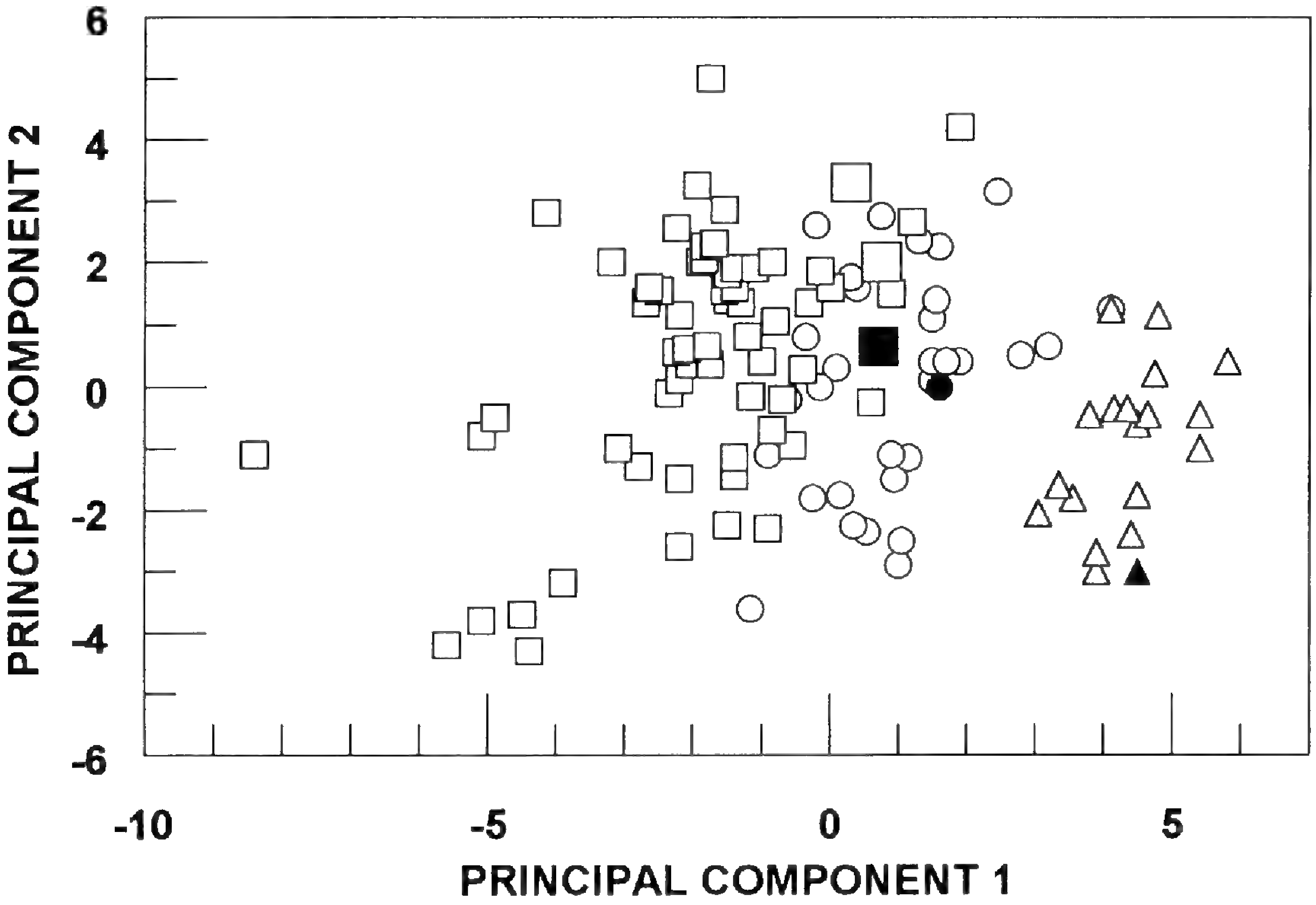

FIG. 6. Plot of specimen OTUs on principal components one and two. Symbols indicate the *a priori* taxonomic group to which each OTU was assigned (squares = *C. gypsophiloides*, triangles = *C. crassifolia*, circles = intergrades). Specimens representing *C. gypsophiloides* var. *stewartii* are indicated by large squares. Type specimens (or, in the case of *C. gypsophiloides*, a specimen collected from near the type locality) are indicated by black figures.

(far left, Fig. 6), has high values of MLR, ULR, FL, PLL, and PLW. It may represent an aberrant individual. It had little affect on the overall results of PCA and CL and was not removed from the analysis.

A similar pattern is produced by a plot of OTUs of components 1 and 3 (Mahrt 1993). *Cyphomeris crassifolia* and *C. gypsophiloides* OTUs form more or less discrete clusters whereas those of intergrades and *C. gypsophiloides* var. *stewartii* overlap extensively with OTUs of *C. gypsophiloides*. A plot of OTUs on components 2 and 3, which primarily measure aspects related to overall size (fruit size for Component 2, leaf size for Component 3), shows little to no separation of *a priori* taxonomic groups (Mahrt 1993) except for two OTUs of *C. gypsophiloides* var. *stewartii*. These show strong separation on Component 3, a reflection of their robust habit and large leaves, attributes noted by Johnston (1944) in the original description of the variety.

Values of D^2 (most are highly significant, $P < 0.01$) for each pair of sample populations are given in Mahrt (1993). Samples joined in Fig. 4 with a solid line have values of D^2 of $P = 0.05$ or greater. Those joined with a dotted line are significant at $P = 0.05$ but not at $P = 0.01$ (Zimmerman and Ludwig 1975). Five groups of interconnected populations are apparent.

TABLE 2. Results of multivariate means separation (see text for explanation of the testing procedure). Samples joined at each step are listed in Appendix A. Significance levels are for the test of populations within groups (Wilks' Lambda).

Group	Samples Combined	Prob. > *F* (Wilks' Lambda)
1	20 with 22	0.64
2	15 with 17	0.61
3	1 with 29	0.7
4	12 with 13	0.36
5	16 with group 2	0.0451*

* Indicates step at which the algorithm was stopped.

The first (samples 1, 2, and 29) consists of three *C. gypsophiloides* populations from New Mexico and Texas. The second (15, 16, and 17) constitutes three populations of *C. crassifolia* from the states of Tamaulipas and Nuevo Leon. The remaining groups are more or less central in distribution and consist entirely of intergrade populations (5, 7, 8, 10, 12, 13, 18, 19, 20, 21, and 22). Populations of *C. gypsophiloides* var. *stewartii* (24 and 28) are distinct from all others in the analysis, including each other. Ten additional population samples are also individually distinct. Five of these (3, 23, 25, 26, and 27) are assigned to *C. gypsophiloides*. Three (4, 6, and 9) are intergrades. The remainder (11 and 14) represent *C. crassifolia*.

Results from the MANOVA indicated significant differences between the centroids of the 29 sample populations (Wilks' Lambda, $P = .001$). The means separation technique resulted in four groups (Table 2). These represent a subset of the results from DA. Groups one and four each consist of two intergrade sample populations. Group two is composed of two *C. crassifolia sample* populations. Group three results from the combination of two *C. gypsophiloides* samples.

DISCUSSION

Results from the CL of population means and the PCA of herbarium specimens indicate that morphological variation in *Cyphomeris* is mostly discontinuous. Two geographically and morphologically defined groups exist, corresponding roughly to the species recognized by Reed (1970) and Standley (1911). The first group comprises *C. crassifolia* from east of the Sierra Madre Oriental, plants characterized by short, warty fruits and short, broad, undulate, moderately to densely pubescent leaves (Fig. 1, a–c). Plants of *C. gypsophiloides* and those designated as intergrades between the two species comprise the second group, an assemblage ranging from southern New Mexico in the United States southward (west of the Sierra Madre Oriental) to the Mexican state of Puebla. They have long, striate fruits and long, narrow, plane to slightly undulate, glabrous to sparsely pubescent leaves. This group can (more or less) be divided into two subgroups. Plants from the northern portion of the range (Fig.1, p–r) usually have glabrous, plane, lanceolate leaves and striate fruits. Intergrade plants (Fig. 1, d–f and j–n) are southern and eastern in distribution, and have sparsely pubescent, lanceolate, plane to slightly undulate leaves and striate to weakly warty fruits. The two forms intermix across western Texas in a more or less clinal fashion.

A third group, consisting of *Cyphomeris gypsophiloides* plants with sessile leaves that have high length to width ratios (Fig. 1, g–i), has no strong geographical unity (Fig. 3, branch C, Fig. 5, branch C). Such plants occur in the widely scattered mountain ranges of western Coahuila, eastern Chihuahua, northeast Durango, and the Big Bend region of Texas.

The CL of herbarium specimens illustrates the problem of the presence of conspicuous variation and the construction of a useful classification in the genus. Twelve individual *Cyphomeris crassifolia* cluster with *C. gypsophiloides* and intergrades (Fig. 3, branch A-2). These plants have large leaves with less pubescence than those of the discrete *C. crassifolia* cluster. Observations of *C. crassifolia* populations in the field suggest certain characters are affected by immediate environmental conditions. Shaded plants tend to have larger, longer, less pubescent leaves with larger length to width ratios than those growing in open sunlight, perhaps resulting in the displacement of *C. crassifolia* specimens by CL. Supporting evidence comes from two sources. First, a CL using only those characters found to be most diagnostic by PCA fully separates the *C. crassifolia* specimens from the *C. gypsophiloides*-intergrade complex, although each group of *C. crassifolia* specimens forms a separate cluster. Second, no displacement occurs in the CL of sample population means, which measures the central tendencies of the respective populations. When these central tendencies are clustered, as opposed to the characteristics of individual specimens, *C. crassifolia* forms a homogeneous group discrete from both *C. gypsophiloides* and intergrades. If the displacement described above is discounted, the CL of herbarium specimens reveals a pattern similar to that from the CL of population samples.

The results from DA and the means separation algorithm show that individual populations of *Cyphomeris* are highly differentiated, most likely due to the effects of selection superimposed on genetic drift resulting from inbreeding and population subdivision, but degree of differentiation varies within the range of the genus (Fig. 4). Populations in the south and east have a higher number of interpopulation connections than those to the north and west. Field observations indicate that populations of *Cyphomeris* in the south and east are less subdivided. In general, they are also characterized by more frequent and dependable rainfall.

Occasionally very different morphs will be found in close proximity. Samples 24 and 25 (Fig. 4) from the Sierra el Diablo, Chihuahua (Appendix A), occur within 1 km of one another and occupy similar habitats (sample 24 comes from slopes with a more southern aspect). Sample 24 has narrow, linear, glabrous leaves (Fig. 1, g–i). In contrast, sample 25 is classic *C. gypsophiloides* var. *stewartii*, with broad, lanceolate, moderately pubescent leaves (Fig. 1, j–l). An extensive search revealed no intergradient plants.

Despite numerous instances of local differentiation, populations of *Cyphomeris* form broadly similar morphological groups with at least some geographic unity, as evidenced by the results of both CL and PCA. Species circumscriptions based on such assemblages are subjective and in general do not represent "real" units in terms of evolution (Ehrlich and Raven 1969). However, they often represent "real" units in terms of geography and ecology, and as such provide the basis for a useful taxonomy. In the case of *Cyphomeris* the most utilitarian approach seems to be division of the genus into two species. *Cyphomeris crassifolia* comprises an entity distinct from the complex formed by *C. gypsophiloides* and the intergrades. The two groups can be separated morphologically by a combination of characters, specifically leaf shape, leaf pubescence, and length and wartiness of the fruit. In addition, the two groups can also be distinguished ecologically. *Cyphomeris crassifolia* is more or less confined to relatively mesic areas east of the Sierra Madre Oriental, and occurs in a variety of settings, from farm fields to subtropical scrub. Densities within a given population are relatively high and the apparent degree of population subdivision relatively low. In contrast, members of the *C. gypsophiloides*-intergrade complex inhabit dry, rocky sites, have low population densities, and a high degree of population subdivision.

Within *C. gypsophiloides* influence of *C. crassifolia* decreases northward and westward across southern Texas in a more or less clinal fashion where suitable habitat for *Cyphomeris* is comparatively undissected but becomes progressively drier. This pattern is particularly evident along southward draining river systems such as the Devil's River. Specimens from the drier limestone rangelands to the north are very much like typical *C. gypsophiloides*, whereas those from the brushy areas at the confluence with the Rio Grande resemble *C. crassifolia*. In general, however, these plants show more affinity to *C. gypsophiloides.* Corresponding with the abrupt habitat changes associated with the Sierra Madre Oriental to the south the two species are relatively sharply delimited.

The existence of subgroups within *C. gypsophiloides* (Fig. 3 and Fig. 5, branches A-1 and A-2) suggests that infraspecific taxa might be recognized. It is not clear, however, whether intergradient plants result from of primary intergradation or secondary contact between northern representatives of *C. gypsophiloides* and *C. crassifolia*, or both. Widely accepted hypotheses of the northward expansion of the Chihuahuan Desert and the evolution of the Mexican flora suggest that the southern intermediate types (from San Luis Potosi south to Puebla) represent an ancestral form that gave rise to the northern, more or less glabrous, component of *C. gypsophiloides* and the eastern, very pubescent *C. crassifolia*. The latter two groups may have then met secondarily to produce the northern intergrades found from Coahuila north to western Texas. Some evidence exists for this. A single population (sample 96) that appears to represent a hybrid swarm has been documented from central Nuevo Leon. Plants in this population exhibit almost the entire range of leaf variation, from plane, glabrous, lanceolate leaves to examples that are undulate, pubescent, and rhombic. The collection *Spellenberg, Zimmerman, and Zucker 8374*, MEXICO. Coahuila: Cuesta de la Muralla, N of Saltillo, 11 Oct 1985, (NMC) is even more suggestive, combining the leaf characters of *C. gypsophiloides* (plane, glabrous, lanceolate leaves) with the short, warty fruits of *C. crassifolia*. Until a more thorough understanding is gained of both the nature and extent of apparent hybridization, and also of local differentiation that results in such extreme leaf types as the linear glabrous leaves in many scattered populations or the large pubescent leaves of robust plants in the local phased named as the var. *stewartii*, we do not recommend formal recognition of infraspecific taxa.

TAXONOMY

Cyphomeris Standl., Contr. U.S. Nat. Herb. 13:428. 1911. *Lindenia* Mart. & Gal., Bull. Acad. Sci. Brux. 10:358. 1843. *Tinantia* Mart. & Gal., Bull. Acad. Sci. Brux. XI:240. 1844. *Senkenbergia* Schauer, Linnea 19:711. 1847.

Perennial herbs with woody taproots, glabrous to densely pubescent with pale, curved, bristle-like to capitate glandular hairs. *Stems* divaricately branched, erect, ascending, trailing or clambering through shrubs, to 2m, often brittle, upper internodes much longer than the lower ones, each internode with a glutinous band near the midpoint. *Leaves* opposite, those at a node unequal, exstipulate, petiolate or rarely sessile, weakly succulent; blades linear to lanceolate, ovate, broadly oblong, or rhombic, entire or undulate. *Inflorescences* axillary or terminal racemes; pedicels subtended by a lanceolate, sparsely ciliate, caducous bract 2.5–6 mm long; pedicels 0.5–1 mm. *Flowers* chasmogamous or cleistogamous. *Perianth* of chasmogamous flowers pale pink to red-violet (rarely greenish-white), broadly funnelform from a short, weakly curved tube constricted above the ovary; limb slightly oblique, 5 lobed, lobes emarginate. *Stamens* 5, exserted. *Pistil* unicarpellate; style filiform, exserted beyond the anthers; stigma capitate. Anthocarp stipitate, clavate, gibbous on the dorsal side, generally concave ventrally, pendant or refracted, longitudinally striate with 10 fine striations and/or series of elongate interrupted ridges, exuding mucilage when wetted from conspicuous wart-like protuberances.

In its racemose inflorescence and clavate fruits *Cyphomeris* resembles some species of *Boerhavia* and has been retained in that genus by F. R. Fosberg (1978).

TYPE SPECIES: *Cyphomeris gypsophiloides* (Mart. & Gal.) Standl.

KEY TO THE SPECIES OF *CYPHOMERIS*

1. Leaves glabrous or sparsely pubescent, blades lanceolate to linear, less than one half as wide as long, entire to shallowly undulate; anthocarps 8–11 mm, striate to weakly warty .... *C. gypsophiloides*
1. Leaves pubescent, blades ovate, broadly oblong, or rhombic, greater than one half as wide as long, undulate; anthocarps 6–8 mm, prominently warty, especially on dorsal side .... *C. crassifolia*

1. **Cyphomeris gypsophiloides** (Mart. & Gal.) Standl., Contr. U.S. Natl. Herb. 13:428. 1911. TYPE: MEXICO. OAXACA: Plains near Tehuacan, *Galeotti 577* (HOLOTYPE: BR!). *Lindenia gypsophiloides* Mart. & Gal., Bull. Acad. Sci. Brux. 10:358. 1843. *Tinantina gypsophiloides* (Mart. & Gal.) Mart. & Gal., Bull. Acad. Sci. Brux. 11:240. 1844. *Senkenbergia gypsophiloides* (Mart. & Gal.) Benth. & Hook., Gen. Pl. 3:6. 1880. *Boerhavia gypsophiloides* (Mart. & Gal.) Coulter, Contr. U.S. Natl. Herb. 2:354. 1894.

Senkenbergia annulata Schauer, Linnea 19:711. 1847. TYPE: Mexico: location unknown, *Aschenborn exs.* #253 (not seen).

Boerhavia gibbosa Pavon ex Choisy in DC. Prodr. 13:457. 1849, nom. non leg.

Plants glabrous to sparsely pubescent with pale curved, occasionally gland-tipped hairs primarily along the stems and the veins of leaves. *Stems* erect to ascending, 0.5–1.5 m. *Leaves* broadly oblong-lanceolate to narrowly lanceolate or rarely, linear (and then sub-sessile), less than one half as wide as long, the distal blades much broader than the proximal (except in linear leaved forms), proximal blades 1–9 cm × 1–30 mm, entire to shallowly undulate. *Perianth* light pink to red violet, 7–10 mm above the ovary. *Anthocarp* 8–11(–14) mm, striate to weakly warty, usually gibbous.

Distribution.—Southern New Mexico and western Texas in United States south to the Mexican states of Puebla and Oaxaca; rocky soils of washes, slopes, and roadsides, common on limestone, desertic scrub to open and dry pine-oak woodland; 500–2500 m. Blooming from mid-April to early November, but mostly mid-summer to early fall. Highly variable (Fig. 1, d-f, g-i, m-o, p-r).

The holotype of *C. gypsophiloides* is fragmentary, consisting only of a leafless branch and several semi-mature fruits, making most of its original character states impossible to determine. The collection *Chiang et. al. 2265* (MEXICO. Puebla: Plateau of San Lorenzo, near Tehuacan, 7 Aug 1981, [TEX]) comes from very near the type locality. It has the elliptic-lanceolate, slightly pubescent leaves, and moderately warty fruits that are characteristic of southern intermediate plants (Fig. 1, m-n).

2. **Cyphomeris crassifolia** (Standl.) Standl., Contr. U.S. Natl. Herb.13:428. 1911. TYPE: MEXICO. COAHUILA: Saltillo and vicinity, *Palmer 172* (HOLOTYPE: UC!; ISOTYPES: F, G!, MO!, NY!, US!). *Senkenbergia crassifolia* Standl., Contr. U.S. Natl. Herb. 12:373. 1909.

Plants finely pubescent with pale, curved hairs (rarely capitate glandular). *Stems* ascending to trailing, 0.5–2.0 m. *Leaves* rhombic to ovate or broadly oblong, one half as wide as long or wider, the distal blades nearly as broad as the proximal ones, proximal blades 1–5 cm × 8–40 mm, undulate and coarsely sinuate lobed or rarely more or less entire. *Perianth* pale pink (rarely greenish-white) to deep pink or red-violet, 6–8 mm above the ovary. *Anthocarp* 6–8(–11) mm, usually strongly gibbous, prominently warty, especially on dorsal side.

Distribution.—Extreme southern Texas in the United States and parts of Nuevo Leon and Tamaulipas in Mexico, primarily east of the Sierra Madre Oriental; fine or rocky soils on flats, washes, slopes, and roadsides, desertic scrub, more common in fallow fields and in semiarid or subtropical scrub; 1200 to 2500 m. Blooming mid-April to mid-December, but mostly late summer to late fall. Compared to *C. gypsophiloides*, *C. crassifolia* comprises a more cohesive, well defined morphological unit (Fig. 1, a-c) occurring in relatively mesic habitats and often having high population densities. It is likely that this species hybridizes with *C. gypsophiloides* (see discussion, preceding). As a result, populations exhibiting various degrees of intermediacy can be expected, particularly along the northern edge of the Sierra Madre Oriental where the geographic barriers to gene flow are less pronounced.

In southern Texas, at the northern limit of the species' range, *C. crassifolia* is known from only two collections; Starr Co., NW of Roma, 17 Dec 1963, *Wood 723* (TEX) and between Sullivan City and Rio Grande, 13 Apr 1941, *Runyon 2547* (TEX US).

APPENDIX A

List of population samples. Bold numbers at the beginning of each citation indicate the sample number (Fig. 5). Italicized numbers following each citation and adjacent to parentheses refer to the *a priori* group to which the sample was assigned (1 = *C. gypsophiloides*, 2 = *C. crassifolia*, 3 = intergrade). Samples representing *C. gypsophiloides* var. *stewartii* are marked with an asterisk. Numbers in parentheses indicate the sample size. Unless otherwise noted all collections are those of Mahrt and various associates. Vouchers are deposited at NMC. Duplicates are widely distributed.

29—UNITED STATES, New Mexico. Doña Ana Co.: W slope of Organ Mtns, 17.6 air km E of Las Cruces, *Spellenberg 5953*, *1*(10). 1—Socorro Co.: White Sands Missile Range, San Andres Mtns., 60 km NE of Truth or Consequences, 29 Jul 1990, *84 1*(9). 6 Texas. Crockett Co.: 6.4 km SE of Sheffield, 12 Oct 1990, *89 3*(10). 2—El Paso Co.: Franklin Mtns., 0.4 km E of Trans Mountain Road pass, 11 Oct 1990, *85 1*(10). 3—Hudspeth Co.: Guadalupe Mtns., 8 km SW of Pine Springs, 12 Oct 1990, *86 1*(10). 27—Jeff Davis Co.: 16 km SE of Fort Davis, 21 Oct 1990, *110 1*(10). 4 -Pecos Co.: 22.4 km E of Bakersfield, 12 Oct 1990, *87 3* (10); 5—89.6 km E of Fort Stockton, 12 Oct 1990, *88 3*(9). 26—Presidio Co: 4.8 km S of Shafter, 21 Oct 1990, *109 1*(6). 7—Val Verde Co.: 88 km NW of Del Rio, 13 Oct 1990, *90 3*(9); 8—28.8 km N of Comstock, 13 Oct 1990, *91 3*(10); 9—19.2 km NW of Del Rio, 13 Oct 1990, *92 1*(10).

24—MEXICO. Chihuahua: Sierra el Diablo, 80 km E of Jimenez, 19 Oct 1990, *107 1*(10); 25—Sierra el Diablo, 80 km E of Jimenez, 20 Oct 1990, *108 1**(10). 10—Coahuila: Sierra la Gavia, 33 km S of Monclova, 14 Oct 1990, *93 3*(10); 11—27.2 N of Saltillo, 14 Oct 1990, *94 2*(10). 23—Durango: 17.6 km S of Cuencame, 18 Oct 1990, *106 1*(10); 28—N end of Sierra el Rosario, 20 km SW of Mapimi, *Spellenberg 5947*, *1**(10). 12—Nuevo Leon: Sierra Madre Oriental, 16.6 km W of Iturbide, 15 Oct 1990, *95 3*(10); 13—Sierra Madre Oriental, 14.4 km W of Iturbide, 15 Oct 1990, *96 3*(10); 14—11.2 km S of Montemorelos, 15 Oct 1990, *97 2*(10); 15—14.4 km S of Linares, 15 Oct 1990, *98 2*(10). 20—San Luis Potosi: 110 km NE of San Luis Potosi, 16 Oct 1990, *103 3*(9); 21—38 km NE of San Luis Potosi, 16 Oct 1990, *104 3*(10); 22—33.6 km W of San Luis Potosi, 17 Oct 1990, *105 3*(10). 16—Tamaulipas: 9.6 km N of El Barretal, 15 Oct 1990, *99 2*(10); 17—E slope of Sierra Madre Oriental, 9.6 km SW of Ciudad Victoria, 16 Oct 1990, *100 2*(10); 18—W slope of Sierra Grande, Sierra Madre Oriental, 27.2 km NE of Jaumave, 16 Oct 1990, *101 3*(10); 19—Sierra Madre Oriental, 16 km SW of Jaumave, 16 Oct 1990, *102 3*(9).

APPENDIX B

Characters measured for multivariate analysis of *Cyphomeris*. The letter in parentheses refers to scoring method (m = mensural, c = meristic). Units of measurement are indicated for mensural characters. Unless otherwise noted, fruit measurements are in ocular units at 10×. Primary line measurements were taken on the first lateral line of fruit. Secondary line measurements were recorded for the secondary line directly beneath the primary line.

VEGETATIVE CHARACTERS: GHD (c)—total number of gland tipped hairs in a 1.5 × 2 mm square at 25×; HD (c)—total number of hairs in a 1.5 × 2 mm square at 25×; MLL (m)—mid leaf length, in mm; MLP (m)—length of mid leaf petiole, in mm; MLPR (m)—distance from tip of mid-leaf to widest point, in mm; MLR (m)—ratio of MLL to MLW; MLW (m)—mid-leaf width, in mm; ULL (m)—upper leaf length, in mm; ULP (m)—length of upper leaf petiole, in mm; ULPR (m)—distance from the tip of upper leaf to widest point, in mm; ULR (m)—ratio of Ull to ULW; ULW (m)—upper leaf width, in mm; UDP (c)—depth of deepest undulation; UND (c)—number of undulations along right margin of mid leaf. FRUIT CHARACTERS: FA (m)—fruit angle, in degrees; FD (m)—depth of fruit, distance from the dorsal to ventral surface; FL (m)—length of fruit; HTW (m)—height of tallest wart on ventral surface, in ocular units at 25×; PLB (c)—number of breaks in primary line; PLL (m)—length of primary line; PLW (m)—length of longest wart of primary line; SLB (c)—number of breaks in secondary line; SLL (m)—length of secondary line; SLW (m)—length of longest wart of secondary line.

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BOOK NOTICES

Shaw, Richard J. 1995. **Utah Wildflowers, A Field Guide to Northern and Central Mountains and Valleys.** (ISBN 0-87421-170-0, pbk). Utah State University Press, Utah State University, Logan, UT 84322-7800. $12.95. 218 pp, 102 color photographs, $4^7/_8$" x $8^1/_2$".

This is a convenient sized book that is a portable pictorial guide to the wildflowers of Utah. Its geographic range is limited to the 21 northern and central counties of Utah. Brief introductory topics include photographing wildflowers, organization of flowers by color, among other topics. There are over 100 species of flowering plants illustrated by excellent color photographs. Each color photograph occupies about $^1/_3$ to $^1/_2$ of each page and the nontechnical species description, common and scientific name occur on the adjacent preceding page so that the reader views the species description and color photograph side by side. There are no keys to the identification of the species other than the pictures. There is a single page of selected references, common botanical terms, and the index finalizes the book. Outdoor enthusiasts such as hikers, bikers, and campers that visit Utah and the Rocky Mountains in neighboring states will find this book a welcome addition to field guides to our western states.—*Harold W. Keller, Research Associate, BRIT.*

Primack, Richard B. 1995. **A Primer of Conservation Biology.** (ISBN 0-87893-730-7, pbk). Sinauer Associates, Inc., Publishers, 23 Plumtree Road, Sunderland, MA 01375. $18.95. 230 pp, 110 b/w illustrations, $7^1/_4$" x $9^1/_8$".

This book, according to the author, follows two previous textbooks used in introductory conservation biology courses. This primer represents a "quick" guide to the field for those who want a basic familiarity with conservation biology that covers the major concepts and problems. It is designed for use in short courses in conservation biology and as a guide for professionals who require a background in the subject but who have no need for the in depth case studies and discussions presented in the other two books.

Chapter headings are as follows: Conservation Biology and Biological Diversity; Threats to Biological Diversity; Conservation at the Population and Species Level; Conservation at the Community Level; Conservation and Sustainable Development. Each chapter is followed by a summary of major points that facilitates the quick recovery of the most important information. Suggested readings, mostly published in the 1990's, are located at the end of each chapter and a more extensive bibliography of over 450 references concludes the book. The appendix has a list of selected environmental organizations and sources of information that will be helpful in obtaining assistance from national and international organizations.—*Harold W. Keller, Research Associate, BRIT.*

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A SYNOPSIS OF THE GENUS *PACKERA* (ASTERACEAE: SENECIONEAE) IN MEXICO

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ABSTRACT

The species of *Packera* (Asteraceae: Senecioneae) have been treated in the past as the "Aureoid" group within the genus *Senecio*. Fifteen species and three varieties of *Packera* are recognized in Mexico; a key, an account of the nomenclature, and statements of ranges and habitats are presented. Three new combinations are proposed: *Packera scalaris* var. *parrasiana* (Greenm.) C.C. Freeman & T.M. Barkley, comb. nov.; *Packera scalaris* var. *carmenensis* (C.C. Freeman) C.C. Freeman & T.M. Barkley, comb. nov.; and *Packera zimapanica* (Hemsley) C.C. Freeman & T.M. Barkley, comb. nov.

RESUMEN

Las especies de *Packera* (Asteraceae: Senecioneae) han sido tratadas en el pasado como grupo "Aureoide" dentro del género *Senecio*. En México se reconocen quince especies y tres variedades de *Packera*. Se presentan una clave, un informe nomenclatural y otro relativo a las áreas y los hábitats. Se proponen tres combinaciones nuevas: *Packera scalaris* var. *parrasina* (Greenm.) C.C. Freeman & T.M. Barkely, comb. nov., *Packera scalaris* var. *carmenensis* (C.C. Freeman) C.C. Freeman & T.M. Barkely, comb. nov., and *Packera zimapanica* (Hemsley) C.C. Freeman & T.M. Barkeley, comb. nov.

Two items prompt this paper: one is the now widely accepted realignment of the generic concepts in the Asteraceae, and the other is the revival of interest in floristics. This paper provides a catalog for the Mexican species of the segregate genus *Packera* and an account of their nomenclature, plus a key for their determination.

The species referable to *Packera* Á. Löve & D. Löve have been treated traditionally as an informal assemblage called the "Aureoid" group within the super-genus *Senecio*; the biology of this group was discussed in detail by Barkley (1988). *Packera* was erected in 1976, and its circumscription has grown to accomodate the whole Aureoid complex. The species of *Packera*

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are distinguished from other members of *Senecio*, s.l., by sharing all or most of the following characters: perennial herbs arising from creeping rootstocks or a caudex; basal leaves well developed, cauline leaves progressively reduced upward; leaf margins without callose denticles; roots fibrous, thin, and branching; haploid chromosome numbers 22 or 23, or numbers derived therefrom. A justification for the segregation of *Packera* is presented by Barkley, Clark, and Funston (in press).

Packera includes some 60 species, ranging from Mexico to the Arctic and into eastern Siberia, but most of them are in temperate North America. Many occur in sites of continued mild disturbance, but few are truly weedy. The species are often imprecisely defined, and this imprecision is reflected in a complicated taxonomic history (Barkley 1988). The generic name commemorates Dr. John Packer of the University of Alberta, Canada, an intrepid student of the northern flora.

The comparative cytology of the members of *Packera* is complicated by polyploidy and some apparent miscounts that have entered the literature. The comparative cytology is the subject of a study in preparation by Dr. R.R. Kowal of the University of Wisconsin, in collaboration with Freeman and Barkley.

The information in this paper rests upon a study of the Aureoid senecios in Mexico, which was presented in a dissertation by Freeman in 1985 (q.v. for distribution maps, descriptions, lists of exsiccatae, and phyletic considerations). Adjustments have been made to account for knowledge accumulated since that time.

The Mexican members of *Packera* are not so well known as the species farther north, and we expect that future field work will add considerably to what is presented here. Doubtless, the known ranges of several of the species will be expanded.

KEY TO *PACKERA* IN MEXICO

1. Herbage glabrous or essentially so at maturity, or with light pubescence in the axils of the leaves and among the heads; basal leaves entire to dentate. The *Aurei* species group.
  2. Heads 1–2(–5); involucres hemispheric; basal and lower cauline leaves often deeply anthocyanic on the abaxial surface. Southern Sierra Madre Occidental. .... 9. *P. rosei*
  2. Heads more than 5; involucres campanulate; basal and lower cauline leaves infrequently anthocyanic on the abaxial surface.
    3. Blades of lowermost leaves cordate or distinctly truncate at the base. Southern Sierra Madre Occidental. .... 1. *P. quebradensis*
    3. Blades of lowermost leaves tapering to the petiole.
      4. Blades of lowermost leaves lanceolate to oblanceolate; plants taprooted or with spreading caudex, but without long stolons. Southeastern Coahuila, southeast to Peña Nevada. .... 2. *P. hintoniorum*

4. Blades of lowermost leaves obovate or oblong-ovate to orbicular; plants usually stoloniferous. Coahuila. .... 3. *P. obovata*

1. Herbage normally pubescent at maturity and/or basal and lower cauline leaves pinnately lobed or pinnate.
   5. Basal leaves entire to dentate, or if lobed, then distinctly loose-tomentose. The *Tomentosi* species group.
      6. Plants 4.5–8(–10.5) dm tall; basal and lower cauline leaves typically 3–4x longer overall than wide. Baja California. .... 4. *P. moranii*
      6. Plants 0.5–5(–10) dm tall; basal and lower cauline leaves (3–)4–12× longer overall than wide.
         7. Margins of basal and lower cauline leaves entire or nearly so, at most undulate to obscurely and unevenly dentate.
            8. Adaxial surface of basal leaves floccose at flowering time, abaxial surface permanently appressed-tomentose to glabrate. Sierra Volcánica Transveral and Oaxaca uplands. .... 5. *P. bellidifolia*
            8. Adaxial and abaxial surfaces of basal leaves permanently densely tomentose to lanate. Northern Sierra Madre Occidental.... 6. *P. candidissima*
         7. Margins of basal and lower cauline leaves variously dentate, sometimes irregularly or obscurely so. Sierra Madre Occidental and central Coahuila. .... 7. *P. neomexicana*
   5. Basal leaves pinnatifid or pinnate, glabrous to sparsely pubescent, rarely densely pubescent. The *Lobati* species group.
      9. Annuals; stems arising from a taproot. Gulf Coast Plain, Río Grande Valley. .... 8. *P. tampicana*
      9. Perennials; stems arising from a caudex or spreading rootstock, but young plants may have a taproot.
         10. Terminal lobe of basal and lower cauline leaves prominent, distinctly larger than the lateral lobes.
            11. Heads 1–2(–5). Southern Sierra Madre Occidental. .... 9. *P. rosei*
            11. Heads mostly 4 or more.
               12. Abaxial surface of the basal and lower cauline leaves glabrous to floccose-tomentose, but never with short, yellowish-brown, multicellular hairs. Northern Sierra Madre Occidental, Coahuila. .... 10. *P. scalaris*
               12. Abaxial surface of the basal and lower cauline leaves with few to many short, yellowish-brown, multicellular hairs, especially on the veins.
                  13. Ray florets ca. 5 or 8; phyllaries ca. (8–)13; involucres cylindrical. Sierra Volcánica Transversal and Oaxaca uplands. .... 11. *P. sanguisorbae*
                  13. Ray florets ca. 8 or 13; phyllaries ca. (13–)21; involucres campanulate. Sierra Madre Oriental. .... 12. *P. coahuilensis*
         10. Terminal lobe of basal and lower cauline leaves no larger than the lateral lobes.
            14. Basal and lower cauline leaves variously pinnatifid; the sinuses between the lobes extending 1/5 to 4/5 the distance to the midrib, thus the midrib is winged.
               15. Herbage with coarse, multicellular hairs; basal leaves often runcinate. Northern Sierra Madre Oriental. .... 13. *P. zimapanica*
               15. Herbage glabrous to floccose-tomentose; hairs not obvi-

ously multicellular; basal leaves crenate or sublyrate to pinnatifid. Northern Sierra Madre Occidental, Coahuila. ... 10. *P. scalaris*

14. Basal and lower cauline leaves pinnate; the sinuses between the lobes extending to an essentially unwinged midrib.
    16. Cauline leaves absent, or rarely 1–2, the plant appearing scapose; heads 2–4(–5); herbage glabrate or rarely densely tomentose. Nuevo León. .... 14. *P. montereyana*
    16. Cauline leaves (1–)3–11(–14); heads (1–)3–21(–32); herbage glabrous or sometimes tomentulose when young. Coahuila, Chihuahua. .... 15. *P. millelobata*

1. **Packera quebradensis** (Greenm.) W.A. Weber & Á. Löve, Phytologia 49:48. 1981. *Senecio quebradensis* Greenm., Ann. Missouri Bot. Gard. 3:117. 1916. TYPE: MEXICO. DURANGO: Quebrada Honda, 20–21 May 1906 (LECTOTYPE, here designated: GH!; photo-MO; ISOLECTOTYPES: F!, MO!, NY!, UC!, US!).

Mesic sites in oak or pine-oak woodlands, in the southern half of the Sierra Madre Occidental; southwestern Chihuahua and northeastern Sinaloa south to Cerro de Tequila in Jalisco; 1000–2800 m. Flowering chiefly in March but year-round in the southern end of the range.

This species is similar to *P. aurea* of the eastern U.S. and adjacent Canada but is shorter, leafier, and with more consistently dentate leaves. Collections from southwestern Durango have leaves with notably obtuse teeth and darkened denticles, plus a distinctive aspect, and may deserve taxonomic recognition.

2. **Packera hintoniorum** (B.L. Turner) C. Jeffrey, Kew Bull. 47:101. 1992. *Senecio hintoniorum* B.L. Turner, Phytologia 67:238. 1989. TYPE: MEXICO. NUEVO LEÓN: Cerro Potosí, rocky treeless summit, 3850 m, 25 Jun 1969, *G.B. Hinton et al. 17048* (HOLOTYPE: TEX!).

Open slopes in oak and pine-oak woodlands, upward to gravelly alpine meadow on Cerro Potosí; northern portion of the High Sierras of Sierra Madre Oriental from southeastern Coahuila, south-southeast to Peña Nevada in southeastern Nuevo León and adjacent southern Tamaulipas; 2000–3700 m. Flowering May through October; lower elevation plants generally begin flowering in May and are in fruit in July, whereas alpine plants flower mostly July through October.

At high elevations, *P. hintoniorum* has a low, subcaespitose aspect, with numerous basal leaves; a stout, weakly spreading caudex; a compact inflorescence with relatively large heads; and persistent tomentum. At lower elevations, the plants tend to be taller and have an erect or suberect caudex that may surmount a taproot; an inflorescence of numerous, smaller heads; and glabrous or glabrate herbage.

This species resembles the more northern *P. tridenticulata*, and differences between the two are summarized by Freeman (1985) and by Barkley

(1988). *Packera hintoniorum* was treated as a portion of *P. scalaris* by Muller (1939) in a discussion of the vegetation of Nuevo León.

3. **Packera obovata** (Mühlenb. ex Willd.) W.A. Weber & Á. Löve, Phytologia 49:47. 1981. *Senecio obovatus* Mühlenb. ex Willd. Sp. Pl. 3:1999. 1804. Type: "America boreali" (holotype: Willd. Herb. no. 15788, B!).

This species has a rich synonymy, but the types are from temperate North America; see Barkley (1962, 1978) for summary.

Widespread across the eastern half of temperate North America, but known in Mexico from only a few locations around seeps and along streams in oak and oak-pine woodlands, Sierra de la Madera and Sierra del Carmen, Coahuila; 1450–2100 m. Flowering March through May.

4. **Packera moranii** (T.M. Barkley) C. Jeffrey, Kew Bull. 47: 101. 1992. *Senecio moranii* T.M. Barkley, Brittonia 30:69. 1978. Type. MEXICO. Baja California Norte: common among granitic boulders on SE slope of Cerro Venado Blanco, San Pedro Mártir, near 31° 05'N, 115° 29'W, ca 2725 m, 15 Sep 1968, *R. Moran 15669* (holotype: NY!; isotypes: BM!, CAS!, GH!, KSC!, MEXU!, MO!, SD!, US!).

Seasonally damp sites in rocky igneous and metamorphic soils in open coniferous woodlands or sarcophyllous desert, San Pedro Mártir of central Baja California Norte and Sierra San Francisco of northern Baja California Sur; 1400–2725 m. Flowering August through October. This is the only *Packera* that is known in Baja California.

5. **Packera bellidifolia** (Kunth) W.A. Weber & Á. Löve, Phytologia 49:45. 1981. *Senecio bellidifolius* Kunth, Nov. Gen. & Sp. 4[folio]: 137. 1818; 4[quarto]: 175. 1820. Type: MEXICO. Southern Mexico: "Crescit in monte ignivomo Jorullo, alt. 580 hex. (Nova Hispania) Floret Septembri," *Humboldt & Bonpland, s.n.* (holotype: P; photo: Field Mus. Neg. 37883: F!, MICH!, MO!, US!; tracing and fragments (isotypes?) from B deposited at GH!).

Senecio cheiranthifolius Kunth, Nov. Gen. & Sp. 4[folio]:13. 1818; 4[quarto]:176. 1820. Type: MEXICO. Southern Mexico: "Crescit locis temperatis juxta Moran et Regla Mexicanorum, alt. 1300 hex., Floret Majo," *Humboldt & Bonpland, s.n.* (holotype: P; photo: Field Mus. Neg. 37881, F!, US!; tracing of holotype by J. M. Greenman on 29 Aug 1900 in GH!).

Senecio pauciflorus Kunth, Nov. Gen. & Sp. 4[folio]:138. pl. 365. 1818; 4[quarto]:176. tab. 365. 1820; non *S. pauciflorus* Pursh, 1814. *S. vulneraria* DC., Prodr. 6: 428. 1838. Type: MEXICO. Veracruz: "Crescit in montibus altissimus Regni Mexicani (Cofre de Perote) juxta Pinahuistepeque, alt. 1500 hex., floret Februario," *Humboldt & Bonpland s.n.* (holotype: P; photo: Field Mus. Neg. 37891 F!, MO!, US!).

Senecio lactucella Sessé & Mociño, Fl. Mex. ed. 2. 186. 1894. Type: MEXICO. Distrito Federal: "Habitat in altoribus et frigidissimus S. Heremi montibus. Floret Julio," 1787–1803, *Sessé & Mociño 3139* (lectotype: MA (McVaugh 1977); syntype: F!).

Senecio vulnerarius Sessé & Mociño, Fl. Mex. ed. 2. 186. 1894, non *Senecio vulneraria* (sic) DC. Type: MEXICO. Distrito Federal: "Habitat in Heremo P.P. Carmelitarum," 1787–1803 *Sessé & Mociño 3147* (lectotype: MA [McVaugh 1977]; syntype: F!).

Frequent in pine and pine-fir forests and in open, high meadows in the Sierra Volcánica Transversal; less frequent in the Oaxaca uplands, the Sierra Madre del Sur, and the Sierra Madre Oriental in Coahuila and Nuevo León; 2740–4420 m. Flowering almost year-round, but most of the flowering specimens were collected March through August.

This species is similar in aspect to *P. cana* of western temperate North America (Barkley 1988 for key) and to *P. candidissima* of Mexico (q.v.).

It is evident in the synonymy that the epithet "vulneraria" was used twice; once as *Senecio vulneraria* (sic) by DeCandolle to replace the pre-occupied *S. pauciflorus* of Kunth, and again (as *Senecio vulnerarius*) by Sessé & Mociño. Despite being homonyms, the two names ride on different type collections.

6. **Packera candidissima** (Greene) W.A. Weber & Á. Löve, Phytologia 49:46. 1981. *Senecio candidissimus* Greene, Pittonia 4:110. 1900. TYPE: MEXICO. CHIHUAHUA: near Colonia García in the Sierra Madres, alt. 2285 m, 24 May 1899, *C.H.T. Townsend & C.M. Barber 1* (LECTOTYPE, here designated: ND-G!; ISOLECTOTYPES: F!, GH!, MEXU!, MO!, MSC!, NMC!, NY!, US!).

Open sites, often on thin soils of igneous origin, in pine oak or pine-fir forests; northern half of the Sierra Madre Occidental from northwestern Chihuahua (Colonia Juárez) south to southwestern Chihuahua on Cerro Mohinora; 2070–3200 m. Flowering April through June.

The type locality, Colonia García, was a small Mormon settlement in the Sierra Madre Occidental, about 55 miles southeast of Casas Grande in northwestern Chihuahua (Goldman 1951). The type collection for *P. scalaris* (q.v.) was also from this area.

This species is somewhat weedy and forms spreading colonies from branching caudices. Ethnobotanical studies show that it has been used medicinally by the Indians of Chihuahua. Herbarium labels and correspondence with Dr. Robert A. Bye indicate that he is actively studying these medicinal uses.

7. **Packera neomexicana** (A. Gray) W.A. Weber & Á. Löve, Phytologia 49:47. 1981. *Senecio neomexicanus* A. Gray, 9:55. 1883, *nomen nudum*. Syn. Fl. N. Amer. 1(2):392. 1884. TYPE: UNITED STATES. ARIZONA. Pima Co: Santa Catalina Mts, Apr 1880, *J.G. Lemmon 49* (LECTOTYPE: GH!). Typification of this name follows Turner (1993) and replaces an earlier notion by Barkley (1978).

Senecio hartmanii Greenm., Monographie der nord- und centralamerikanischen Arten der Gattung *Senecio*. I. Teil. 24. 1901, *nomen nudum*. Engl. Bot. Jahrb. 32:20. 1902. *nomen nudum*. Ann. Missouri Bot. Gard. 5:44. 1918 TYPE: MEXICO. CHIHUAHUA: Puerta de St. Diego, alt. 1980 m, 12 Apr 1891, *C.V. Hartman 623* (LECTOTYPE, here designated: GH!; ISOLECTOTYPE: US!; photo: KSC!).

This species has a complicated taxonomy and synonymy; see Barkley (1978, 1980) for summary.

Widespread and frequent in southwestern U.S. but represented in Mexico by rather few collections; rocky soils, mostly in oak scrub and open oak-pine woodlands, scattered in central Coahuila, the northern Sierra Madre Occidental, and northeastern Sonora; 1650–4210 m. Flowering March through August.

Three varieties are more or less discernable in the U.S. (Barkley 1978, 1980), and a case can be made for recognizing more than one species within the complex (Turner 1993). The Mexican plants are regarded here as belonging to the widespread and variable var. *neomexicana*.

8. **Packera tampicana** (DC.) C. Jeffrey, Kew Bull. 47:101. 1992. *Senecio tampicanus* DC., Prodr. 6:427. 1838. TYPE: MEXICO. TAMAULIPAS: Tampico de Tamaulipas, 1827, *J. Berlandier 186* (LECTOTYPE, here designated: G-DC, Prod. Herb. microfiche, 800. 1141: I, 1; ISOLECTOTYPE: F!; photo: Field Mus. Neg. 33823: F!, MICH!, MO!. Tracing and fragments apparently taken by J. M. Greenman at B are deposited at GH!).

Senecio imparipinnatus Klatt, Abh. Naturf. Ges. Halle 15:333. 1882. TYPE: UNITED STATES. TEXAS: "Bejar a la villa de Austin," Apr 1828, *J. Berlandier 1741* (LECTOTYPE: GH! [Barkley 1978]).

Senecio greggii Rydb. Bull. Torrey Bot. Club 27:170. 1900. TYPE: MEXICO. CHIHUAHUA. valley of Río Parral, near Santa Rosalía (= Ciudad Camargo, according to Goldman 1951), 21 Apr 1847, *Dr. Gregg 11* (HOLOTYPE: NY!; ISOTYPES: GH!, MO!).

Senecio ervendbergii Greenm., Monographie der nord-und centralamerikanischen Arten der Gattung *Senecio*, I. Teil. 24. 1901, *nomen nudum*. Engl. Bot. Jahrb. 32:19. 1902, *nomen nudum*. Publ. Field Columbian Mus., Bot. Ser. 2:275. 1907. TYPE: MEXICO. VERACRUZ: near Tantoyuca, province of Huasteca, Oct 1858, *C.L. Ervendberg 90* (HOLOTYPE: GH!).

Monocarpic weed in open, disturbed sites, especially along the Coastal Plain in Tamaulipas, Nuevo León, and northern Veracruz, and less frequently in the Basin and Ranges of Chihuahua; 0–1400 m. Flowering mostly February through April. It also occurs northward into the central U.S., as far as Kansas.

9. **Packera rosei** (Greenm.) W.A. Weber & Á. Löve, Phytologia 49:48. 1981. Monographie der nord- und centralamerikanischen Arten der Gattung *Senecio*, I. Teil. 24. 1901, *nomen nudum*. Engl. Bot. Jahrb. 32:20. 1902, *nomen nudum*. Publ. Field Columbian Mus., Bot. Ser. 2:276., Pl. 3, fig. 1. 1907. TYPE: MEXICO. NAYARIT: Territory of Tepic, in the Sierra Madre, near Santa Teresa, 10 Aug 1897, *J.N. Rose 2157* (LECTOTYPE: GH! [McVaugh 1984]; ISOLECTOTYPE: US!).

Marshy ground or mesic sites in pine forest regions, southern Sierra Madre Occidental from southwestern Durango (La Ciudad) south to Santa Teresa in northwestern Nayarit; 2130–2740 m. Flowering mostly in August and September. *Packera rosei* is a facultative aquatic and can grow in saturated ground or shallow puddles, at least for a short time. This species belongs to the *Lobati* species group but it is also keyed among the *Aurei* for convenience.

10. Packera scalaris (Greene) C. Jeffrey

Three varieties are recognized here and are distinguished as follows:

1. Basal and lowermost cauline leaves abaxially glabrous or essentially so.
    2. Inflorescence a compact, subumbellate or corymbiform cyme; cypselas glabrous; lower stem and basal leaves seldom anthocyanic. Northern Sierra Madre Occidental. .... 10a. *P. scalaris* var. *scalaris*
    2. Inflorescence a loose corymbiform cyme; cypselas hirtellous on the angles; lower stem and basal leaves frequently anthocyanic. Southwestern Coahuila. .... 10b. *P. scalaris* var. *parrasiana*
1. Basal and lowermost cauline leaves abaxially lightly tomentose or floccose-tomentose. Northern Coahuila. .... 10c. *P. scalaris* var. *carmenensis*

10a. Packera scalaris (Greene) C. Jeffrey var. **scalaris** Kew Bull. 47:101. 1992. *Senecio scalaris* Greene, Pittonia 4:108. 1900. TYPE: MEXICO. CHIHUAHUA: near Colonia García in the Sierra Madres, alt. 7600 ft, 13 Jul 1899, *C.H.T. Townsend & C.M. Barber 131* (LECTOTYPE, here designated: US!; ISOLECTOTYPES: F!, GH!, KSC!, MO!, MSC!, NMC!, NY!, TEX!, US!).

Gravelly to sandy soils in open pine forests and in cleared pastures, in the northern Sierra Madre Occidental from northwestern Chihuahua south to northwestern Durango; 1525–3140 m. Flowering mostly June through August but infrequently into October.

10b. Packera scalaris var. **parrasiana** (Greenm.) C.C. Freeman & T.M. Barkley, comb. nov. *Senecio parrasianus* Greenm., Ann. Missouri Bot. Gard. 4: 20. 1917. *S. scalaris* var. *parrasianus* (Greenm.) C.C. Freeman, Phytologia 67:238. 1989. TYPE: MEXICO. COAHUILA: Sierra de Parras, Jul 1910, *C.A. Purpus 4575* (LECTOTYPE, here designated: US!; ISOLECTOTYPES: F!, MO!).

Gravelly, calcareous sites in open pine-oak-juniper woodlands and scrub in the Sierra de Parras of southwestern Coahuila; 1500–2880 m. Flowering mostly May through July.

10c. Packera scalaris var. **carmenensis** (C.C. Freeman) C.C. Freeman & T.M. Barkley, comb. nov. *Senecio scalaris* var. *carmenensis* C.C. Freeman, Phytologia 67:249. 1989. TYPE: MEXICO. COAHUILA: Mpio. Villa Acuña, Sierra del Carmen, Canon de Sentenela (= Cañon del Centinel) on Hacienda Piedra Blanca; moist stream side, 6 Jul 1936, *F.L. Wynd & C.H. Mueller 546* (HOLOTYPE: NY!; ISOTYPES: GH!, MICH!, MO!, TEX!).

Gravelly loam that apparently is derived from rhyolite, in open pine-oak woodlands in the Sierra del Carmen of northwestern Coahuila; 1500–2590 m. Flowering May through September.

11. Packera sanguisorbae (DC.) C. Jeffrey, Kew Bull. 47:101. 1992. *Senecio sanguisorbae* DC. Prodr. 6:427. 1838. TYPE: MEXICO. MÉXICO: "circa Toluccanum [Toluca], Floret Aprili," 1834, *G. Andrieux 292* (LECTOTYPE: G-DC [McVaugh, 1984], Prod. Herb. IDC Microfiche 800. 1141: I, 3; photo: Field Mus. Neg. 38811, F!, MICH!, MO!).

Cineraria pinnata La Llave in La Llave & Lexarza, Nov. Veg. Descr. 1:29. 1824, non *Senecio pinnatus* Poiret. *Senecio pinnatisectus* DC., Prodr. 6:427. 1838. TYPE: MEXICO. VERACRUZ: "crescit ab umbram in petrosis, amque martio florentem inveni, in declivitate quae ducit ad ultimum cataractam fluminis Blanco," *P. La Llave* (HOLOTYPE: G).

Along streams and on mesic sites in pine, pine-oak, and pine-fir forests throughout the Sierra Volcánica Transversal, the southern end of the Sierra Madre Oriental, and the Oaxaca Uplands of the Sierra Madre del Sur; 1465–3355 m. Flowering mostly May through November but also throughout the year.

12. **Packera coahuilensis** (Greenm.) C. Jeffrey, Kew Bull. 47:101. 1992. *Senecio coahuilensis* Greenm., Monographie der nord- und centralamerikanischen Arten der Gattung *Senecio*, I. Teil 23. 1901, *nomen nudum*. Engl. Bot. Jahrb. 32:19. 1902, *nomen nudum*. Publ. Field Columbian Mus., Bot. Ser. 2:275. pl. 19, fig. 2. 1907. TYPE: MEXICO. COAHUILA: Lerios (= Lirios?), Feb-Oct 1880, *E. Palmer 755* (LECTOTYPE, here designated: GH!, ISOLECTOTYPES: K, NY!, US!; photo: MO!. The NY specimen has the following: "mt section 15 leagues E of Saltillo, about 10000 ft, Jul 10-13, 1880").

Senecio leonensis Greenm., Monographe der nord- und centralamerikanischen Arten der Gattung *Senecio*. I. Teil 23. 1901, *nomen nudum*. Engl. Bot. Jahrb. 32:19. 1902 *nomen nudum*. Publ. Field Columbian Mus., Bot. Ser. 2:276. pl. 19, fig. 1. 1907. TYPE: MEXICO. NUEVO LEÓN: Sierra Madre, near Monterrey, 1 Jun 1899, *C.G. Pringle 2894* (HOLOTYPE: GH!; photo: MO!).

Senecio cyclophyllus Greenm., Publ. Field Columbian Mus., Bot. Ser. 2:276. 1907. TYPE: MEXICO. NUEVO LEÓN: Sierra Madre above Monterrey, 2500–3000 ft, 31 Mar 1906, *C.G. Pringle 10230* (HOLOTYPE: GH!; ISOTYPES: F!, GH!, KANU!, LL!, MICH!, MSC!, NMC!, SD!, US!, WIS!; photo: F!, MO!).

Senecio hypotrichus Greenm., Ann. Missouri Bot. Gard. 2:612. 1915. TYPE: MEXICO. SAN LUIS POTOSÍ: chiefly in the region of San Luis Potosí, 6000–8000 ft, 1878, *C.C. Parry & E. Palmer 533* (HOLOTYPE: US!; photo with fragments, MO!). Greenman (1915) noted that *Parry & Palmer 533* is a mixed collection, and that the species was described from the specimen at US. The specimens of that number at F, GH, and NY are included here within *P. tampicana*.

Along streams and in open mesic to mildly xeric sites in pine-oak, pine, and pine-fir woodlands and occasionally in alpine meadows, throughout the Sierra Madre Oriental but most frequent in the High Sierras of west-central Nuevo León and southeastern Coahuila and the northern sierras of Coahuila; 1345–3720 m. Flowering mostly April through August, but also at other times.

The name *Senecio cyclophyllus* has been used for plants on which the terminal lobe of the basal and lower cauline leaves is much enlarged and the lateral lobes are relatively reduced. Examination of a series of specimens suggests that this morphotype is merely a part of a large cline and it is accomodated comfortably within *P. coahuilensis*.

13. **Packera zimapanica** (Hemsley) C.C. Freeman & T.M. Barkley, comb. nov. *Senecio zimapanicus* Hemsley, Biol. Centr. Amer. Bot. 2:248. 1881. TYPE: MEXICO. HIDALGO: Zimapán, *J.M. Coulter 423* (Putative HOLOTYPE: K [Greenman 1915]).

Gravelly soils and stream banks in pine woodlands in the Sierra Madre Oriental from Cerro Potosí in southeastern Nuevo León, southward to northern Hidalgo; 2740–3430 m. Flowering July and August. A highly distinctive and poorly known species.

14. **Packera montereyana** (S. Watson) C. Jeffrey, Kew Bull. 47:101. 1992. *Senecio montereyanus* S. Watson, Proc. Amer. Acad. Arts 25:255. 1890. TYPE: MEXICO. NUEVO LEÓN: dry shaded ledges on the Sierra Madre, near Monterrey, 27 Jun 1888, *C.G. Pringle 1922* (LECTOTYPE, here designated: GH!; ISOLECTOTYPES: COLO!, F!, K, MICH!, MO!, NY!, UC!, US!).

Known only from limestone ledges in pine forests in the Sierra Madre above Monterrey, Nuevo León; 1370–1525 m. Flowering April through September and rarely at other times.

15. **Packera millelobata** (Rydberg) W.A. Weber & Á. Löve, Phytologia 49: 47. 1981. *Senecio millelobatus* Rydb. Bull. Torrey Bot. Club 27:171. pl. 5. 1900. TYPE: UNITED STATES: TEXAS: hills on the Limpia, 1851-1852, *C. Wright 1287* (HOLOTYPE: NY!; ISOTYPES: GH!, MO!, NY!, PH!, US!; photo: KSC!).

Mesic open sites in oak woodlands of northern Coahuila and central Chihuahua and north of the Rio Grande in adjacent Trans-Pecos Texas; 1066–2130 m. Flowering mostly March through September, but also at other times.

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The authors gratefully acknowledge the assistance of the staff of the Herbario Nacional (MEXU), Instituto de Biologia, Universidad Nacional Auto'noma de México for making the facilities of that institution available and for collegial kindness. Particular thanks are due to Dr. José Luis Villaseñor (MEXU) for his interest in the work and for sharing his considerable knowledge. This paper is Contribution no. 95-549-J from the Kansas Agricultural Experiment Station, Manhattan.

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BOOK NOTICES

TERANISHI, ROY, RON G. BUTTERY, and HIROSHI SUGISAWA (Eds.). 1993. **Bioactive Volatile Compounds from Plants.** ACS Symposium Series. (ISBN 0-8412-2639-3, hbk). American Chemical Society, P.O. Box 57136, Washington, DC 20037-0136. $79.95. 309 pp, 6" x 9".

This book was developed from a symposium sponsored by the Division of Agricultural and Food Chemistry at the 203rd National Meeting of the American Chemical Society. Chapter one is an overview of the book contents that discusses some of the latest methods and equipment in sample preparation, analyses and identification of volatiles from various flowers, leaves, and fruits. Perfumery and flavor chemists from industry, government and academia have identified and catalogued tens of thousand of compounds and this book presents the latest findings of volatile bioactive compounds from plants. There are 20 chapters divided into thematic sections: Biogenesis and Biochemistry; Essential Oils; Flowers. Some examples of the chapter headings include more general subject matter and in most cases very specific topics: Formation of Some Volatile Components from Tea; Antimicrobial Activity of Green Tea Flavor Components: Effectiveness against *Streptococcus mutans*; Therapeutic Properties of Essential Oils and Fragrances; On the Scent of Orchids; Volatile Components of Apricot Flowers; Flower Scent of Some Traditional Medicinal Plants. The invited and peer reviewed papers are highly technical and will be of special interest to biochemists and chemists working in the this special field.—*Harold W. Keller, Research Associate, BRIT.*

MANASTER, JANE. 1994. **The Pecan Tree.** (ISBN 0-292-75153-2, hbk). The University of Texas Press, P.O. Box 7819, Austin, TX 78719. The Corrie Herring Hooks Series, No. 27. $17.95. 112 pp, Eight color and b/w photographs, with six of the color by Paul Montgomery, $5^1/_2$" x 9".

This is another volume in the natural history series for the general readership. It is of interest to the personnel of the pecan industry as well as to the public and especially Texans, since the Pecan Tree (*Carya illinoinensis*) has been designated as the state tree of Texas.

The Chapters cover: Introduction and Range, Botanical Niche, History, Cultivation and Improvement, Texas: A Case Study, Orchards, Animal Predators, The Pecan Industry, Nutrition, Recipes, Conclusion, and Resources.

From 7000 B.C. to the present time, the history of the pecan and its uses by humans unfolds in a narrative style. The pecan tree itself has evidently been found as fossilized remnants in the lower Cretaceous period (135 million years ago).

In the 1700s during the westward immigration, the settlers encountered the pecan in the country of the Illinois Indians. The "Illinois Nut" became popular back east and in Europe where it was first described in a scientific article from a plant in cultivation. Wangenheim designated the specific epithet (species name) as "*illinoinensis*" that means belonging to the Illinois even though that geographical area is today in the northeastern part of its native range. The pecan is not native to Georgia in spite of the fact that today Georgia is the top producer of pecans in the nation.

This is an excellent book relating to the many historical up to current aspects of the pecan and its importance in today's life.—*Wm. F. Mahler.*

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HISTORICAL EVIDENCE OF THE NATIVE PRESENCE OF *SABAL MEXICANA* (PALMAE) NORTH OF THE LOWER RIO GRANDE VALLEY

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ABSTRACT

References by Lindheimer (1845a and b, 1879) and Engelmann (Gray 1850) to Texas central coast palm trees, and a description of the distribution and uses of *Sabal mexicana* Mart. by Sargent (1905, 1922), add to the evidence that a wild population of the species discovered in Jackson and Victoria counties in 1989 is indigenous.

RESUMEN

Referencias de Lindheimer (1845a y b, 1879) y Engelmann (en Gray 1850) a palmeras en la litoral central de Texas, y una descripción de la distribución y los usos de *Sabal mexicana* Mart. hecha por Sargent (1905, 1922), contribuyen a la evidenciar que una población natural de la especie descubierta en los condados de Jackson y Victoria en 1989 es autóctona.

Lockett and Read (1990) report the discovery of a wild population of *Sabal mexicana* (syn. *S. texana*) along Garcitas Creek (Jackson and Victoria counties), 200 miles north of the Lower Rio Grande Valley (LRGV), the region previously considered the northern limit of the species range (Correll & Johnston 1970, p. 341). Since *S. mexicana* has been widely cultivated in Texas, Lockett and Read (1990) presented historical evidence, going back to the colony established on Garcitas Creek by French explorer René-Robert Cavelier, Sieur de La Salle, in 1685, in order to show that the Garcitas Creek population is not a case of escape from cultivation. Further, Lockett (1991, p. 66) presents historical evidence that the species may have also been native to San Antonio Springs, the headwaters of the San Antonio River. The purpose of the present paper is to present historical evidence discovered since Lockett and Read (1990) and Lockett (1991).

While Ferdinand Lindheimer was collecting specimens in Texas for Asa Gray he corresponded with George Engelmann, and his letters to Engelmann are now in the possession of the Missouri Botanical Garden. The late Minetta Goyne performed the arduous task of translating these letters, and the translation appears in Goyne (1991). As Goyne explains in her preface, the letters were hand written in German under field conditions and in an archaic script. Accordingly she assures us (p. xii) that "Translating the letters was not nearly so great a challenge as deciphering them."

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In reading Goyne's entire book, two passages in her translation of Lindheimer's letters caught my attention:

Passage 1.—In a letter dated "22 January 1845" from "Camp on the Agua Dulce," which Lindheimer describes as "7 miles from Port Lavaca on the West Matagorda Bay," and in a paragraph titled "*Cactus*." (Goyne 1991, p. 111.)

> I collected seeds of the fanshaped agave ["*Fächerpulke*"] with stem that is often 20' to 40' high;

Passage 2.—In a letter from "New Braunfels, Bexar County" dated "beginning of August 1845" and describing the vegetation as one moves inland, up the rivers, from the shore of Matagorda Bay. (Goyne 1991, p. 123.)

> Farther upstream occasional single elms, the aforementioned *Yucca* and *Opuntias*, but less vigorous ones, often … with trunk about 15' high, a palmetto (*Chamaerops palmetto*).

Since the description of the plant referred to in Passage 1 seemed to fit a palm tree better than any known agave, and Passage 2 clearly referred to a palm (even though unclear as to whether the palm or another plant had the 15' trunk), I contacted Goyne, told her of the discovery of *Sabal mexicana* on Garcitas Creek (15 miles north of Port Lavaca), and asked her to reevaluate her interpretation of the two passages in question. She replied that when she translated the letters she had no idea palm trees could be native near Port Lavaca, but since receiving my communication had decided that the correct interpretation of the handwritten word she had transcribed as *Fächerpulke* (literally "fan *pulque*") was *Fächerpalme* ("fan palm"). The original translation ("fanshaped agave") was due, she explained, to her having interpreted Lindheimer's scrawled *a* as *u*, and his *m*, which had an overly large first loop, as *ke*. As this interpretation yielded a German spelling of the Spanish word *pulque*, which refers to a Mexican alcoholic beverage made from the juice of the agave, she reasoned that, since she knew that Lindheimer had lived in Mexico and liked to play with words, he had used *-pulke* to mean "agave." Her placing the word *Fächerpulke* in brackets in her first translation indicates, of course, her original doubt about the *-pulke* interpretation. Her emended translation of Passage 1, which appears in a signed statement (see Appendix) she sent both to me and to the Texas A&M Press, reads as follows:

> I collected seeds of the fan palm [*Fächerpalme*] with trunk that is often 20' to 40' high;

Figure 1 is a photocopy of the numbered paragraph of Lindheimer's letter (1845a) that contains Passage 1. A transliteration of Passage 1, in modern orthography, reads as follows:

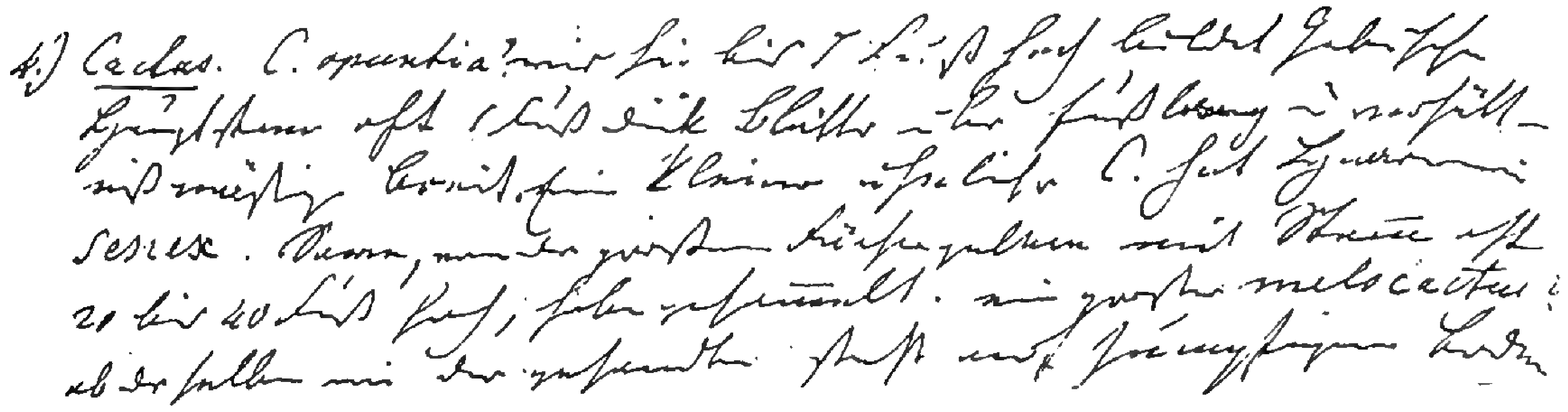


FIG. 1. Excerpt from Lindheimer letter dated "22 January 1845." Passage 1 begins with second word of fourth line from top and ends with period just right of center of fifth line. The transliteration reads as follows: *Samen, von der grossen Fächerpalme mit Stamm oft 20 bis 40 Fuss hoch, habe {ich} gesammelt.*

> Samen, von der grossen Fächerpalme mit Stamm oft 20 bis 40 Fuss hoch, habe [ich] gesammelt.

Although Passage 1 clearly includes the adjective *grossen* "large," Goyne omitted it from both her original and revised translations. But because she included the translation of this word in an intermediate version of her translation of the sentence (pers. comm.), and because its absence does not significantly change the meaning, I assume its omission was an oversight.

Reexamining Passage 2, Goyne determined that the ellipsed word is *nicht* "not," and that she had accidentally placed the ellipsis after *häufig* when it should have preceded it. Her emended translation (see Appendix), which makes it clear that the 15 foot trunk pertains to the palm, is as follows:

> Farther upstream occasional single elms; the aforementioned *Yucca* and *Opuntias*, but less vigorous ones; not often, with trunk about 15' high, a fan palm (*Chamaerops palmetto*).

Figure 2 is a photocopy of the portion of Lindheimer's letter (1845b) containing Passage 2. A transliteration, in modern orthography, of the portion of Passage 2 pertaining to palms (the segment beginning with "not often" and ending with "*palmetto*") reads as follows:

> nicht häufig aber mit ohngefähr 15 Fuss hohem Stamm eine Fächerpalme (*Chamaerops palmeto*).

The correctness of Goyne's revisions is confirmed by Lindheimer himself in "Overview of the Flora of Texas," an essay published decades later in Germany (Lindheimer 1879, p. 37). In a description of the coast, going inland from Indianola, there is a passage paralleling Passage 2 above. As translated by Goyne it reads:

> A bit farther from the water *Sabal adansonii.* Farther upstream the aforementioned large *Yucca* and *Opuntia* but not as vigorous as [those] in the vicinity of the sea [Gulf]. Occasionally the palm *Sabal palmetto.*

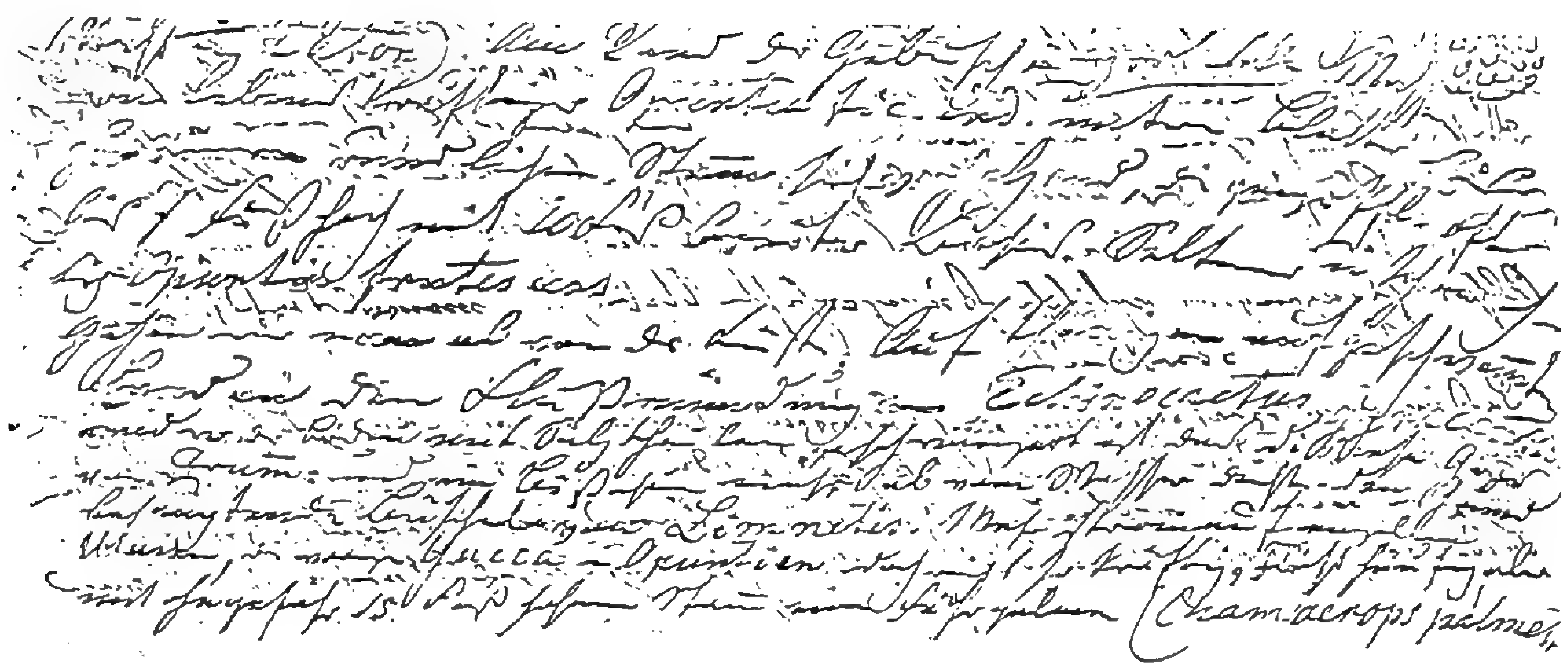


FIG. 2. Excerpt from Lindheimer letter dated "beginning of August 1845." The portion of Passage 2 pertaining to palms begins with the word *nicht* near the end of the next to last line of the excerpt, and continues till the end of the excerpt. *nicht* appears after the comma seen over the first *a* of *Chamaerops*. The transliteration reads as follows: *nicht häufig aber mit ohngefähr 15 Fuss hohem Stamm eine Fächerpalme (Chamaerops palmeto).*

In 1845 Lindheimer had, like others in his time, incorrectly applied the genus name of a European palm (*Chamaerops*) to an American palm. In the essay he corrects this to *Sabal*. The epithet *palmetto* actually refers to a tall palm native to the southeastern United States. This error is to be expected, however, since in his time the Texas palms had not yet been identified as a species distinct from *S. palmetto*, which they closely resemble. His separate reference to *S. adansonii* (syn. *S.minor*) makes it clear his *S. palmetto* was a tall palm, and not dwarf palmetto.

Engelmann, who apparently never visited the area but was the recipient of Lindheimer's letters, also confirms Goyne's emended translations of Passages 1 and 2. In an addendum to Gray's (1850, p. 235) description of plants collected by Lindheimer during 1845-1848, Engelmann identifies the area where the specimens were collected as that drained by the Colorado, Navidad, Lavaca, Guadalupe and San Antonio rivers. In an account of the vegetation of that area he first describes the plants of the bay shore, then writes:

> Some miles higher up the rivers, on the clayey soil, solitary Elms and Palm trees are seen; the prairies have a stiff black soil thickly matted with grass. The prevalent tree now becomes the Live Oak along the rivers, as well as in small groves on the prairies.

Garcitas Creek lies between the Lavaca and the Guadalupe. The Engelmann quote ("Some miles higher up the rivers"), and both Lindheimer quotes ("Farther upstream") fit the Garcitas Creek population today. Because *Sabal mexicana* is not salt tolerant, as is *S. minor*, the Garcitas Creek palm trees do not begin until about four miles upstream from the bay.

Since Engelmann writes of "rivers", the implication of his statement is that *S. mexicana* occurred along all the rivers from the Colorado to the San Antonio. As reported in Lockett and Read (1990, pp. 82-83), the central coast population of *S. mexicana* was almost entirely removed, due to a demand for use of the trunks as wharf pilings, and for landscaping.

There is, however, evidence that the range of *S. mexicana* may have reached as far northeast as the San Bernard River. Sargent (1905, p. 109) gives the distribution of the species as "Rich soil of the bottom-lands near the mouth of the Rio Grande, in Texas, and southward in Mexico in the neighborhood of the coast." In Sargent (1922, p. 104), however, the distribution is given as: "Rich soil of the bottom-lands on the Bernado [sic] River, Cameron County, and near the mouth of the Rio Grande, Texas, and southward in Mexico in the neighborhood of the coast."

The Sargent (1922) statement is unclear, and partly redundant. First, there is no "Bernado River" in Cameron County, or anywhere in Texas. Second, since Cameron County is the southernmost county in Texas, and is bordered by the Rio Grande on the south and the Gulf of Mexico on the east, any place "near the mouth of the Rio Grande, Texas" is in Cameron County. But, while there is no "Bernado River" in Texas, there is the San Bernard (from Spanish: *San Bernardo*) River, which flows into the Gulf 240 miles northeast of the Rio Grande, and is the next river up the coast from the Colorado. Further, six miles southwest of the San Bernard River, in the extensive bottomland forest that covers western Brazoria County, there is a small population of tree-sized palms that appear to be hybrids of *Sabal mexicana* and *S. minor* (Lockett 1991).

In spite of the ambiguity of Sargent's (1922) statement, we could hypothesize that sometime between 1905 and 1922 Sargent was informed, probably orally, that *S. mexicana* grew in the bottomlands of the "Bernardo River." Since Sargent, like almost all other botanists since him (for an exception see Cook 1908, p. 5n.a; and 1913 p. 11), had theretofore believed that the Texas range of the species was restricted to the LRGV, he then assumed that the river in question must be in the LRGV. The discrepancy in spelling between the informant's "Bernardo" (although we don't know how this person actually pronounced it) and Sargent's "Bernado" could be attributed to Sargent's Bostonian speech, characterized by loss of postvocalic *r*. Since the San Bernard is little known outside of Texas, we could assume Sargent had never seen the name "Bernardo" written. Adding to the likelihood of Sargent's misinterpretation is the fact that his informant could have also spoken with an *r*-dropping dialect, since such speech is common in Texas, especially in Brazoria County, where the hybrids occur, and through which the San Bernard flows.

In both the 1905 and 1922 editions of Sargent the description of the uses of *S. mexicana* reads as follows: "On the Gulf coast the trunks are used for wharf-piles, and on the lower Rio Grande the leaves for the thatch of houses." Aside from confirming historical evidence reported in Lockett and Read (1990, p. 82), this statement suggests the existence of two separate populations of the species—one on the "Gulf coast" and the other on the "lower Rio Grande."

Although in his letter dated 22 January 1845 Lindheimer told of collecting seeds from the tall palms he refers to, searches by curators at GH, A, MO, BH, TEX and BRIT failed to reveal any Lindheimer palm specimens other than a single specimen of *Sabal minor*. Likewise searches by curators at GH, A, BH, TEX and BRIT (including a search of Sargent's correspondence at A), failed to reveal any specimen or correspondence that would form the basis for Sargent's "Bernado River" reference.

So far as I know the only well established wild population of *S. mexicana* that, on the basis of historical evidence, does not appear to be an escape from cultivation (although it is presumably second growth) is the Garcitas Creek population. This population is scattered through the bottomland forest for several miles along the east side of Garcitas Creek, and contains many mature (reproducing) specimens. The other wild, reproducing populations known to me are apparent escapes from cultivation, and have only one mature palm each. One is along the Aransas River on and adjacent to the Welder Wildlife Refuge; another is near the Guadalupe River, south of Victoria; and the third is along a normally dry tributary of the Medina River, 12 miles northwest of Bandera. The fact that *S.mexicana* is establishing itself in the wild in the apple-growing region of the Hill Country, almost 300 miles northwest of Brownsville, should discourage hasty assumptions about its hardiness, or just how far north it might have once ranged.

A factor that has probably contributed to the long-standing assumption that *S. mexicana* is not native north of the LRGV is the widespread belief that Spanish explorers named the Rio Grande River the Río de las Palmas, presumably because of the *S. mexicana* palms growing along its banks. According to Weddle (1985, pp. 104-105) and Chipman (1995), however, this belief, often expressed in articles and even textbooks, stems from a misinterpretation of Spanish explorers' journals. Although there is a river that was called the Río de las Palmas, it is the Río Soto la Marina, in Mexico, and not the Rio Grande.

There are probably more wild populations of *S. mexicana* in the thick bottomland forests along South Texas rivers, either as remnants of the original population, as on Garcitas Creek, or escapes. To the extent conservationists are able to locate such populations and persuade land owners to protect them, and reintroduce the species in appropriate habitat, perhaps *Sabal mexicana* can be restored to its former range. Palms with trunks of 20 to 40 feet will overtop the live oaks, creating a scene that may seem exotic to us, but apparently would have been familiar to La Salle and the Karankawas.

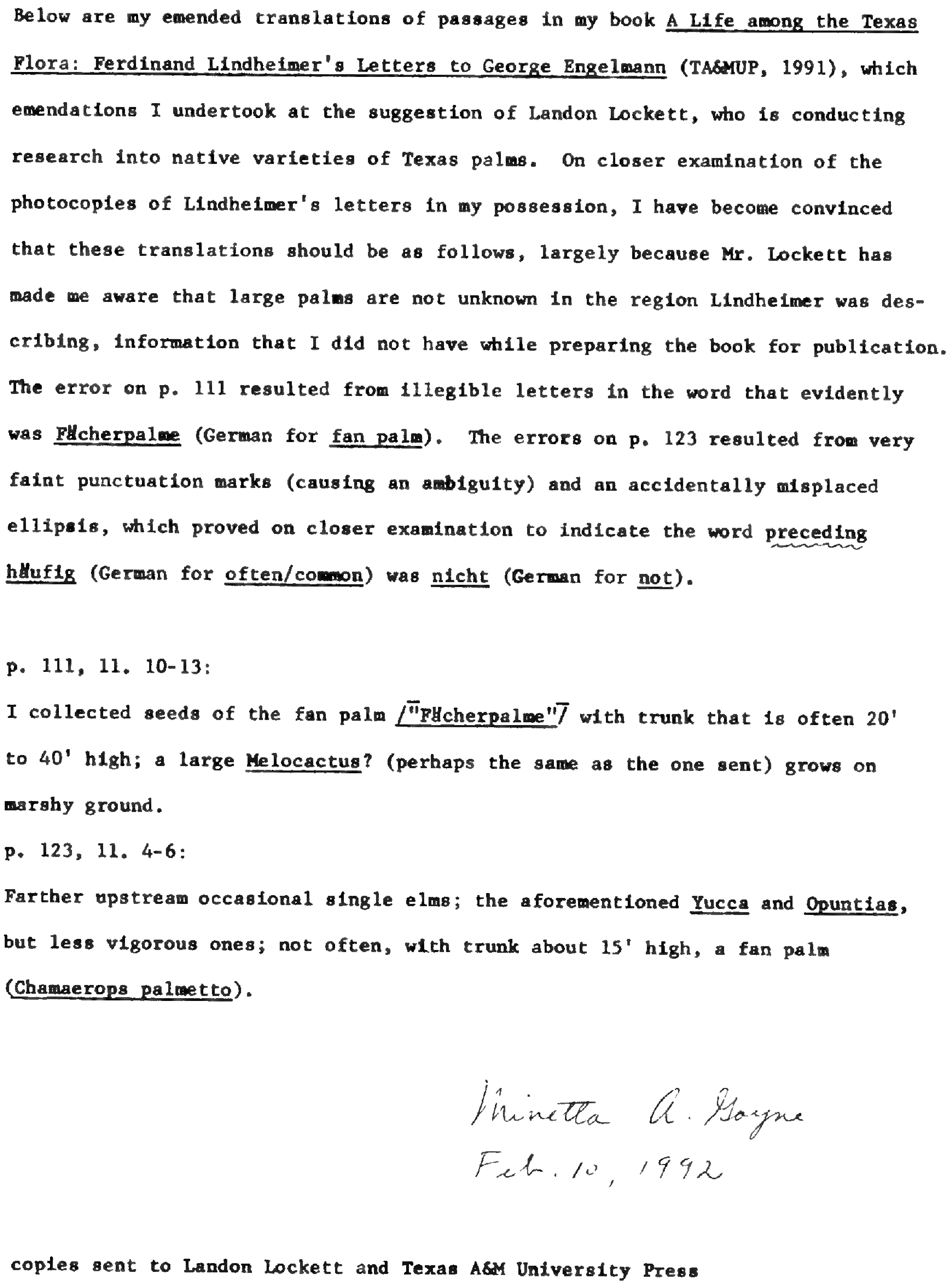
ACKNOWLEDGMENTS

I am grateful to Martha Riley (MO) for furnishing me photocopies of Lindheimer's letters; to Helga von Schweinitz and Barbara Bresslau for help in translation; to Chris Durden, of the Texas Memorial Museum, for calling my attention to the statements in Sargent; and to Del Weniger, Anders Saustrup, and the staff of the University of Texas Center for American History for help in searching for early references to palms. For their help in my search for herbarium specimens and early botanical records I am grateful to Judith Warnement of The Botany Libraries, Harvard University; to Emily W. Wood (GH, A); to Steve Spongberg, Jennifer Brown and Richard Howard (A); to James C. Solomon and Chris Dietrich (MO); to Philippe Morat (P); to Natalie Uhl (B); and to Barney Lipscomb and Yonie Hudson (BRIT). I am especially grateful to Robert Read (US) and Billie Turner (TEX) for their guidance, encouragement and interest in my research. I very much appreciate the generosity of David Marlowe, Emily Dial, Patricia Martin and Charles W. Weber.Jr. for letting me look for palms on their ranches; and of James Teer and Lynn Drawe of the Rob and Bessie Welder Wildlife Foundation for letting me stay at the foundation's wildlife refuge while searching for palms there. For helping me in this fieldwork I am grateful to my wife Carol, Mike Rayburn, Mikel Borg, George Stevenson, and H. Dixon Hoese. I also want to thank Benny Simpson, Dorothy Mattiza, William F. Mahler and the other members of the Native Plant Society of Texas for their continued help, support and recognition of my research.

Finally, I want to dedicate this article to the late Minetta Altgelt Goyne, without whose research and cooperation it would not have been possible.

APPENDIX

Photocopy of Goyne's signed statement presenting her emended translations of Passages 1 and 2.



Below are my emended translations of passages in my book A Life among the Texas Flora: Ferdinand Lindheimer's Letters to George Engelmann (TA&MUP, 1991), which emendations I undertook at the suggestion of Landon Lockett, who is conducting research into native varieties of Texas palms. On closer examination of the photocopies of Lindheimer's letters in my possession, I have become convinced that these translations should be as follows, largely because Mr. Lockett has made me aware that large palms are not unknown in the region Lindheimer was describing, information that I did not have while preparing the book for publication. The error on p. 111 resulted from illegible letters in the word that evidently was Fächerpalme (German for fan palm). The errors on p. 123 resulted from very faint punctuation marks (causing an ambiguity) and an accidentally misplaced ellipsis, which proved on closer examination to indicate the word preceding häufig (German for often/common) was nicht (German for not).

p. 111, ll. 10-13:

I collected seeds of the fan palm ["Fächerpalme"] with trunk that is often 20' to 40' high; a large Melocactus? (perhaps the same as the one sent) grows on marshy ground.

p. 123, ll. 4-6:

Farther upstream occasional single elms; the aforementioned Yucca and Opuntias, but less vigorous ones; not often, with trunk about 15' high, a fan palm (Chamaerops palmetto).

Minetta A. Goyne
Feb. 10, 1992

copies sent to Landon Lockett and Texas A&M University Press

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BOOK NOTICE

BHATLA, SATISH C. 1994. **Moss Protonema Differentiation.** (ISBN 0-471-94438-6, hbk). John Wiley & Sons Inc., 605 Third Avenue, New York, NY 10158. $79.95. 296 pp.

This is also Series No. 13 of Research Studies in Botany and Related Applied Fields (Research Studies Press Ltd., Taunton, Somerset, England: ISBN 0 86380 157 9).

The following chapter titles describe the coverage: 1) Structure and Germination of Spores, 2) The First Formed Protonema, 3) Structure and Development of Caulonema, 4) Orientation of Protonema by Light and Gravity, 5) Regulation of Caulonema Formation by Auxins, 6) Auxin-cyclic Adenosine Monophosphate (cAMP) Interaction in Protonema Differentiation, 7) Cytokinin Action on Caulonema Cells, 8) Calcium Mediation of Cytokinin-induced Bud Formation, 9) Nucleic Acid and Protein Synthesis in Relation to Protonema Differentiation, and 10) Concluding Remarks.

From the Preface:

"A need for the present volume was felt because there has been no effort so far to critically evaluate and compile the available information, in a single comprehensive volume, although some of the topics have been discussed occasionally in various symposia and conferences. This work provides an up-to-date, in-depth analysis of our present understanding of cell differentiation in moss protonema. It is intended for advanced students and professionals interested in cell differentiation in plants in general and mosses in particular.

Written in ten chapters, the book provides an insight into the ultrastructural, physiological, biochemical and molecular events associated with moss protonema differentiation. ..."

The literature cited in the References extend from page 255 to 291 and is indicative of the depth of the subject matter that is discussed and evaluated throughout the text. —*Wm. F. Mahler.*

SIDA 16(4): 720. 1995

TAXONOMIC NOTES ON NEW VARIETIES OF SPECIES OF *CLITORIA* (LEGUMINOSAE - PHASEOLEAE - CLITORIINAE)

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ABSTRACT

New varieties of 10 species of *Clitoria* (Leguminosae - Phaseoleae - Clitoriinae) are described with commentary. Characteristics of segregation from other varieties within the species are presented. Newly described varieties include: *C. arborea* var. *pseudoamazonica* (Western Brazil), *C. epetiolata* var. *angustissima* (Brazil: Paraná), *C. guianensis* var. *macrocleistogama* (Brazil: Minas Gerais), *C. leptostachya* var. *fruticosa* (Brazil: Pará), *C. mariana* var. *pubescentia* (United States: Florida), *C. polystachya* var. *congesta* (México: México), *C. polystachya* var. *pringlei* (México: Morelos), and *C. pozuzoensis* var. *schunkei* (Perú: Loreto). New combinations include: *C. falcata* var. *aurantiaca* (Southern Brazil), *C. falcata* var. *latifolia* (Brazil: Pará), *C. heterophylla* var. *pedunculata* (Madagascar, Mauritius), *C. guianensis* var. *chapadensis* (Brazil: Mato Grosso), and *C. stipularis* var. *latifolia* (Brazil: Ceará, Maranhão).

RESUMEN

Se describen variedades nuevas de diez especíes de *Clitoria* (Leguminosae - Phaseoleae - Clitoriinae). Se presentan las características de segregación de otras variedades dentro de las especíes. Estas variedades nuevamente descritas incluyen las siguientes: *C. arborea* var. *pseudoamazonica* (Brasil oeste), *C. epetiolata* var. *angustissima* (Brasil: Paraná), *C. guianensis* var. *macrocleistogama* (Brasil: Mineas Gerais), *C. leptostachya* var. *fruticosa* (Brasil: Pará), *C. mariana* var. *pubescentia* (Estados Unidos: Florida), *C. polystachya* var. *congesta* (México: México), *C. polystachya* var. *pringlei* (México: Morelos), and *C. pozuzoensis* var. *schunkei* (Perú: Loreto). Se incluyen las siguientes combinaciones nuevas: *C. falcata* var. *aurantiaca* (Brasil del sur), *C. falcata* var. *latifolia* (Brasil: Pará), *C. heterophylla* var. *pedunculata* (Madagascar, Mauritius), *C. guianensis* var. *chapadensis* (Brasil: Mato Grosso), y *C. stipularis* var. *latifolia* (Brasil: Ceará, Maranão).

INTRODUCTION

Clitoria (Leguminosae, Phaseoleae, Clitoriinae) comprises 60 species within the pantropical-subtropical belt. Several species are divisible into populations that are sufficiently distinct, and have been recognized at the level of *varietas*. All types cited have been examined, unless noted. The objective of this paper is to validate these names.

TAXONOMY

1. **Clitoria arborea** Hoffm. ex Benth. var. **pseudoamazonica** Fantz, var. nov.

Varietas nova *pseudoamazonica* distinguibili a *Clitoria arborea* var. *arborea* foliolis acuminatos, infra pubescentibus, calyce glabrato et vexillo subglabrato, et inflorescentia elongato.

SIDA 16(4): 721–730. 1995

Leaflets ovate-elliptic, acuminate with acumen 7–15 mm long, conspicuously pilose on nerves below. Inflorescence 10–30 cm long, primary branches 8–15 mm long that bear the pedicels. Calyx glabrate, appressed trichomes concentrated on ventral margin. Vexillum subglabrate with few appressed hairs along nerves and concentrated near the folded margin. Western Brazil.

TYPE: BRAZIL. AMAZONAS: Mun. São Paulo de Olivencia near Palamares, Basin Rio Solimóes, 11 Sep-26 Oct 1936, *Krukoff 8208* (HOLOTYPE: US 2169816; ISOTYPES: A, F 927714,G 295 & 296, MICH, MO 1175978 & 1250450, S, U 38199A.

PARATYPES: BRAZIL. ACRE: near mouth Rio Macauhan, Basin Rio Purus, 27 Aug 1933, *Krukoff 5719* (A, BM-2 sheets, F, G-2 sheets, LA, M, MICH, MO, NY-2 sheets, PR-2 sheets, S, U, UC).

These specimens have been identified by botanists frequently as *Clitoria amazonum* Mart. ex Benth. Closer examination indicates that these specimens are distinquished easily from *C. amazonum* by (1) the smaller flowers, bracteoles, calyx, gynoecium and androecium, (2) a different pubescence on the leaves, calyx and vexillum, and (3) the larger stipules, stipels and inflorescence. Other botanists have reached the same conclusion, as evidenced by their annotations, but disagree upon the placement of this taxon. Specimens commonly have been assigned to *Clitoria arborescens* R. Br., *Clitoria glaberrima* Pittier, *Clitoria javitensis* (Kunth) Benth. or *Clitoria racemosa* Benth. [= *Clitoria fairchildiana* R.A. Howard], but rarely to *C. arborea*. Occasionally, an annotation note has raised the question of a new species. These specimens agree with *C. arborea* in (1) habit, (2) inflorescence type, (3) flowers and its associated floral parts, and (4) legumes. There are too many characteristics in agreement with *C. arborea* to warrant its separation from this species.

Variety *arborea* is distinguished from var. *pseudoamazonica* by the obtuse to abruptly short-acuminate leaflets (acumen 0.3–5 mm long) that are glabrate below, short inflorescences (2–7 cm long), calyces with appressed trichomes over its surface and a vexillum with moderately dense, appressed trichomes abaxially.

2. **Clitoria epetiolata** var. **angustissima** Fantz, var. nov. [*Clitoria guyanensis* (Aubl.) Benth. f. *angustissima* Hoehne, nom. in sched.]

Varietas nova *angustissima* distinguibili a *Clitoria epetiolata* var. *epetiolata* Burkart foliolis angustati.

Leaflets 3–5 mm wide, lower surface bearing a few, scattered, appressed trichomes ca 0.5 mm long. Flowers 5.5–6.5 cm long. Calyx tube 16–19 mm long, 6–9 mm wide at the throat, lobes 7–9 mm long. Bracteoles 5–7 mm long. Cerrado and campos, Paraná, Brazil.

TYPE: BRAZIL. PARANÁ: Jaguariahyva [= Jaguariaiva], 5 Nov 1928, *Hoehne 23404* (HOLOTYPE: GH).

Hoehne was the first to recognized this taxon as distinct, named it *angustissima*, and assigned it as a form of *C. guyanensis* [= *C. guianensis*] in annotations of herbarium specimens. Currently, no record has been found of the publication of this name. I used Hoehne's name, changed the status to the rank of variety, and assigned it to *C. epetiolata*. Hoehne was unaware of *C. epetiolata* as Burkart (1949) did not circumscribed this closely related species until twenty years later.

This variety is represented poorly in herbarium collections, but is distinguished quickly by the narrower leaflets. Variety *epetiolata* (Paraguay and Corrientes, Argentina) has leaflets commonly 6–12(17) mm wide and bracteoles 7–12 mm long, with other characters similar to var. *angustissima*. Variety *latiuscula* Burk. (Paraguay and Paraná, Brazil) has leaflets 15–30 mm wide, sericeous below with trichomes ca 1 mm long, flowers 6–8.5 cm long with calyx tube (17)22–25 mm long, 13–15 mm wide at throat, lobes 11–13 mm long, and bracteoles 9–11 mm long.

3. **Clitoria falcata** Lam.

This species is characterized as an herbaceous vine with white flowers (pale to deep yellowish in dried state) on elongate axillary peduncles from filiform, voluble, densely rufo-pilose stems. The petioles, rachis, and calyx surface commonly are rufo-pilose with leaves densely sericeous (thinning with age) beneath. Legumes are costate to ecostate. Table 1 contrasts the four varieties.

Variety *falcata* has medium-sized flowers (3.5–5.5 cm) with larger leaflets 3–5.5 cm wide. The calyx tube is 10–16 mm long, moderately to densely pilose with lobes ovate-lanceolate, 2.5–4 mm wide. Bracteoles are ovate-lanceolate, acute, broadly cuneate below, 7–11 mm long, 3–4 mm wide. Legumes commonly are costate with a prominately raised medial costa extending nearly the entire length of the valve, infrequently ecostate or weakly costate with a slightly elevated costa extending a 1/4–3/4 the length of the valve in f. *heteromorpha* (Griseb.) Fantz. This variety is widespread in the neotropics, from southern Mexico to Peru, east to Paraguay and southern Brazil, and introduced infrequently into Africa and recently documented (Huang et al. 1990) from Taiwan.

Variety *glabrescens* (Verdc.) Fantz is distinguished easily by the glabrescent appearance of the stem, petiole and calyx, lower leaf surface, and only ecostate fruits. Other characters agree with var. *falcata*. This variety is found in West Africa with limited collections cited by Fantz (1990) from Guadeloupe and Martinique (introductions?). Two new varieties are added as follows:

3a. **Clitoria falcata** var. **aurantiaca** (Benth.) Fantz, comb. nov. *Clitoria glycinoides* DC. var. *aurantiaca* Benth., Mart. Fl. Bras. 15(1):119. 1862. TYPE: BRAZIL. Rio Grande: fl. orange flushed red, *Fox 325* (HOLOTYPE: K-hb. Hooker; photo of K: S).

Clitoria glycinoides DC. var. *megapotamica* Malme, Ark. Bot. 23a(13):32. 1931. TYPE: BRAZIL. RIO GRANDE DO SUL: Cruz Alto, 16 Jan 1902, *Malme II:1102* (LECTOTYPE: S,

mounted on two sheets). SYNTYPES: BRAZIL. MINAS GERAIS: Caldas, 18 Jan 1860, *Regnell III:437* (S-2 sh.); 18xx, *Regnell III:437* (S); 26 Dec 1862, *Regnell III:437* (S).
Neurocarpum rufescens Benth., Ann. Wiener Mus. Naturgesch. 2:116. 1837; *Clitoria rufescens* (Benth.) Benth., J. Proc. Linn. Soc. Bot. 2:39. 1858. TYPE: BRAZIL. MINAS GERAIS: in campis editis ad Tejuco et Villa do Principe, *Martius s.n.* (HOLOTYPE: M 12446).

Vine, stem with upper portion conspicuously pubescent, trichomes dense, erect, rufus. Leaves conspicuously pubescent below, leaflets oblong, 3–5.5 cm wide. Flowers (5.5) 6–7.5 cm long, vexillum white becoming dark yellowish-orange in the dried state. Calyx tube 16–20 mm long, laxly pilose with trichomes primarily along ventral and dorsal surfaces; lobes oblong, abruptly acuminate, broad, 4–7 mm wide. Bracteoles oblong, obtuse, widening above the middle, 7–11 mm long, 3–4 mm wide. Legume costate. Southern Brazil.

Bentham (1862) published his varietal name with a question mark and a short diagnosis that included the orangish flowers with broad calyx lobes, two of the diagnostic characteristics. Bentham cited the Fox collection in Hooker's herbarium, but neglected to cite the collection number. Only one specimen was cited with a location of deposit, thus there is no doubt that *Fox 325* is the holotype. Malme (1931) did not designate a type, but cited two collections (syntypes) without locality of deposit. Syntype *Malme II:1102* was selected as the lectotype because Malme cited it immediately following the diagnosis, and preceding a more detailed description. Syntype *Regnell III:437* was cited after a note that interpreted Bentham's name as published with an incomplete description.

Clitoria rufescens is rarely mentioned in the literature. Rizzini (1963) cited it as a Brazilian species, but did not examine any specimens of it. The type agrees with *Fox 325* and the circumscription of this variety.

3b. Clitoria falcata var. latifolia (Rizzini) Fantz, stat. et comb. nov. *Clitoria rubiginosa* Juss. ex Pers. f. *latifolia* Rizzini, Arch. Jard. Bot. Rio de Janeiro 17:180. 1963. TYPE: BRAZIL. PARÁ: Mayan Tapajós, Cachoeira do Mangabal, 8 Feb 1917, *Ducke 16739* (HOLOTYPE: RB 11861, mounted on two sheets; ISOTYPES: BM! MG 17171, non vidi).

Vine, stem with upper portion conspicuously pubescent, trichomes dense, erect, rufous. Leaves conspicuously pubescent on lower surface, leaflets elliptic-oblong to oval, 5–8 cm wide. Flowers 3.5–4 cm long, white, drying pale yellow. Calyx tube 12–15 mm long, pilose; lobes ovate-lanceolate, acuminate, 2–4 mm wide. Bracteoles oblong-lanceolate, abruptly acuminate, 10–15 mm long, 4–6 mm wide. Brazil: Pará.

Rizzini's form is recognized as a variety distinguished easily by the broader leaflets and longer bracteoles. Rizzini's taxon *Clitoria rubiginosa* Juss. ex Pers. f. *longifolia* Rizz. (Arq. Jard. Bot. Rio de Janeiro 17:180. 1963) is part of the natural variation of the species, and is regarded as a synonym of var. *falcata*.

TABLE 1. A comparison of the varieties of *Clitoria falcata* Lam.

CHARACTER	*falcata*	*glabrescens*	*aurantiaca*	*latifolia*
STEM				
Pubescence	Rufo-pilose	Glabrate	Rufo-pilose	Rufo-pilose
LEAFLETS				
Larger-width	3–5.5 cm	3–5.5 cm	3–5.5 cm	5–8 cm
Pubescense below	Sericeous	Glabrate	Sericeous	Sericeous
FLOWERS				
Size	3.5–5.5 cm	3.5–5.5 cm	6–7.5 cm	3.5–5.5 cm
Color dried	Pale to deep yellow	Pale to deep yellow	Dark yellowish-orange to orange	Pale to deep yellow
CALYX				
Tube length	10–16 mm	10–16 mm	16–20 mm	12–15 mm
Lobe width	2.5–4 mm	2.5–4 mm	4–7 mm	2.5–4 mm
Pubescence	Pilose	Glabrate	Lax Pilose	Pilose
BRACTEOLES				
Shape	Ovate-lanceolate	Lanceolate to ovate-lanceolate	Oblong	Ovate-lanceolate
Length	7–11 mm	7–11 mm	7–11 mm	10–15 mm
Width	3–4 mm	3–4 mm	3–4 mm	4–6 mm
LEGUMES				
Costate	Costate or ecostate	Ecostate	Costate	Costate

4. **Clitoria guianensis** (Aubl.) Benth.

This species is characterized as a subshrub with subsessile, 3-foliolate leaves with narrow elongated leaflets, axillary peduncles bearing a pair of large (5.5–7.5 cm) blue to lavender flowers, and costate legumes. Cleistogamy with reduced, apetalous flowers is common. Members are found from southern Mexico to Brazil, and western Cuba (Pinar del Río, Isla de Pinos) in savannas, rocky cerrado, pine or pine-oak forests usually in dry sandy soil. Although well documented in collections, specimens with fruits borne from chasmogamous flowers are rare (2%, 8 of 347 collections), a pattern not observed in other species of *Clitoria* with cleistogamy. Two new varieties are noted below:

4a. **Clitoria guianensis** var. **chapadensis** (Malme) Fantz, stat. nov. *Clitoria chapadensis* Malme, Ark. Bot. 23:82. 1931; *Clitoria guyanensis* (Aubl.) Benth. f. *chapadensis* (Malme) Rizzini, Arch. Jard. Bot. Rio de Janeiro 17:184. 1963. TYPE: BRAZIL. MATO GROSSO: Santa Anna de Chapada, 5 Aug 1902, *Malme II:2067b* (LECTOTYPE: S; ISOLECTOTYPES: S, 24 Jul 1902, *Malme 2067*; 2 Aug 1902, *Malme 2067a*; 10 Aug 1902, *Malme 2067d*; 26 Sep 1902, *Malme 2067e*.

Leaves 3-foliolate, occasionally 1-foliolate; leaflets shorter and broader (L/W ratio is 2–2.5:1), oblong-elliptic to oblong-obovate, 5.5–9 cm long, (2) 2.5–4 cm wide. Petioles 3–6 mm long; rachis 2–5 mm long; stipules 7–12 mm long, 4–5 mm wide. Calyx tube of cleistogamous flowers 5–8 mm long. Legumes costate; stipes 9–14 mm long. Brazil (Mato Grosso: Chapada dos Guimarães).

Malme (1931) cited the type as *Malme 2067a-e*. This group of specimens represents a series of plants collected from one generalized locality over a period of time. Thus, they are treated as syntypes. *Malme 2067*, *2067a*, and *2067e* represent immature plants with small leaves and early flowering stages. *Malme 2067c* includes one plant with cleistogamous flowers and fruits. *Malme 2067d* has more material, but lacks 1-foliolate leaves. *Malme 2067b* has the best material, represented well in flowering, with both 1- and 3-foliolate leaves; thus it is selected as the lectotype.

Variety *guianensis* can be distinguished by the linear to lanceolate leaflets (7–20 cm long, 1–2.5 cm wide, with L/W ratio 3–6:1), smaller stipules (5–9 mm long, 2–4 mm wide), and elongate leaf axes (petiole 3–10 mm long; rachis 2–10 mm long).

4b. **Clitoria guianensis** var. **macrocleistogama** Fantz, var. nov.

Varietas nova *macrocleistogama* a distinguibili *Clitoria guianensis* var. *guianensis* petiolo et rhachidi et stipite elongato et floribus cleistogamis cum macrocalycibus.

Leaves 3-foliolate; leaflets linear to lanceolate, 7–16 cm long, 1–1.8 cm wide, with L/W ratio 3–8:1. Petioles 10–20 mm long; rachis 8–18 mm long; stipules 5–8 mm long, 2–3 mm wide. Calyx tube of cleistogamous flowers 9–12 mm long. Legumes weakly costate, the medial vein extending nearly the entire length of the valve; stipes 14–20 mm long. Brazil: Minas Gerais.

TYPE: BRAZIL. MINAS GERAIS: Serra da Caracol prope prodium Brata in campo alto audo preta, 20 Dec 1875, *Mosen 4082* (HOLOTYPE: S, mounted on two sheets).

Variety *guianensis* is distinguished by the smaller calyces of cleistogamous flowers (4–8 mm long), shorter leaf axes, and shorter fruit stipes (6–14 mm long).

5. **Clitoria heterophylla** var. **pedunculata** (Bojer ex Benth.) Fantz, stat. et comb. nov. *Clitoria pedunculata* Bojer ex Benth., Ann. Wiener Mus. Naturgesch. 2:114. 1837 (non Micheli 1875); *Ternatea pedunculata* (Bojer ex Benth.) Kuntze, Revis. Gen. Pl. 1:210. 1891. TYPE: MADAGASCAR: inter frutices ad margines fluviorum, Mar 1830, *Bojer v.77* (LECTOTYPE: W).

Vine. Leaflets (3)5–9, 3–8 mm wide, upper surface micro-uncinate with scattered, short (0.2–0.5 mm) subappressed, macrotrichomes. Peduncle elongate, arcuate, (15) 25–70 mm long; pedicel commonly solitary, borne laterally from peduncle apex, occasionally paired. Legume 3.5–6 cm long, pubescence erect to subappressed. Madagascar, with one collection from Mauritius.

Bentham (1837) did not cite any collection with the original publication of Bojer's species; thus no holotype. However, a later publication provided clues as to a probable type. Bentham (1858) cited one collection for the species as "*Bojer* (herbaria Musaei Vindobensis)." Descriptions published by Bentham consistently noted 3-foliolate leaves, an uncommon leaflet number in the species (typically 5-11-foliolate). Only *Bojer v.*77 (W) has some 3-foliolate leaves and bears the identification "*Clitoria pedunculata* mihi" (handwriting unknown; Bojer or Bentham?). *Bojer v.*77 (W) was a specimen utilized by Bentham in describing the plant, thus selected as the lectotype.

Variety *heterophylla* (common in Mauritius, infrequent in Madagascar) is distinguished easily by narrower leaflets (1–4 mm wide) glabrate above, shorter peduncles (3–10 mm long) with pedicels solitary, borne medially from the peduncle apex, and shorter legumes (2–3.7 cm long).

6. **Clitoria leptostachya** var. **fruticosa** Fantz, var. nov.

Varietas nova *fruticosa* distinguibili a *Clitoria leptostachya* var. *leptostachya* fruticosa cum apice interdum scandens, bracteola longis, et legumine angustato.

Shrub with apices occasionally climbing. Leaflets with midrib raised on upper surface. Bracteoles lanceolate, 3–4 mm long. Flowers rose to lilac. Legume 12–16 mm wide. Brazil (Amazonas, Pará).

TYPE: BRAZIL. PARÁ: prope medium fl. Tapejoz [Rio Tapajós], loco Quataguara, 15 Aug 1923, *Ducke 17244* (HOLOTYPE: S; ISOTYPES: G-hb. Barbey-Boissier (209 & 210), RB 17244 (two sheets), U 63828, US 1442540.

Variety *leptostachya* (Guyana) is distinguished as a liana bearing pinkish-white to mauve-white flowers with a smaller bracteole (2 mm long), broader fruits (15–20 mm wide), and leaflets with the midrib weakly raised on the upper surface.

7. **Clitoria mariana** var. **pubescentia** Fantz, var. nov. BASIONYM: *Clitoria mariana* var. *mariana* f. *pubescentia* Fantz, nom. in sched.

Varietas nova *pubescentia* distinguibili a *Clitoria mariana* var. *mariana* foliolis infra piloso-sericeis et in Florida meridionala endemica.

Leaflets moderately to densely pilose-sericeous below, the trichomes conspicuous, suberect to erect, thinning with age, but not widely scattered nor confined to veins; upper surface bearing inconspicuous micro-uncinate trichomes (vidi 20–30x) beneath conspicuous whitish macrotrichomes (0.3–1 mm long), trichomes falcate to subappressed, deciduous with age; stipules 2–3 mm wide at the base. Inflorescence short, stout, 1–4 cm long, 1-2-flowered. Calyx pubescence of micro-uncinate trichomes with moderate to scattered, subappressed to slightly spreading, 0.3–1 mm long macrotrichomes that are deciduous with age. Legume stipes from chasmogamous flowers 12–17 mm long. Endemic to central and southern Florida.

TYPE: UNITED STATES. FLORIDA [LAKE COUNTY]: near edge of Lake at Leesburg, 7 Jun 1967, *Baltzell 120* (HOLOTYPE: FLAS 99034).

Specimens of this variety had been annotated as a form of var. *mariana* because the distinction was based upon one character, an increase in pubescence. Populations from the coastal plains of other states (North Carolina to Texas) maintain their sparse degree of pubescence, similar to upland to mountainous members. When representatives of both varieties were grown together in the greenhouse, they retained their characteristic pubescence. Other botanists have encouraged me to treat this taxon as a variety because of its geographical isolation and the constancy in characters when transplanted.

Members of var. *mariana* are rarely found south (Alachua, Lake, Marion Counties) of an imaginary line across north-central Florida (Cedar Key to Ponte Verda Beach), but maintain their glabrate characteristic. Variety *mariana* is distinguished by its leaves being glabrate below, the trichomes subappressed and scattered when young, and confined to major veins in the mature state. The upper leaf surface lacks macrotrichomes. The macrotrichomes on the calyx are sparse to lacking. Florida populations are found in the panhandle and counties north of the line noted. Variety *orientalis* Fantz is endemic to Southeast Asia (Fantz and Predeep 1992), and distinguished by elongate, more lax inflorescences (5–15 cm) with 2–6 flowers, shorter stipes (5–9 mm long), and broader stipules (3–5 mm wide at base).

8. **Clitoria polystachya** Benth.

This species is characterized as a shrub with axillary, multiflowered, paniculate inflorescences bearing small (2.5–3 cm long) white flowers or ecostate, strigose fruits that are weakly depressed between the seeds. Members range from southern Mexico to western Panama. Two new varieties are noted below:

8a. **Clitoria polystachya** var. **congesta** Fantz, var. nov.

Varietas nova *congesta* distinguibili a *Clitoria polystachya* var. *polystachya* inflorescentia cum floribus congestis.

Leaflet base rotund to subcordate. Stipules 6–12 mm long. Inflorescence contracted, 1–3 cm long; peduncle 1–2 cm long; flowers congested near the peduncle apex, pedicels appearing to be nearly fasciculate. Calyx tube 7–9 mm long, lobes 2–3 mm long. Bracteoles 6–9 mm long. Endemic to District Temascaltepec, state of México, México.

TYPE: MÉXICO. MÉXICO: Dist. Temascaltepec, Rincón, 1960 m, 21 Aug 1933, *Hinton 4447* (HOLOTYPE: NY; ISOTYPE: GH).

PARATYPES: MÉXICO. MÉXICO: Dist. Temascaltepec, San Lucas, 24 Oct 1935, *Hinton 8597* (F 1497429, G-excluding vine around specimen, MO 1800932, NY, S, US 1979941,W 13453).

This variety would be very ornamental if cultivated. It is recognized easily by the globular cluster of congested flowers on contracted inflorescences typically shorter than the petiole. The paratype collection has fruits borne from both chasmogamous and cleistogamous flowers. Variety *polystachya* has elongated inflorescences (3–16 cm) with flowers loosely arranged and pedicels paired at the nodes, an elongated calyx tube (8–12 mm) and lobes (3–4 mm), shorter stipules (4–7 mm) and bracteoles (4–6 mm), and leaflets rotund, non subcordate.

8b. **Clitoria polystachya** var. **pringlei** Fantz, var. nov.

Varietas nova *pringlei* distinguibili a *Clitoria polystachya* var. *polystachya* stipulis et bracteolis elongatis.

Leaflet base rotund. Stipules 7–10 mm long. Inflorescence elongate, 3–16 cm long; peduncle 1.5–7 cm long; flowers separated. Calyx tube 8–12 mm long, lobes 3–4 mm long. Bracteoles 6–8 mm long. Endemic to Morelos, México.

TYPE: MÉXICO. MORELOS: Barranca near Cuernavaca, 4 Aug 1896, *Pringle 7253* (HOLOTYPE: GH; ISOTYPE: MICH).

Variety *polystachya* is distinguished by the smaller stipules (4–7 mm long) and bracteoles (4–6 mm long). Collections of *Clitoria* from the state of Morelos are rare. Variety *polystachya* is well represented in herbaria from southern México, but has not been documented from Morelos.

9. **Clitoria pozuzoensis** Macbride var. **schunkei** Fantz, var. nov.

Varietas nova *schunkei* distinguibili a *Clitoria pozuzoensis* var. *pozuzoensis* fruticosa cum apice scandentis, inflorescentia et pedicello elongato.

Shrub with apices scandent. Inflorescence elongate, 8–19 cm long, weakly flexuous towards apex; pedicels 10–12 mm. Peru (Loreto).

TYPE: PERÚ. LORETO: en bosque bajo, a 1 km abajo de Ipariá al noroeste del Río Ucayali, 250 m, 5 Sep 1968, *Schunke 2773* (HOLOTYPE: F 1688611; ISOTYPES: G-2 sheets, NY).

This species is poorly represented in herbarium collections. Variety *pozuzoensis* is distinguished as a liana with a short, weakly flexuous inflorescence (1.5–6 cm long), pedicels that are 5–7 mm long, and has a broader distributional range (Perú: Huanuco, Loreto; Ecuador: Manabí, Orientale.

10. **Clitoria stipularis** Benth. var. **latifolia** (Rizzini) Fantz, stat. nov.

Clitoria stipularis Benth. f. *latifolia* Rizz., Arch. Jard. Bot. Rio de Janeiro 17:181. 1963. TYPE: BRAZIL. MARANHÃO: Rio Jurupy [Gurupi], Serra de Pirocana, 25 Apr 1909, *Coll. Ignotus 10387* (LECTOTYPE: RB 5697; ISOLECTOTYPES: BM, G-hb. Delessert, MG 10387 -non vidi, US 1044109).

Leaflets elliptic, obtuse becoming emarginate, more or less mucronate, 3.5–8 cm long; length/width ratio is 1.2–1.7:1. Stipules broadly ovate, 10–13 mm wide. Petiolules 3–4 mm long. Bracteoles 16–19 mm long. Brazil: Ceará, Maranhão.

Rizzini (1963) described a new form based upon broader obtuse leaflets. He cited one collection consisting of two specimens deposited at different institutions (MG,RB). These are regarded as syntypes since a holotype was not designated (Fantz 1993). I have not seen the MG collection (MG unable to locate it, possibly distributed to another institution?), thus designated the RB specimen as the lectotype. No collector was listed on the specimens examined (BM,G,RB,US) that were distributed from the Herbario do Museu Parense Goeldi. It may be a collection of Ducke. Rizzini cited *Ducke 10387* (R 2435-non vidi) under f. *stipularis*, not the new form.

Variety *stipularis* is distinguished by the oblong to oblong-elliptic leaflets, being longer (7–13 cm) and appearing to be narrower (length/width ratio = 2–3:1), longer petiolules (4–8 mm) and bracteoles (17–24 mm), and narrower stipules (7–9 mm wide). This variety is found in Bahia, Brazil with one collection from Amazonas. Leaflets in var. *latifolia* give the false appearance of being broader as widths are similar, but leaflet length is shorter than the typical variety, providing a smaller ratio of length to width.

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TWO NEW SPECIES OF *ICHTHYOTHERE* (HELIANTHEAE: ASTERACEAE) FROM ECUADOR AND PERU

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ABSTRACT

The tuberculate-fruited *Ichthyothere pastazensis* from Ecuador and the pinnately veined *I. macdanielii* from Peru are described as new.

RESUMEN

Se describen como nuevas especies *Ichthyothere pastazaensis*, con frutos tuberculados, de Ecuador y *I. macdanielii*, de hojas pinnatinervias, de Perú.

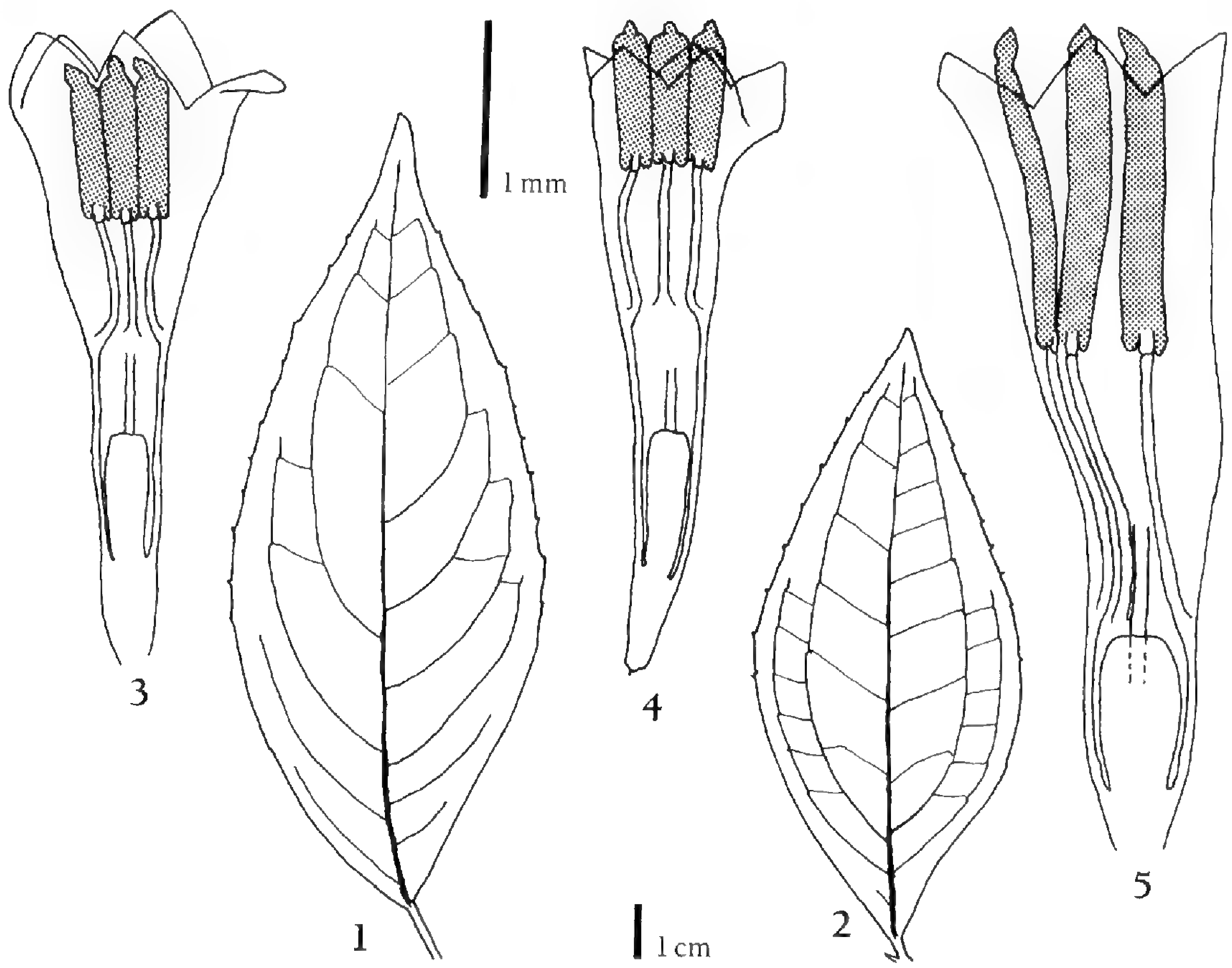
Andean material of the genus *Ichthyothere* has been reviewed for the treatment of the Heliantheae in the Flora of Ecuador, and two undescribed species have been detected. Both new species are related to *I. peruviana* Poepp. but occur to the north of the range of that species. *Ichthyothere pastazensis* of eastern Ecuador has tuberculate achenes while *I. macdanielii* has pinnately veined leaves.

Ichthyothere macdanielii H.Rob., sp. nov. (Figs. 1, 3, 6)

Ad I. peruvianae affinis sed in foliis pinnate nervatis differt.

Shrubs to 1.2 m high, moderately branched; stems blackish, hirsute with pale hairs, internodes 4–12 cm long, fistulose. Leaves opposite, petioles 0.5–1.0 cm long; leaf blades elliptical to obovate, thinly herbaceous, 9–21 cm long, 2.5–7.0 cm wide, base acute to cuneate, margins minutely denticulate to serrulate, apex shortly and broadly acuminate, upper surface with weak, long pilosity, lower surface pilosulous, especially on veins, with sparse, minute glandular dots; secondary veins pinnate, 5 or 6 on each side, arching but mostly ending below distal third of blade. Inflorescences terminal and sessile on leafy stems and branches, glomerate or with few short, dense seriate-cymes, branches covered with subulate bracteoles ca. 5 mm long. Heads sessile, subspherical to somewhat obovate, 4–6 mm high; outer large involucral bracts 2 or 3, subtending female florets, moderately concave, broadly oblong to suborbicular, 4–6 mm long and wide, broadly apiculate, with many stout, multiseriate hairs outside; inner bracts and pales ca. 30, subtending male florets, obovate, 3.5–4.5 mm long, 2.5–3.5 mm

SIDA 16(4): 731–736. 1995

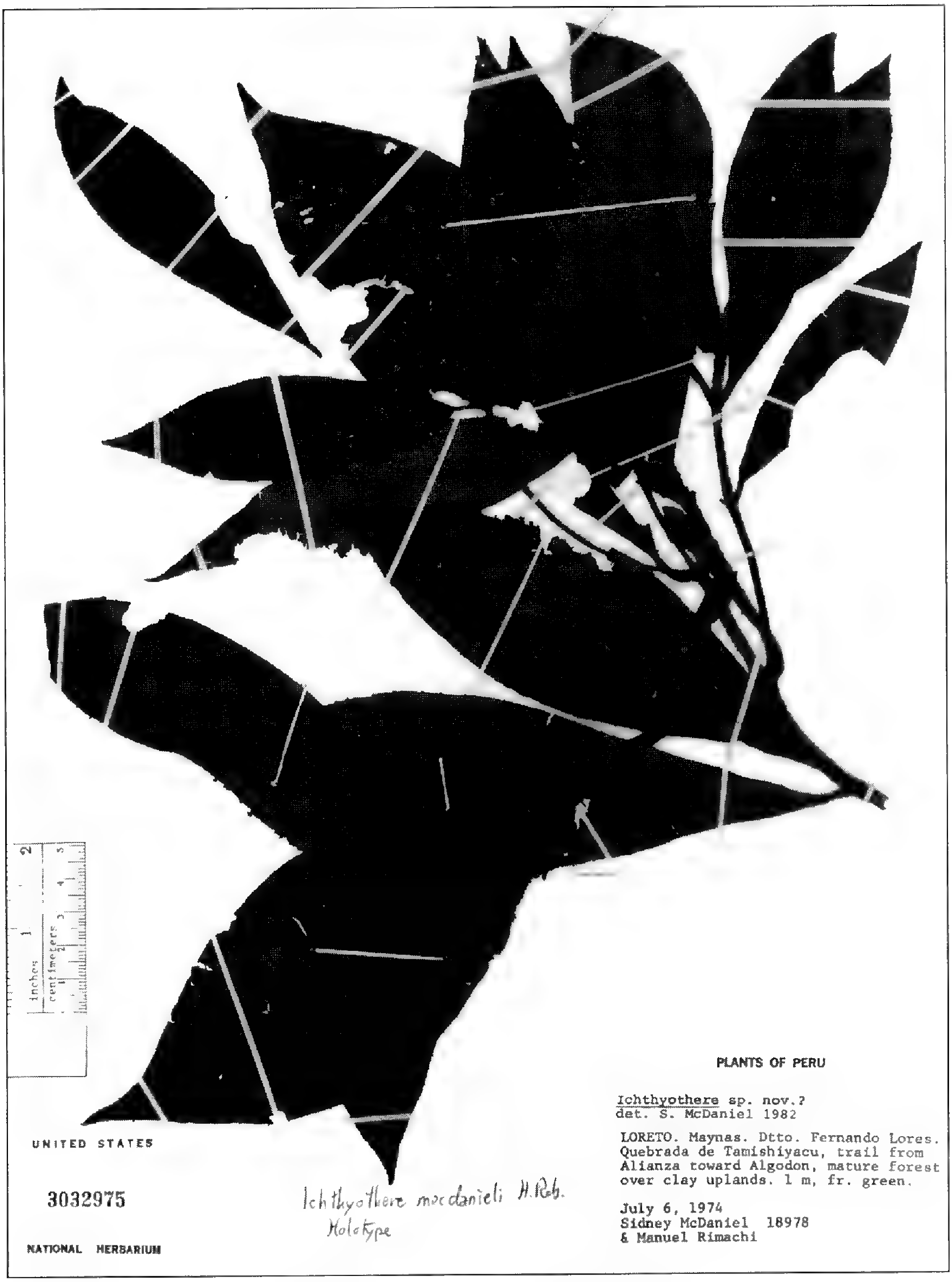


FIGS. 1-5. *Ichthyothere*, leaves, 1 cm scale, corollas, 1 mm scale. 1, 3. *I. macdanielii*, 1, leaf showing pinnate venation, 2, corolla with short throat and anthers. 2, 4. *I. pastazensis*, 2, leaf showing trinervate venation, 2, corolla showing short throat and anthers. 5. *I. peruviana*, corolla showing long throat and anthers. 1. *McDaniel et al. 27587* (US). 2, 4. *Brandbyge & Asanza 30856* (US). 3. *McDaniel & Rimachi 18978* (US). 5. *Vargas 11742* (US).

wide, subangulate with scarious wings on upper margin, apex obtuse and apiculate. Female florets 2 or 3; corollas tubular, strongly bent to one side at base, ca. 1 mm long, with gland-tipped hairs and uniseriate and biseriate non-glandular hairs; style branches scarcely broadened. Male florets ca. 30; corollas whitish, 3.0–3.5 mm long, mostly glabrous, basal tube 1.2–1.5 mm long, throat, narrowly campanulate to nearly cylindrical, 1.3–1.5 mm long, with slender veins, lobes, ca. 0.7 mm long, with numerous glands outside; anther thecae 0.8-1.0 mm long. Achenes of female florets oblong to obovate, 4–5 mm long, 2.0–2.5 mm wide, with 3 costae on inner and outer surfaces when mature, not tuberculate in material seen, glabrous. Pollen grains ca. 25 µm in diam.

TYPE: PERU. LORETO: Dtto. Fernando Lores, Quebrada de Tamishiyacu, trail from Alianza toward Algodon, 6 Jul 1974, *McDaniel & Rimachi 18978* (HOLOTYPE: US: ISOTYPES: AMAZ, IBE, US, USM).

PARATYPE: PERU. LORETO: Maynas. Dtto. Fernando Lores, Quebrada de Tamishacu, trail



UNITED STATES

3032975

NATIONAL HERBARIUM

Ichthyothere macdanieli H. Rob.
Holotype

PLANTS OF PERU

Ichthyothere sp. nov.?
det. S. McDaniel 1982

LORETO. Maynas. Dtto. Fernando Lores. Quebrada de Tamishiyacu, trail from Alianza toward Algodon, mature forest over clay uplands. 1 m, fr. green.

July 6, 1974
Sidney McDaniel 18978
& Manuel Rimachi

FIG. 6. *Ichthyothere macdanielii* H. Rob., holotype, United States National Herbarium.

from Nueva Chachapoya to Río Manatí, 100–120 m, 7 Jan 1984, *McDaniel, Rimachi & McMannes 27587* (AMAZ, IBE, US, USM).

The species was collected in mature "upland" forest over clay or chacra. The species distinctions are discussed below.

Ichthyothere pastazensis H.Rob., sp. nov. (Figs. 2, 4, 7)

Ad I. peruvianae affinis sed in floris masculinis minoribus et acheniis radiis tuberculatis differt.

Small shrubs ca. 0.7 m high, moderately branched; stems brownish, striated, antrorsely pilose with pale hairs, narrowly fistulose. Leaves opposite, petioles 0.2–0.4 cm long; blades membranceous to thinly herbaceous when dry, ovate to broadly elliptical, 5–11 cm long, 2–5 cm wide, acute to shortly acuminate at base and apex, margins remotely, minutely denticulate, upper surface pilose, lower surface with antrorsely appressed pilosity denser on veins, with many minute glandular dots; two pairs of ascending secondary veins near base, pairs separated by ca. 0.5 cm, upper of the pairs reaching distal fifth of blade. Inflorescences terminal and sessile on leafy stems and branches, with few, short branches bearing heads sessile in dense seriate-cymes, bracteoles to 8 mm long, bracteoles at base of heads 2–3 mm long. Heads 4–6 mm high, subspherical; outer large involucral bracts 2 or 3, subtending female florets, broadly obovate, 4–5 mm long, ca.3 mm wide, apex shortly apiculate, outer surface with numerous stout, multiseriate hairs; inner bracts and pales ca. 20, subtending male florets, obovate, ca. 4 mm long, 3 mm wide, with scarious, denticulate angles on upper margins, apex shortly obtuse and apiculate, with few or no hairs outside. Female florets 2 or 3; corolla tubular, without evident basal bend, ca. 1 mm long, with dense brush of long trichomes, biseriate-stalked glands mixed with uniseriate and biseriate non-glandular hairs; style branches not or scarcely broadened. Male florets ca. 20; corollas yellowish green, ca. 3 mm long, tubes ca. 1.2 mm long, throats ca. 1.5 mm long, very narrowly funnelform to nearly cylindrical, with narrow veins, lobes ca. 0.7 mm long and wide, with numerous glandular dots outside; anther thecae ca. 1 mm long. Achenes of female florets obovate, ca. 5 mm long, 3 mm wide, surface strongly tuberculate with age on margins and costae, glabrous, without striations or furrows. Pollen grains ca. 30 µm in diam.

TYPE: ECUADOR. PASTAZA: Lorocachi, on path to Lagartococha, 01°38'S, 75°58'W, 200 m, 25 May 1980, *Brandbyge & Asanza 30856* (HOLOTYPE: US; ISOTYPE: AAU).

The species is known only from the type collected in a wet primary rain forest.

The related *Ichthyothere peruviana* is distributed from San Martin southward to Cuzco, Madre de Dios and Puno in Peru. The more typical north-

Ichthyothere pastazensis H Rob
Holotype

UNITED STATES
3206230
NATIONAL HERBARIUM

FLORA OF ECUADOR
Collected by J. Brandbyge
E. Asanza C.

30856 Compositae
Ichthyothere peruviana (Poepp. & Endl.)Baker
det. H. Robinson
Province PASTAZA
Lorocachi. On the path to Lagartococha. Wet type of primary forest.

(75° 58' W 01° 38' S) Alt. 200 m. 25 May 1980
Shrublet 0.7 m. Leaves subscabrous. Inflorescences yellowish green.

Botanical Institute, Aarhus University, Denmark (AAU)
in collaboration with **P. Universidad Católica, Quito, Ecuador (QCA)**

FIG. 7. *Ichthyothere pastazensis* H. Rob., holotype, United States National Herbarium.

ern material has its lower leaves with longer petioles and longer acuminate leaf blade bases. The specimens of the species vary in the hirsute pubescence of the stems and inflorescence. Nevertheless, all elements recognized here in *I. peruviana* have distinctly broadened style branches in the ray florets, long and slender throats on the male corollas, 2.5–3.0 mm long, and slender anther thecae, nearly 2 mm long (Fig. 5). The leaf tips are usually narrowly acuminate. The details of the northern element of *I. peruviana* are represented well in the plate by Poeppig (1843, pl. 252), the long petioles of the lower leaves, long lower secondary veins of the leaf, elongate anther thecae, even distribution of hairs on the ray corolla, and broad branches of the ray style.

The two new species are somewhat disjunct to the north of *Ichthyothere peruviana* but have all the leaves with shorter petioles as in the southern material of *I. peruviana*. Both new species have acute to slightly acuminate leaf tips, longer hairs on the ray corollas concentrated on the distal half, style branches of the rays scarcely broadened, shorter disk corolla throats, ca. 1.5 mm, and shorter anther thecae, 0.7-1.0 mm (Figs. 3, 4). The species from Loreto, Peru, is particularly unusual in the genus by the pinnate leaf venation (Fig. 1). Other species of *Ichthyothere*, including *I. peruviana* and *I. pastazensis* (Fig. 2), have leaves that are obviously tri- to quinque-nervate or have lower veins that spread at the base but arch upward to near the leaf apex. The pilosity on the upper leaf surface of *I. macdanielii* is longer than that of related species, and the female corolla is strongly bent at the base. The type of *I. macdanielii* has unusually long cuneate bases on some leaf blades, but such bases occur in only some leaves of the type and are lacking in the paratype.

From near the Peruvian border in Ecuador, *Ichthyothere pastazensis* has smaller leaves (Fig. 2), more branched plants, and the mature achenes are strongly tuberculate. The pressed specimens of the Ecuadorian plant show a number of branches, while the longer segments of *I. macdanielii* and *I. peruviana* on the herbarium sheets rarely show any branching. The tuberculate condition of the achenes in *I. pastazensis* develops only at maturity, but such tuberculae have not been seen in any apparently mature achenes of either *I. macdanielii* or *I. peruviana*.

ACKNOWLEDGMENTS

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REFERENCE

POEPPIG, E. 1843. Nova genera ac species plantarum 3(5–6):33–52, pl. 241–260.

CLUSIA FABIOLAE, A NEW SPECIES, WITH A SYNOPSIS OF *CLUSIA* SECTION *ANANDROGYNE* (CLUSIACEAE) IN GUAYANA

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ABSTRACT

In preparation of the treatment of *Clusia* section *Anandrogyne* for *Flora of the Venezuelan Guayana, Flora of the Guianas,* and *Flora of Central French Guiana*, the section is lectotypified and its description is emended. A key to the species, along with updated descriptions with citation of types and representative specimens examined, are also provided for each species, concomitant with discussions of distribution, ecology and conservation status. Discussions of postulated phylogenetic relationships are presented for each taxon. *Clusia fabiolae* is described and illustrated. *Clusia scariosa* is relegated to synonymy under *Clusia pachyphylla*. *Clusia duartei* is placed in the section for the first time, based on new data from flowering material, and *C. savannarum* is newly recorded for Venezuela. *Clusia sessilis* is a homonym and a *nomen novum, Clusia wurdackiana,* is provided for it.

RESUMEN

Al preparar un tratamiento taxonómico del género *Clusia* secc. *Anandrogyne* para las floras de la Guayana Venezolana, de las Guayanas, y de la Guayana Francesa Central, se lectotipifica la sección y se amplia su descripción. Además, se ofrece una clave para distinguir las especies, junto con descripciones actualizadas, tipos y especímenes citados. Se discute el parentesco, la distribución geográfica, ecología y estatus en cuanto a conservación para cada especie. Finalmente, se discute lo que sabe de la filogenia de dichas especies. Se describe, se ilustra y se discute el parentesco de *Clusia fabiolae*. Se relega *C. scariosa* a la sinonímia bajo *C. pachyphylla*. Se ubica *Clusia duartei* en la sección por la primera vez, en base a nuevo material en flor, y se cita *C. savannarum* como nuevo para Venezuela. *Clusia sessilis* es un homónimo y por lo tanto, se ofrece para ella un nombre nuevo, *Clusia wurdackiana*.

INTRODUCTION

In preparation for a forthcoming treatment of the genua *Clusia* for the Flora of the Venezuelan Guayana, Flora of the Guianas, and Flora of Central French Guiana, it became clear that a revision of section *Anandrogyne* was needed. Overall, the section consists of 69 species, of which 19 are as yet undescribed, and is defined by the largely anantherous staminodes of the pistillate flowers and the pluriseriate, acropetally longer stamens of the staminate flowers with anthers dehiscent by wide longitudinal slits. This section, the "*Clusia multiflora* Group" of Hammel (1986), is the largest and most taxonomically complex of all infrageneric groups within the genus. While apomixis has not been proven for the group, several individuals of a *Clusia elliptica* H.B.K. population in northern Colombia have been seen with young fruit forming before the petals have completely opened, implying that apomixis may occur. As a result of the present study, seven species are now known from the Guayana Floristic Province (sensu Maguire 1979).

TAXONOMIC TREATMENT

Clusia section **Anandrogyne** Planchon & Triana, Ann. Sci. Nat. 2 sér 14:323. 1860. A. Engler, Nat. Pflanzenfam. 3(6):225. 1895. LECTOTYPE SPECIES (here designated): *Clusia multiflora* H. B. K., Nov. Gen. Sp. 5:200. 1822.

Clusia section *Criuva* Bentham & Hooker subsection *Anandrogyne* (Planchon & Triana) Engler in Martius, Fl. Bras. 12 (1):402. 1888.

Clusia subgenus *Thysanoclusia* Vesque section *Anandrogyne* (Planchon & Triana) Vesque, in A. DC. & DC. Monogr. Phan. 8:29. 1893.

Free-standing shrubs or trees; latex white. Leaves subsessile or petiolate; petioles canaliculate and/or marginate, usually with prominent adaxial margined pits basally. Staminate inflorescence a terminal cyme or panicle of cymes, subtended by foliaceous bracts, the bracts early caducous or rarely, persistent (*C. wurdackiana*); peduncle tetragonal; secondary inflorescence bracts 2, cartilaginous or coriaceous; floral bracts 2, cartilaginous; pedicels tetragonal or angulate; bracteoles 2–6, cartilaginous. Staminate flowers pink, yellow or white; sepals (4–)6–8(–10), cartilaginous, the outer opposite, the inner decussate or contorted; petals (4–)6–8(–10), carnose, coriaceous or membranaceous, the outer decussate, the inner decussate and/or contorted, sometimes progressively larger acropetally; stamens numerous, the androphore poorly developed, cubic or hemispherical, the filaments apically free, basally connate, linear, flattened, coriaceous, the anthers muticous, extrorsely or latrorsely dehiscent by wide longitudinal slits, the thecae linear or ovate; pistillode absent. Pistillate flowers as in staminate but staminodes 4–numerous, linear, anantherous or rarely with ovate antherodes (sterile anthers), producing mostly abortive pollen or sometimes wholly sterile, sometimes early caducous; pistil ovoid or subglobose; carpels (4–)5–10(–12); styles obsolete or equalling carpels in number; stigmas cuneiform or corniculoid. Fruit ovoid or subglobose, rarely urceolate, the stigmas and styles persistent.

Distribution.—Sixty-nine species, throughout the Neotropics, but with centers of diversity in the Andes of Colombia and Peru, principally in premontane and montane moist, wet or pluvial forests.

Clusia section *Anandrogyne* is one of the most difficult groups within the genus, not only because of the lack of adequate collections for many of the Andean taxa, but also because of the tendency for the staminodes to be early caducous. Staminodia frequently begin to fall out from beneath the sepals once they become reflexed, even if the sutures of the capsule have not begun to open. When sterile or without staminodia, some members of section *Anandrogyne* are virtually indistinguishable from other species in sections *Polythecandra* or *Retinostemon.* In addition, many taxa are known only from mature fruit, and have been placed in the section because no staminodes are known. Likewise, for those taxa, we do not know if staminodes were "lost" or if they ever occurred, thus increasing the probability that the section is paraphyletic as currently defined.

Members of the group are usually locally common. My field experience has shown that they often occur in numbers exceeding 30 individuals/ha. Therefore, given their ecological importance in the *Clusia* scrub forests of many tepuis and the thickets of the Andean subpáramo life zone, a comprehensive systematic revision of the group throughout its entire geographic range is needed. The present treatment is designed to provide descriptions, specimen citations, and explain concepts thus far established in detail not possible for the aforementioned floristic treatments, until a more comprehensive monograph can be undertaken. Morphological terminology follows Pipoly and Graff (1995).

Clusia multiflora H. B. K. was chosen as the lectotype species instead of *Clusia ducu* Bentham, the other taxon mentioned in the protologue, because *C. multiflora* more adequately fits the most narrow interpretation of the section *Anandrogyne* concept, with its large flowers, 4–5-merous calyx and 5–6-merous corolla, the prominent androphore, and 5 anantherous staminodia.

KEY TO GUAYANA SPECIES OF *CLUSIA* SECTION *ANANDROGYNE*

1. Branchlets 2–7(–8) mm diam., pedicels thin, 2.5–6.5 mm long; stigmas cuneiform.
    2. Branchlets verrucose, decussately tetragonal, 2–3 mm diam., not semisucculent; leaf blades (2–)3.5 cm long, (1.5–)2.5–3.3 cm wide, the bases cordate; sepals 5 .... 1. *C. fabiolae*
    2. Branchlets smooth, simply tetragonal, or subtetragonal, (3.5–)5–7 (–8) mm diam., semisucculent; leaf blades 5–9 cm long, (3.4–)5–8 cm wide, the bases truncate or broadly acute; sepals 4.
        3. Petioles without conspicuous adaxial margined pits; leaf bases subacute; peduncle obsolete to 1 cm long; petals 5; staminodia numerous, early caducous. .... 2. *C. phelpsiae*
        3. Petioles with large adaxial margined pits; leaf bases rounded to truncate; peduncle (1.2–)2.5–5 cm long; petals 4; staminodia 4–10, persistent in fruit.
            4. Inflorescence 3–4 times compound, 9–12-flowered; antherodes producing small amounts of pollen; styles obsolete; fruit ovoid; at margins of scrub forests with small savannas, in open, rocky areas, 1,250–2,000 m, southern Amazonas, Venezuela .... 3. *C. rotundifolia*

4. Inflorescence simple, 1–3-flowered; antherodes without pollen; styles thin, 1–1.5 mm long; fruit subglobose; shrub islands in savannas, 460–1,000 m, eastern Bolívar, Venezuela and adjacent Guyana. .... 4. *C. savannarum*

1. Branchlets (8–)8.5–15(–22) mm diam.; pedicels thick, 7–15 mm long; stigmas corniculoid.
   5. Leaf blades chartaceous to coriaceous, obovate to oblanceolate, the bases acute, the margins flat; sepals stiffly coriaceous, the margins entire; styles thick, radiate, 3–5 mm long at maturity; ovary and fruit smooth, not sulcate .... 5. *C. wurdackiana*
   5. Leaf blades cartilaginous, elliptic to suborbicular, the bases obtuse to truncate; sepals chartaceous, the margin variously incised; styles obsolete; ovary and fruit deeply sulcate.
      6. Branchlets 8–11 mm diam.; petioles 1–1.5(2) cm long; leaf blades with secondary veins prominently raised above and below; floral bracts 4, 0.8–1.2 cm long. .... 6. *C. pachyphylla*
      6. Branchlets 15–22 mm diam.; petioles 2–3 cm long; leaf blades with secondary veins inconspicuous above and below; floral bracts 2, 1.5–3 cm long. .... 7. *C. duartei*

1. **Clusia fabiolae** Pipoly, sp. nov. (Fig. 1)

Ob ramulos angulatos, pedicelos usque ad 6.5 mm longos, laminas cartilagineas, inflorescentiam terminalem necnon stigmates cuneiformes *C. rotundifoliae* valde arcte affinis, sed ab ea ramulis tetragonis (non sulcatis) 2–3 (nec 5–8) mm diametris, lamina ad basem cordata (non rotundata vel truncata), secus marginem plana vel subrevoluta (nec manifeste revoluta), pedunculo obsoleto vel usque ad 1 (non 2.5–5) cm longo, denique fructu globoso (non ovoideo) statim separablis.

Terrestrial, free-standing shrub or small tree to 4(–7) m tall. Branchlets decussately tetragonal, with a few subacute angles, 2–3 mm diam., verrucose, ultimately terete with age, glabrous. Leaves subsessile; blades cartilaginous, ovate to oblong, (2–)3.5–4.5 mm long, (1.5–)2.5–3.3 mm wide, symmetric, apex obtuse, base cordate, adaxially nitid, abaxially dull, with conspicuous, black linear latex canals, the midrib prominently raised and the secondary veins not visible above and below, the margin translucent, thick, flat or rarely subrevolute when dried; petioles very small, 3–5 mm long, deeply canaliculate, verrucose when dried, the adaxial pits broadly margined.. Staminate inflorescence a terminal panicle of 3-flowered cymes, 2–3 cm long and wide; peduncle tetragonal, obsolete to 1 cm long; secondary inflorescence bracts 2, opposite, coriaceous, oblate, 3–3.2 mm long, 4.2–4.3 mm wide, apex obtuse, carinate, medially crassate and somewhat verrucose, the margin scarious, ca. 0.3 mm wide, entire; pedicels tetragonal, like branchlets, 2.5–5.5(–6.5) mm long, glabrous; bracteoles 2, opposite, coriaceous, suborbicular, 5.4–5.6 mm long, 5.6–5.8 mm wide, apex rounded, medially crassate, carinate, verrucose, without latex canals, the margin undulate, incised, scarious, the margin ca. 0.2 mm wide. Flowers pink; sepals 5, the outer whorl 2, decussate to the bracteoles, subcoriaceous, oblate,

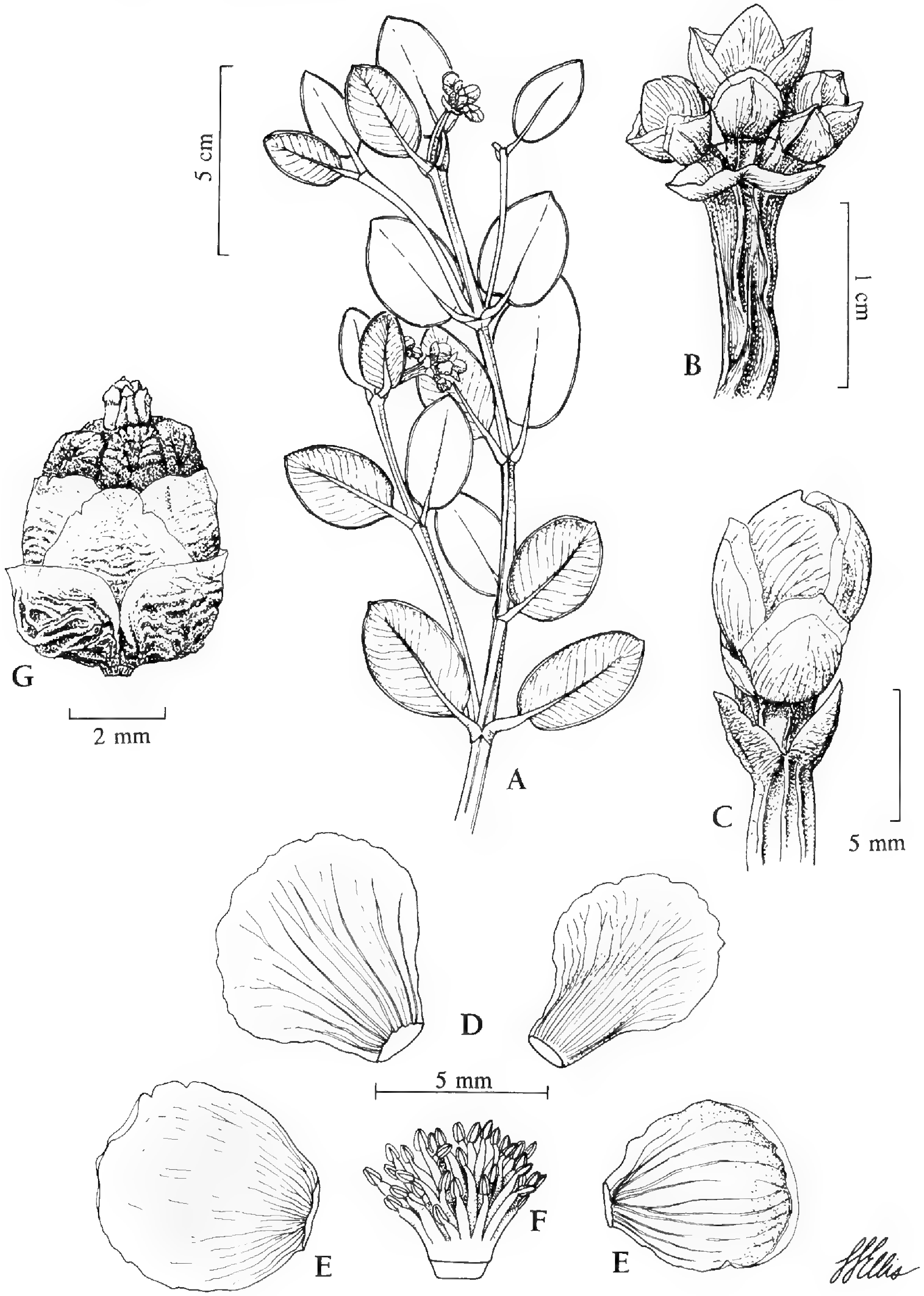

FIG. 1. *Clusia fabiolae* Pipoly. A. Habit. B. Cyme. C. Bracteoles and flower bud. D. Petals of staminate flower. E. Sepals. F. Androphore and androecium. G. Calyx and fruit. A-B, drawn from *Steyermark 93190* (staminate); C-E, drawn from *Liesner 21021* (staminate); F, drawn from *Steyermark 128298* (pistillate).

5.9–6.1 mm long, 7–7.2 mm wide, apex rounded, carinate, verrucose, with brown latex canals conspicuous subapically, the margin subentire, hyaline, scarious, with a few incisions, glabrous, the inner whorl 3, contorted, chartaceous, suborbicular, 5.5–8 mm long, 6–8.5 mm wide, apex rounded, medially crassate, hyaline, with brown latex canals conspicuous everyhwere but the margin, the margin subentire, hyaline, scarious, with a few incisions, glabrous; petals 4, contorted, membranaceous, spreading, abruptly obovate-spathulate, the proximal portion 2.1–2.2 mm long, 2.9–3 mm wide, the distal portion suborbicular, 6.6–6.7 mm long and wide, apex rounded, flat, the margin undulate, entire, glabrous; receptacle concave, without resin; stamens numerous, more than 60, the androphore hemispherical, 0.4–0.5 mm tall, 2.3–2.4 mm diam., the distal ca. 2–3 mm long, progressively longer acropetally to 5.5(–6) mm long, the filaments linear, flat, as wide as the anthers, 1–3 mm long, 0.3–0.5 mm wide, the anthers muticous, 0.7–0.8 mm long, 0.5–0.6 mm wide, apex emarginate, base cordate, dehiscent by broad longitudinal slits running entire length, the connective medially darkened on both sides; pistillode absent. Pistillate inflorescence as in staminate but secondary inflorescence bracts very widely ovate, 3.8–3.9 mm long, 4–5 mm wide, apex short-acuminate, medially crassate, carinate, rugose, the margin hyaline, entire, glabrous. Flowers; sepals 4, the outer pair decussate to the bracts, chartaceous, suborbicular, 6–6.2 mm long, 5.5–5.7 mm wide, asymmetric, hyaline, apex rounded, medially crassate, rugose, carinate, cucullate, latex canals inconspicuous, the margin hyaline, scarious, ca. 0.2 mm wide, with 1–2 incisions, glabrous, the inner pair decussate, chartaceous, widely ovate, 5.9–6.1 mm long, 5–5.2 mm wide, symmetric, hyaline, apex obtuse, medially crassate, rugose, carinate, cucullate, latex canals inconspicuous, the margin scarious, hyaline, ca. 0.1 mm wide, with 1 incision, glabrous; petals 4, contorted, thinly carnose, widely obovate, 6.4–6.6 mm long, 4.8–5 mm wide, apex rounded, medially rugose, flat, the margin somewhat translucent, flat, entire; staminodes 4, flat, linear, anantherous, 2.3–2.5 mm long, 0.8–1.1 mm wide, persistent in early fruit; pistil ovoid, 5.5–6 mm long, 4–4.5 mm diam.; carpels 5; styles erect, short, ca. 0.3–0.5 mm long, the stigmas sessile, cuneiform, 1.2–1.5 mm long, 0.9–1 mm wide, apex acute, base obtuse, attached toward base and apex. Fruit globose, 1–1.2 cm long, 0.9–1 cm diam.

Type: **VENEZUELA. Bolívar:** Dtto. Piar, Camarcaibarai-tepuí, summit; fourth of four tepuis from W to E in Aparamán range; 5°53'N, 61°59'W; highly eroded tepui summit with deep canyon S to 100 m; 26 Mar 1987 (pist. fl), *B. Holst 3626* (holotype: VEN; isotypes: BRIT, F, MO, NY, US).

Paratypes: **VENEZUELA. Bolívar:** Abacapá-tepuí, Macizo del Chimantá, 2,125–2,300 m, 13 Apr 1953 (F (2 shts), MO, NY, US, VEN); Amurí-tepuí, Macizo del Chimantá, section W of Acopán-tepuí, 5°10'N, 62°07'W, 1,850 m, 2–5 Feb 1991 (pist. fl, precocious), *J. Steyermark et al. 128555* (MO, VEN); Apacará-tepuí, E-C section, 21–22 June 1953 (pist. fl, fr), *J. Steyermark 75935* (F-2 shts, NY, US, VEN); Apacará-tepuí, Macizo del Chimantá, S base, 5°20'N, 62°12'W, 2,200 m, 30 Jan–1 Feb 1983 (fr), *J. Steyermark 128298* (MO, US, VEN); Auyán-tepuí, above Salto La Catira, C section, E of Río Churúm, 1,950 m, 27–28 Dec 1977 (fr), *C. Brewer-Carias s.n.* (MO, VEN); Auyán-tepuí, summit, 1800 m, 5 Feb 1988 (fr), *F. Delascio & R. López 13573* (MO, VEN); Auyán-tepuí, summit, SE, between "Boggy Camp" & "Oso Woods Camp", 2,200 m, 1 May 1964 (stam. fl), *J. Steyermark 93190* (F, NY, US, VEN); summit, C portion of NW branch, near Jimmy Angel airplane, 1,800 m, 7 May 1964 (stam. fl), *J. Steyermark 93479* (F, NY, US, VEN); summit Auyán-tepuí, SE section, 5°42'N, 62°26'W, 2,140 m, 26 Feb 1978 (stam. fl), *J. Steyermark et al. 116013* (F, MO, VEN). Dtto. Piar, Camarcaibarai-tepuí, E of Auyán-tepuí, 2,400–2,500 m, 25–26 Mar 1987 (pist. fl, fr), *F. Delascio 13111* (MO, US, VEN); C & W part of saddle between Camarcaibarai-tepuí and Tereké-Yurén-tepuí, 1,800–1,900 m, 23 May 1986 (stam. fl), *R. Liesner & B. Holst 21021* (COL, F, MO, US, VEN); summit of Tereké-Yurén, W edge, 5°52'N, 62°02'W, 2,135 m, 26 May 1986 (pist. fl), *R. Liesner et al. 21066* (MO, US, VEN), (stam. fl), *Liesner et al. 21070* (MO, US, VEN); Central section, Macizo del Chimantá, 1940 m, 4 Feb 1955 (fr), *J. Steyermark & J. Wurdack 414* (F, NY, VEN); Murey-(Euroda)-tepuí, NE sector of Macizo del Chimantá, 5°23'N, 62°03'W, 2,550 m, 1–3 Apr 1989 (stam. fl), *J. Pruski & O. Huber 3588* (NY, VEN). Ptari-tepuí, summit, 5°45'N, 61°45'W, N of Sta. Teresita de Kavanayén, 2,360–2,420 m, *J. Steyermark et al. 115697* (MO, US, VEN).

Distribution.—Endemic to the tepuis of the southeastern portion of Bolívar state, Venezuela, at 1,600–2,500 m elevation.

Ecology and conservation status.—*Clusia fabiolae* grows in rocky savannas below large rock walls. It is locally common, and is a conspicuous element of the vegetation. While its range is extremely restricted, most of it is protected and thus, *C. fabiolae* appears not to be threatened at this time.

Etymology.—It is a great pleasure to dedicate this species to my wife, Fabiola Monje-Pipoly (née Monje Silva), who, with the late Mario Maurielo, were instrumental in funding Venezuelan botanical projects while employed at Seguros Anauco, S. A., in Caracas. She has accompanied me in the field on numerous occasions and provides critical moral support, despite my frequent absences to pursue fieldwork.

The angulate branchlets, compound inflorescences, thin pedicels, cuneiform stigmas and cartilaginous leaves of *Clusia fabiolae* indicate a close relationship with *C. rotundifolia*. However, the thinner, decussately tetragonal, non-succulent branchlets, leaf blades with cordate bases and flat or subrevolute margins, shorter or obsolete peduncle and globose fruit immediately separate *Clusia fabiolae* froom *C. rotundifolia*. The Tereké-Yurén populations of *Clusia fabiolae* are diminutive compared to those of Auyán-tepuí and the Chimantá-Massíf, but are qualitatively identical.

2. **Clusia phelpsiae** Lasser & Maguire, Brittonia 7:81. 1950. TYPE: VENEZUELA. AMAZONAS: Cerro Yaví, 1,850–2,200 m, 1–3 Mar 1947 (fr), *W. Phelps & C. Hitchcock 69* (HOLOTYPE: NY!; ISOTYPE: VEN).

Small tree, to 3 m tall. Branchlets subtetragonal, semisucculent, deeply sulcate when dried, 5–7 mm diam., glabrous. Leaves subsessile; blades coriaceous, obovate, 5–9 cm long, 3–6 cm wide, apex broadly rounded, base subacute, midrib prominently raised above and below, secondary veins numerous, prominulous above and below, the submarginal vein inconspicuous, the margin thick, translucent, entire; petioles obsolete to 5 mm long, without adaxial margined pits. Inflorescence terminal, cymose, 3-flowered; peduncle obsolete to 1 cm long; floral bracts early caducous; pedicels obsolete to 5 mm long. Flowers yellow; sepals 4, decussate, coriaceous, widely ovate, 6–8 mm long, 4–6 mm wide, apex broadly rounded, medially carinate, the margin entire, opaque; petals 5, carnose, obovate-spathulate, 12–15 mm long, 6–8 mm wide, apex broadly rounded, the margin subentire; staminodia numerous, early caducous; pistil ovoid, the carpels 5; styles thick, 5 mm long; stigmas sessile, cuneiform, 2.5 mm long. Fruit urceolate, 2.5 cm long, 1.5 cm wide.

Distribution.—Known only from Cerro Yaví, state of Amazonas, Venezuela, at 1,850–2,200 m elevation.

Ecology and conservation status.—*Clusia phelpsiae* is a rare species, occuring only near the summit of Cerro Yaví. It is from one of the more inhabited areas of the Guayana in Amazonas, and therefore should be considered threatened.

PARATYPE examined: **VENEZUELA. Amazonas:** Cerro Yaví, 1,850–2,200 m, 1–3 Mar 1947 (pist. fl), *W. Phelps & C. Hitchcock 69* (NY, VEN).

Clusia phelpsiae is similar to, and may be closely related to *C. rotundifolia*, but the broadly acute leaf bases, obsolete peduncle, higher floral merosity, early caducous staminodia, obsolete styles and larger, urceolate fruit, all allow easy recognition of the species. *Clusia phelpsiae* should not be confused with *C. phelpsiana* Maguire, of section *Clusiastrum.*

3. **Clusia rotundifolia** Gleason, Bull. Torrey Bot. Club 28:406. 1931. TYPE: VENEZUELA. AMAZONAS: Cerro Duida, Savanna Hills, 1,341 m; Aug 1928–Apr 1929 (stam. fl), *G. Tate 798* (HOLOTYPE: NY!; ISOTYPE: F!).

Tree to 3 m tall. Branchlets tetragonal, the angles acute but not winged, 5–8 mm diam., semisucculent, deeply sulcate. Leaves subsessile; blades cartilaginous, suborbicular, to very broadly obovate, rarely oblong, 6–8(–9) cm long, (4–)6–8 cm wide, apex broadly rounded, truncate or rarely retuse above, base truncate, midrib slightly elevated above and below, the secondary veins numerous, the collecting vein 1–2 mm from margin, the margin revolute. Staminate inflorescence a compound cyme, each branch bearing 3 flowers; peduncle tetragonal, 3–4 cm long, deeply sulcate; secondary inflorescence bracts cartilaginous, oblate, 2–3 mm long, 4–6 mm wide, apex broadly rounded, prominently carinate, the margin opaque, not scarious, entire; secondary inflorescence bracts cartilaginous, oblate, 1–2 mm long, 3–4 mm wide, apex broadly rounded, prominently carinate medially; pedicels 3–4.5 mm long; bracteoles 6, decussate, cartilaginous, the outer pair widely triangular, 1.5–2 mm long, 3–4.5 mm wide, apex subacute, the following pair stiffly coriaceous, suborbicular, 2.5–3.5 mm long and wide, apex broadly rounded, the margin thin but not scarious, entire; the innermost pair stiffly coriaceous, suborbicular to oblate, 3–4 mm long, 4–5 mm wide, apex broadly rounded, the margin scarious, entire. Staminate flowers whitish cream; sepals 4, cartilaginous, the outer pair opposite, suborbicular, 5–7 mm long and wide, apex broadly rounded, the margin hyaline, scarious, entire, the inner pair decussate, obovate, 6–8 mm long, 4–6 mm wide, apex broadly rounded, the margin scarious, irregularly notched; petals 4, decussate, carnose, obovate, 9–1.1 mm long, 5–6 mm wide, apex truncate, irregularly notched, somewhat cucullate, gradually narrowed to 3 mm wide basally; stamens numerous, 3–4.5 mm long, the androphore cubic, 1–1.2 mm diam., the filaments linear, fleshy, 1–1.5 mm long, the anthers linear, 1–1.5 mm long, the apex muticous, latrorsely dehiscent by wide longitudinal slits; pistillode absent. Pistillate inflorescence; as in staminate but peduncle (5–)25–45 mm long; primary bracts 10–12 mm long, 12–14 mm wide; secondary bracts 11–12 mm long, 12–13 mm wide; pedicels subobsolete to 8 mm long; floral bracts 6, as in staminate but the outer 1.3–1.5 mm long, 3.5–4 mm wide; the following pair 3–3.2 mm long and wide; the innermost pair 3–3.2 mm long, 4–4.2 mm wide. Pistillate flowers; sepals 4, as in the staminate but 7–7.3 mm long and wide, the inner ones 7.5–7.7 mm long, 6–6.2 mm wide; petals 4, obovate, 10–12 mm long, 6–6.5 mm wide, gradually tapering to 3 mm wide at base; staminodes 16, 3–3.5 mm long, the filaments basally fused to 0.3 mm, apically free 1.3–1.5 mm, the antherodes producing small amounts of pollen, ovate, 1.5–1.7 mm long, the apex obtuse, latrorsely dehiscent by wide longitudinal slits; pistil ovoid; carpels 4; stigmas cunieform, sessile, the angles rounded, 1.3–1.5 mm long and wide. Fruit ovoid, 1.2–1.5 cm long, 2.3–2.5 cm wide.

Distribution.—Endemic to Cerro Duida, Cerro Parú, and Sierra Parima, the area between tributaries of the Río Ventuari and Río Orinoco, between the Río Paru to the north and the Río Padamo to the south, with a disjunct population on Sierra Parima, Amazonas, Venezuela, at 1,250–2,000 m.

Ecology and conservation status.—*Clusia rotundifolia* occurs at the margins of scrub forests with small savannas, on rather open, rocky areas. The population density and pressure to cultivate are extremely low in the area, so the species is not considered threatened.

Specimens examined: **VENEZUELA. Amazonas:** Depto. Atabapo, Plateau of Cerro Duida above Culebra, 03°36'N, 65°42'W, 1,250 m, 2 Mar 1985 (stam. fl), *R. Liesner*

18168 (MO, US, VEN); Cerro Duida, Río Cunucunuma, ridge W of Caño Culebra, 1,800 m, 22 Nov 1950 (fr), *B. Maguire et al. 29658* (F, MO, NY, US, VEN); Cerro Duida, N escarpment, 1,600 m, 23 Nov 1950 (stam. fl), *B. Maguire et al. 29659-A* (MO, NY, VEN); Sierra Parima, headwaters of Río Matacuni, along the Venezuelan-Brazilian border, No. 7, 04°05'N, 64°24'W, 1,500 m, 19 May 1973 (fr), *J. Steyermark et al. 107525* (BRIT, MO, NY, US, VEN); Serranía Parú, Río Parú, Caño Asísa, Río Ventuari, 12 km N along W rim, 2,000 m, 4 Feb 1951 (fr), *R. Cowan & J. Wurdack M31259* (MO, NY, US, VEN); Depto. Atures, Serranía Parú, Central Plain, SW sector, 04°25'N, 65°32'W, 1,200–1,250 m, 5–7 Mar 1991 (fr), *P. Berry et al. 4995* (MYF); Serranía del Parú (Aroko), 3rd central mesa, central-northern sector of the Serranía, 04°31'N, 65°35'W, 1,100 m, 3–4 Oct 1979 (stam. fl), *O. Huber 4298* (MYF, NY, US, VEN); Serranía Parú, Río Parú, Caño Asisa, Río Ventuari, 6 km along W rim from Camp Caño, 2,000 m, 4 Feb 1951 (stam. fl), *R. Cowan & J. Wurdack M31256* (F, NY, US, VEN).

Clusia rotundifolia is most closely related to *C. savannarum*, but is easily distinguished by the compound inflorescence, antherodes bearing pollen, albeit frequently abortive, sessile stigmas, ovoid fruit and montane tepui scrub forest habitat.

4. **Clusia savannarum** Maguire, Bull. Torrey Bot. Club 75:422. 1948. TYPE: GUYANA. POTARO-SIPARUNI REGION: Kaieteur Savanna, 6 May 1944 (pist. fl, fr), *B. Maguire & D. Fanshawe 2367* (HOLOTYPE: NY!; ISOTYPES: F!, FDG).

Tree to 3 m tall. Branchlets rounded quickly below, obtusely tetragonal near apex, 3.5–5 mm diam., glabrous. Leaves petiolate; blades cartilaginous, widely elliptic to suborbicular, (3–)4–8 (–9.5) cm long, (3–)5–7 cm wide, apex and base broadly rounded, nitid above, pallid below, midrib raised at bottom of adaxial groove, prominently raised below, secondary veins numerous, the collecting vein on the revolute margin; petioles subobsolete to 5 mm long, with broadly margined adaxial pits. Staminate inflorescence unknown. Pistillate inflorescence 1–3(–7)-flowered; peduncle tetragonal, not flattened, 8–12 mm long; primary inflorescence bracts opposite, stiffly coriaceous, suborbicular to elliptic, 3–10 mm long, 2–4 mm wide, apex subacute to obtuse, base obtuse to broadly rounded, the margin revolute; secondary bracts 2, opposite, carnose, suborbicular,2.5– 3 mm long, 1.5–2 mm wide, apex obtuse to subacute, sessile, medially prominently carinate, the margin scarious, flat, entire; pedicels 2–3 mm long. Flowers; sepals 4, decussate, stiffly chartaceous, widely ovate to suborbicular, 5–7 mm long and wide, apex broadly rounded, the margin scarious, with several notches; petals 4, rarely 5, the fifth one vestigial, contorted, carnose, obovate-spathulate, 7–10 mm long, apex truncate, irregular, tapering to 2.5–3.5 mm wide at base, white and often pink toward base; staminodia 10, 1.8–2.7 mm long, the filaments flat, 1–1.5 mm long, connate 0.2–0.3 mm into a tube, the apical free portion 0.8–1.2 mm long , the antherodes ovate, 1–1.5 mm long, apex subacute to obtuse, latrorsely dehiscent, containing small amounts of pollen; pistil ovoid, 3–5 mm long, 7–8 mm wide, carpels (4–)5, stigmas cuneiform, peltate, on short styles to 1.5 mm long. Fruit subglobose, yellowish green at maturity, 1–1.2 cm long, 1.3–1.5 cm diam.

Distribution.—*Clusia savannarum* is known only from the eastern portion of the state of Bolívar, Venezuela, and the Kaieteur Plateau of Guyana, at 460–1,000 m elevation.

Ecology and conservation status.—*Clusia savannarum* grows in the shrub islands in savannoid formations on white sands from sandstone below the tepuis. The shrub islands are characterized by the presence of *Cybianthus fulvopulverulentus* (Mez) Agostini (Myrsinaceae), *Clusia pusilla* Steyermark (Clusiaceae), *Emmotum* spp. (Icacinaceae), *Humiria balsamifera* St.-Hilaire (Humiriaceae), and *Licania* spp. (Chrysobalanaceae). The Kaieteur Plateau of Guyana lies in Kaieteur National Park, and is therefore protected, so this species cannot be considered threatened.

Specimens examined: **VENEZUELA. Bolívar:** Dtto. Roscio, slope N of Kamámeru, 05°25'N, 61°25'W, 1,000 m, 4 Mar 1983 (fr), *O. Huber et al. 7303* (MYF, NY, VEN). **GUYANA. Cuyuni-Mazaruni Region:** Pakaraima Mts., Base camp on tributary of Partang River, 8.6 km NE of Imbaimadai, 05°46'N, 60°16'W, 650 m, 19 May 1992 (fr), *B. Hoffman et al.. 1681* (BRG, FDG, US). **Potaro-Siparuni Region:** Savanna near Kaieteur Falls, 460 m, 4 Mar 1962 (fr), *R. Cowan & T. Soderstrom 2037* (FDG, NY, US).

Clusia savannarum is most closely related to *C. rotundifolia*, but may be recognized by its simple, 1-3-flowered inflorescence, the completely sterile antherodes, thin styles 1–1.5 mm long, and subglobose fruit. The shrub island habitat in the white sand savannas below the tepuis is quite different from the scrub forests on the tops which houses *C. rotundifolia.*

5. **Clusia wurdackiana** Pipoly, nom. nov.

Clusia sessilis Klotzsch ex Engler in Martius, Flora Brasiliensis 12(1):105. 1888, syn. nov. TYPE: VENEZUELA [GUYANA]: Roraima, Nov 1842 (stam. fl), *Rich. Schomburgk 1037* (HOLOTYPE: B- destroyed; F Neg. 9200!), *non Clusia sessilis* G. Forster, Fl. Ins. Austr. 74. No. 391. 1786, = *Garcinia sessilis* (G. Foster) Seeman.

Clusia cerroana Steyermark, Fieldiana, Bot. 28:386. 1952. TYPE: VENEZUELA. BOLÍVAR: Ptari-tepuí, S-facing slopes between plateau portion and "Cave Camp," 1,700–1,800 m, 1 Nov 1944 (fr), *J. Steyermark 59702* (HOLOTYPE: F!; ISOTYPE: VEN).

Shrub to small tree to 5(–15) m tall. Branchlets somewhat angulate, at times tetragonal but with obtuse angles, 8–10 mm diam., the bark transversely checked and exfoliating in the uppermost nodes. Leaves petiolate; blades chartaceous to coriaceous, obovate to widely oblanceolate, 9–24 cm long, 6–11 cm wide, apex broadly rounded to truncate or rarely, emarginate, base acute, midrib prominent above and below, the secondary veins numerous, prominulous above and below, the margins entire, flat; petioles canaliculate and marginate, 3–5 mm long, the adaxial margined pit as wide as the petiole. Staminate inflorescence a 6–9-flowered panicle of 3-flowered cymes; peduncle 3–5 cm long; secondary inflorescence bracts coriaceous, suborbicular, 0.8–1.3 mm long and wide, apex broadly rounded, cucullate but not carinate, the margin scarious, entire; pedicels 1–1.5 mm long; bracteoles 4, decussate, the outer 2 stiffly coriaceous, oblate, 5–7 mm long, 6–8 mm wide, apex broadly rounded, medially carinate, the margin scarious, entire, the inner 2 chartaceous, obovate, 7–9 mm long, 4–6 mm wide, apex broadly rounded, the margin scarious, entire; Staminate flowers white; sepals 6, the outer 2 opposite, stiffly coriaceous, suborbicular, 5–7 mm long and wide, apex broadly rounded, medially carinate, the margin scarious, entire, the inner 4 contorted, increasingly larger, to 10 mm long and wide, cucullate but not medially carinate, the margin scarious, irregular, entire; petals 6, contorted, membranaceous, oblanceolate, 12–15 mm long, 5–7 mm wide, apex broadly rounded, cucullate, the margin opaque, not scarious, entire; stamens numerous, 15–20 mm long, the androphore cubic 6–9 mm diam., the filaments 9–11 mm long, the anthers linear, 5–7 mm long, apex muticous, the base truncate, latrorsely dehiscent by wide longitudinal slits; pistillode absent. Pistillate inflorescence a 3-flowered cyme; peduncle obsolete to 2(–5) cm long; secondary inflorescence bracts resembling leaves but narrowly oblanceolate to obovate, 4–8 cm long, 2–4 cm wide; bracteoles 2, cartilaginous, oblate, 4–6 mm long, 10–12 mm wide, apex broadly rounded, medially carinate, the margin scarious; pedicels obsolete to 1 cm long. Pistillate flowers like the saminate but sepals 4, decussate, suborbicular, 5–7 mm long and wide, apex broadly rounded, cucullate but not medially carinate, the margin scarious; petals unknown; staminodia obsolete; ovary subglobose, 5–7 mm long and wide; 5-carpellate; styles thick, radiate, 3–5 mm long at maturity; stigmas corniculoid, 5–7 mm long and wide, convex. Fruit subglobose, 1.5–2 cm long and wide, smooth, not sulcate.

Distribution.—Known from the Guayana Highland of Venezuela, Guyana, Surinam and adjacent Brazil, 330–2,000 m elevation.

Ecology and conservation status.—*Clusia wurdackiana* is a common element on rocky outcrops throughout its range. It frequently forms large colonies and reproduces rapidly from seeds as well as lammas shoots. It appears to be fire resistant, judging from populations observed in Brazil, which had distorted trunks from fire exposure. This is the most resilient species of the genus because it tolerates the greatest amount of ecological disturbance. Therefore, it is not considered threatened.

Etymology.—This species is dedicated to John Julius Wurdack, Curator of Botany Emeritus at the U. S. National Museum of Natural History, Smithsonian Institution. John is best known for his outstanding plant collections from the Guayana Highland of Venezuela and the Andean/Amazonian transitional region of Peru and for his pre-eminence as an authority on the systematics and ecology of Neotropical Melastomataceae. His willingness to share his wealth of knowledge and to provide encouragement to younger systematists throughout the botanical community has had a profound effect on all of us who work in neotropical plant systematics.

Representative specimens examined: **VENEZUELA. Amazonas:** Cerro Aracamuni, summit, Proa Camp, 01°26'N, 65°47'W, 1,550 m, 16 Oct 1987 (fr), *R. Liesner & F. Delascio 22021* (MO, US, VEN); 01°32'N, 65°49'W, 1,400 m, 26 Oct 1987 (fr), *R. Liesner & G. Carnevali 22485* (MO, US, VEN); Cerro Aracamuni, N part, 01°32'N, 65°49'W, 1,415 m, 16–18 Oct 1987 (fr), *F. Delascio & R. Liesner 13518* (MO, NY, US, VEN); N slopes of Cerro Duida, 2 km S of Culebra, 03°43'N, 65°45'W, 700 m, Apr 1990 (fr), *A. Fernández 7757* (BRIT, PORT, VEN); on Plateau of Cerro Duida above Culebra, 03°36'N, 65°42'W, 1,250 m, 2 Mar 1985 (fr), *R. Liesner 18151* (MO, US, VEN); Base of cliff on slope of Cerro Huachamacari, 03°39 'N, 65°43'W, 1,000–1,300 m, 5 Mar 1985 (fr), *R. Liesner 18312* (MO, US, VEN); Cerro Huachamacari, base of main wall and slope below it, E side, 03°49'N, 65°43'W, 800–1,300 m, 5 Nov 1988 (stam. fl), *R. Liesner 25870* (BRIT, MO, US, VEN), (fr), *R. Liesner 25876* (BRIT, MO, US, VEN); Cerro Huachamacari, Río Cunucunuma, 5 Dec 1950 (stam. fl), *B. Maguire et al. 29854* (NY, US, VEN); vicinity of Summit Camp, Cerro Huachamacari, 1,800 m, 6 Dec 1950 (stam. fl), *B. Maguire et al. 30016* (MO, NY, US, VEN), 1,600 m, 15 Dec 1950 (stam. fl bud), *B. Maguire et al. 30254* (NY, US, VEN), 1,620 m, 15 Dec 1950 (fr), *B. Maguire et al. 30255* (NY, US, VEN); Slope of Cerro Marahuaca, above Río Yameduaka, 03K 38'N, 65K 28'W, 1,225 m, 19 Feb 1985 (fr), *R. Liesner 17692* (MO, US, VEN); Cerro de la Neblina,S face of Pico Phelps Massif, 00°48'N, 66°00'W, 1,550–1,650 m, 13 Apr 1984 (fr), *A. Gentry & B. Stein 46600* (MO, NY, US, VEN); Cerro de la Neblina, 6.5 km SSW of base camp, S extension of range, 00°47'N, 66°11'W, 1,600 m, 18 Apr 1984 (fr), *B. Stein et al. 1652* (BRIT, F, MO, NY, US, VEN); Vicinity of Camp VI, Cerro Neblina, on ridge on Venezuelan-Brazilian border, 3,5 km W of Pico Zuloaga, 00°53'N, 65°56'W, 2,000 m, 13–15 Apr 1984 (fr), *W. Thomas & T. Plowman 3059* (BRIT, F, MO, NY, US, VEN); Above Camp III, Cerro de la Neblina, Río Yatua, 1,600–1,700 m, 17 Nov 1957 (stam. fl), *B. Maguire et al. 42044* (NY, US, VEN); Above Camp IV, Cerro de la Neblina, 1,650–1,700 m, 12 Nov 1957 (stam. fl), *B. Maguire et al. 42056* (NY, US, VEN); Caño Grande, Cerro de la Neblina, E of Cumbre Camp, 1,100–1,300 m, 25 Nov 1957 (fr), *B. Maguire et al. 42228* (NY, US, VEN); Cerro de la Neblina, along W escarpment, 1,900–2,00 m, 6 Jan 1954 (fr), *B. Maguire et al. 37076* (NY, US, VEN); Cerro Sipapo (Paráque), below Camp Grande Terrace, 1,400 m, 15 Dec 1948 (fr), *B. Maguire & L. Politi 27686* (NY, US, VEN); Cerro Sipapo, S terraces of Peak IV, 1,800 m, 3 Jan 1949 (fr), *B. Maguire & L. Politi 28133* (NY, US, VEN); In Caño Profundo, Cerro Sipapo, 10 Jan 1949 (fr), *B. Maguire & L. Politi 28628* (NY, US, VEN); Serranía de Tapirapecó, Campo Tamacuari, stream trail from camp, 01°14'N, 64°40'W, 1,300 m, 10 Feb 1989 (fr), *H. Beck et al. 939* (BRIT, NY, VEN), (fr), *A. Henderson 1025* (BRIT, NY, VEN); On plateau N of unamed 1,760 m peak, 9 km NW of settlement of Yutajé, 4 km W of Río Coro-Coro, W of Serranía de Yutajé, 05°41'N, 66°10'W, 1,050–1,300 m, 7 Mar 1987 (fr), *R. Liesner & B. Holst 21732* (MO, US, VEN); 5–8 km NW of Yutajé, S slope below Serranía de Yutajé, 3 km W of Río Coro-Coro, W of Serranía, 05°40'N, 66°09'W, 700–1,000 m, 10 Mar 1987 (fr), *R. Liesner & B. Holst 21841* (MO, NY, US, VEN); Cumbre of Cerro Yutajé, E sector of Serranía de Yutajé, headwaters of Caño Yutajé, 05°45'N, 66°03'W, 1,800 m, 21 Mar 1988 (fr), *O. Huber 12618* (MYF, NY, US, VEN); SE summit of Serranía Yutajé, Río Manipiare, 2,100 m, 17–19 Feb 1953 (fr), *B & C. Maguire 35343* (NY, US, VEN). **Bolívar:** Auyán-tepuí, summit, in S-central region, headwaters of Río Churún, 05°51'N, 62°32'W, 1,700 m, 29 Mar 1987 (fr), *B. Holst 3730* (MO, US, VEN); SE of second wall, near Río Churún, near S camp, 1,690 m, S section, W division of Auyán-tepuí, 3 May 1964 (fr), *J. Steyermark 93319* (F, MO, NY, US, VEN); Río Lomita Camp, summit of SE portion of NW arm, W division of Auyán-tepuí, near "Río Lomita Camp", 1,800 m, 10 May 1964 (fr), *J. Steyermark 93569* (MO, NY, US, VEN); Chimantá Massif, Central Section, NNW of Summit Camp, 1,970 m, 19 Feb 1955 (fr), *J. Steyermark & J. Wurdack 941* (F, MO, NY, US, VEN); Alto Río Cuyuni, above escarpment of La Escalera, 850 m, 20–21 Aug 1962 (fr), *B. Maguire et al. 46834* (NY, US, VEN); Cerro Guaiquinima, Río Paragua, below rim of W Escarpment, 1,600–1,700 m, 31 Dec 1951 (fr), *B. Maguire 32893* (NY, US, VEN); Ilu-tepuí, Gran Sabana, 1,500 m, 8 Mar 1952 (fr), *B. Maguire 33315* (NY, US, VEN); Sierra de Lema, headwaters of Río Chicanán, at base of NE-facing bluffs, 80 km SW of El Dorado, 06°05'N, 62°00'W, 500 m, 28 Aug 1961 (fr), *J. Steyermark 89550* (F, MO, NY, US, VEN); Mcpio. Cedeño, Serranía de Maigualida, sandstone mountains 20 km E of San José de Kayamá, 45 km N of Cerro Impacto, 06°19'N, 65°12'W, 1,250 m, Apr 1969 (fr), *A. Fernández 5397* (BRIT, PORT, VEN); Cerro Impacto, 06°00'N, 65°10'W, 1,250 m, Jun 1988 (fr), *S. Elcoro 348* (BRIT, PORT, VEN); Trirepón-tepuí, SW side of Río Asaporpo, 1,300 m, 7 Jan 1953 (fr), *J. Wurdack M34040* (F, NY, US, VEN); Cerro Venamo, along right bank of W slope near Guyana border, 950–1,150 m, 29–30 Dec 1963 (fr), *J. Steyermark et al. 92363* (F, MO, NY, US, VEN). **BRAZIL. Amazonas:** Mpio. de Barcelos, Platô da Serra Aracá, Serra Norte, 6 hours W of well camp, 00°51'N, 63°22'W, 1,150 m, 20 Feb 1984 (fr), *I. do Amaral, J. Pipoly et al. 1635* (INPA, K, MG, NY); Pico Rondôn, 0–3 km N of km 211 of Perimetral Norte Hwy, Pico Rondôn, 01°32'N, 62°48'W, 3 Feb 1984 (fr), *J. Pipoly et al. 6617* (INPA, K, MG, NY, US). **GUYANA. Cuyuni-Mazaruni Region:** Mt. Ayanganna, E-most peak, 05°25'N, 59°57'W, 1,350–1,380 m, 11 Mar 1987 (fr), *J. Pipoly et al. 11113* (B, CAY, FDG, NY, P, U, US). **Potaro-Siparuni Region:** Kaieteur Plateau, Kaieteur Falls, along W rim of Potaro Gorge, 330 m, 18 Feb 1962 (fr), *R. Cowan & T. Soderstrom 1896* (BRG, K, US); Kaieteur Falls, 05°12'N, 59°29'W, 500 m, 2 Apr 1988 (fr), *W. Hahn et al. 4113* (BRG, NY, US); Mahdia River Valley, tributary of Potaro River, E-facing escarpment of Mt. Ebini, 700 m, 15 Oct 1951 (fr), *B. Maguire 32123* (FDG, NY, US); Pakaraima Mts., Mt. Kukuinang, adjacent W edge of Kukuinang Savanna, 05°04'N, 59°57'W, 900-1,000 m, 26 Feb 1993 (fr), *T. Henkel et al. 1574* (BRG, BRIT, US); Mt. Wokomung, summit ridge of Kamiewah Pinnacle NE to S Pinnacle, "Little Ayanganna", 05°04'N, 59°52'W, 1,550–1,650 m, 17 Nov 1993 (fr), *T. Henkel et al. 4459* (BRG, US). **Surinam:** Wihelmina Gebergte, upper slopes and summit of Juliana Top, 15 km N of Lucie River, 1,000–1,230 m, 18 Aug 1963 (stam. fl), *H. S. Irwin et al. 54862* (BBS, NY, U, US).

The thick branchlets and pedicels and corniculoid stigmas of *Clusia wurdackiana* indicate that it is closely related to *C. pachyphylla*. However, the chartaceous to coriaceous, obovate to oblanceolate leaf blades, with acute bases and flat margins, stiffly coriaceous sepals with entire margins, thick, radiate styles and smooth ovary and fruit clearly distinguish *Clusia wurdackiana* from *C. pachyphylla*. *Clusia wurdackiana* is a polymorphic ochlospecies (*sensu* Prance 1982; White 1962; Pipoly 1983), with great quantitative variation across a broad geographic range.

Steyermark (1981) corrected the common misconception that Schomburgk's Roraima collections took place on the Guyanese side of the mountain, when in fact, he approached the upper slopes from the Venezuelan side, hence the correction in the type citation.

6. **Clusia pachyphylla** Gleason, Bull. Torrey Bot. Club 58:405. 1931. TYPE: VENEZUELA. AMAZONAS: Cerro Duida, summit of Peak 7, 2,230 m, Aug 1928–Apr 1929 (pist. fl), *G. Tate 609* (HOLOTYPE: NY!).

Clusia scariosa Lasser & Maguire, Brittonia 7:81. 1950. syn. nov. TYPE: VENEZUELA. AMAZONAS: Cerro Yaví, 2,200 m, 1–3 Mar 1947 (fr), *Phelps & C. Hitchcock 51* (HOLOTYPE: NY!; ISOTYPE: VEN).

Free-standing tree to 6 m tall; branchlets tetragonal, 8–11 mm diam., strongly sulcate, glabrous. Leaves petiolate; blades thickly cartilaginous, elliptic to obovate, (5–)8–10(–18) cm long, (2.5–)6.5–10 cm wide, apex broadly rounded to broadly obtuse, midrib slightly raised above, prominently raised below, decurrent to petiole base, secondary veins numerous, prominently raised above and below, the collecting vein on the revolute margin; petioles trigonal, sub- to strongly marginate, 1–1.5(–2) cm long, the adaxial pit deep, strongly margined, less than petiole diameter. Staminate inflorescence 1–3-flowered; peduncle 1–1.5 cm long; tetragonal, deeply sulcate; flora bracts 4, decussate, suborbicular, cartilaginous, 0.8-1.2 cm long and wide, apex obtuse, prominently carinate, the margin scarious, opaque, irregularly notched; pedicels obsolete to 3 mm long. Staminate flowers; sepals 8–10, the outer four decussate, cartilaginous, suborbicular, 8–15 mm long, 10–16 mm wide, apex broadly rounded, the margin whitish scarious, variously incised, the inner ones as in the outer but contorted, acropetally larger, obovate to reniform, 15–20 mm long, 18–23 mm wide; petals 6–8, the outer two decussate, the inner ones contorted, all similar in shape and size, coriaceous to carnose, obovate, 2.5–3 cm long, 1.3–2 cm wide, apex deeply erose, stamens numerous, 5–7 mm long, the androphore cubic, 1.5–2 mm long, the filaments linear, thick, 2–3 mm long, the anthers linear, 3–4 mm long, extrorsely dehiscent by wide longitudinal slits, the connective muticous; pistillode absent. Pistillate inflorescence as in staminate but peduncle 1.5–2 cm long; bracts as in staminate; pedicels obsolete to 5 mm long. Pistillate flowers as in staminate but sepals 8–15 mm long 11–18 mm wide; petals but 2.0–2.5 cm long, 1.2–1.6 cm wide, persistent in fruit; staminodia numerous, as in staminate but not on androphore, 5–6 mm long, the filaments 3–3.5 mm long, irregularly grouped in phalanges, the antherodes 1–1.5 mm long, some of them producing pollen; pistil ovoid, 5–8 mm long; carpels 6–8, the stigmas sessile, convex, corniculoid, the corners acute, 4–5 mm long, 3–5 mm wide. Fruit subglobose, 2.3–2.8 cm long, 3.3–4 cm diam.

Distribution.—Endemic to the NW portion of the state of Bolívar, westward through southern Amazonas, Venezuela, at 1,700–2,200 m.

Ecology and conservation status.—*Clusia pachyphylla* is infrequent on rocks in savannas on the summits of the tepuis it inhabits. The areas in which it occurs are quite remote and therefore, this species is not considered threatened.

Specimens examined: **VENEZUELA. Amazonas:** Summit of Cerro Coro-Coro, NW headwaters of Río Manipiare, (NW sector of Serranía Yutajé), 05°46'N, 66°12'W, 2,200 m, 12 Nov 1987 (fr), *O. Huber 12310* (MYF, NY, VEN); Summit of Cerro Duida, 1,800–2,075 m, 4 Sep 1944 (fr), *J. Steyermark 58344* (F, VEN); Depto. Atures, Sierra Maigualida, NW sector, small valley along an upper tributary of Caño Iguana, 05°30'N, 65°15'W, 2,000 m, 28 Feb–3 Mar 1991 (fr), *P. Berry et al. 4862* (BRIT, MO, VEN),(fr), *4883* (BRIT, MO, VEN), (stam. fl), *4885* (BRIT, MO, VEN), 2 Mar 1991 (fr), *O. Huber et al. 13103* (BRIT, MO, VEN); Serranía Uasadi, NW sector, summits at E headwaters of Río Asita, right tributary of Río Ventuari, 05°21'N, 65°12'W, 1,850 m, 22 Nov 1988 (fr), *O. Huber 12850* (MYF, US, VEN); Cerro Yaví, 2,200 m, 1–3 Mar 1947 (fr), *K. Phelps & C. Hitchcock 53* (NY, VEN); Summit of Cerro Yaví, headwaters of Río Parucito, W tributary of Río Manipiare, in the NE sector of summit, 05°43'N, 65°52'W, 2,100 m, 29 Oct 1986(stam. fl), *O. Huber 11880.* (MYF, NY, VEN), (pist. fl, fr), *O. Huber 11868* (MYF, NY, VEN); Summit of Cerro Yutajé, E sector of Serranía Yutajé, headwaters of Caño Yutajé, 05°45'N, 66°03'W, 1,800 m, 21 Mar 1988 (fr), *O. Huber 12622* (MYF, NY, US, VEN). **Bolívar:** Auyán-tepuí, Sep 1937 (fr), *F. Cardona 232* (F, NY, US, VEN); Cerro Guaiquinima, Río Paragua, N Valley, 1,700 m, 2 Jan 1952 (fr), *B. Maguire 32926* (F, MO, NY, US, VEN); Summit, Cerro Guaiquinima, 1 km NW of Cumbre Camp, 26 Dec 1951 (fr), *B. Maguire 32788* (F, NY, US, VEN); Meseta de Jaua, Central-Southern sector, southern plateau, headwaters of Río Maranjo, headwaters of Río Cácaro, 04°48'N, 64°32'W, 1,750–1,800 m, 20 Nov 1989 (stam. fl), *O. Huber 13020* (BRIT, MYF, VEN); Dtto. Cedeño, Sierra de Maigualida, NE sector, plateau on the headwaters of the Río Chajura, W tributary of the Río Erebato, ca. 100 km SW of Campamento Entreríos, 05°33'N, 65°13'W, 2,100 m, 28 Mar 1988 (stam. fl), *O. Huber 12728* (MO, MYF, US, VEN); Sierra de Maigualida, NE sector, headwaters of Río Chajura, W tributary of Río Erabato, 100 km SW of Campamento Entreríos, 05°33'N, 65°13'W, 2,100 m, 18 Nov 1988 (fr), *O. Huber & L. Izquierdo 12789* (MYF, NY, US, VEN).

The thick branchlets and pedicels, and corniculoid stigmas of *Clusia pachyphylla* indicate a close relationship to *C. wurdackiana*. However, the cartilaginous, elliptic to suborbicular leaf blades, with obtuse to truncate bases, chartaceous sepals with incised margins, the obsolete styles, and deeply sulcate fruit clearly distinguish *C. pachyphylla*. This species is one of a very few with prominent secondary venation despite the cartilaginous texture of the leaf blades.

The type of *Clusia scariosa* Maguire differs only in the smaller, more closely veined leaves, larger petals and more numerous staminodia, all quantitative characters which have now been found to vary widely based on analysis of many more gatherings than were available to Maguire. One collection from Sierra Magualida (*P. Berry et al. 4883*) has fruits with much narrower stigmas whose margins are fimbriate, and may represent an undescribed taxon. More collections from the Sierra and environs will be necessary to fully understand variation in *Clusia pachyphylla*.

7. **Clusia duartei** Maguire, Moscosoa 4:215. 1986. TYPE: VENEZUELA. AMAZONAS: Cerro Sipapo, Campo Grande, 1,500 m, 10 Dec 1948 (stam. fl), *B. Maguire & L. Politi 27575* (HOLOTYPE: NY!; ISOTYPES: F!, G, JBSD, K!; MO!; US!, VEN).

Tree to 10 m tall; branchlets tetragonal, the angles acute but not alate, 15–22 mm diam., semisucculent, not sulcate. Leaves petiolate; blades cartilaginous, suborbicular to very widely elliptic, 20–27 cm long, 19–21.5 cm wide, apex very broadly rounded to subtruncate, base very broadly rounded, midrib slightly raised above ca. 3/4 its length, decurrent to petiole base, prominently raised below, secondary veins numerous, inconspicous above, barely visible below, the submarginal collecting vein ca. 2 mm from margin, the margin flat; petioles trigonal, somewhat marginate, 2–3 cm long, the adaxial pits strongly marginate. Staminate inflorescence 1–3-flowered; peduncle tetragonal, the angles acute, 2 cm long; primary inflorescence bracts foliaceous, opposite, cartilaginous, suborbicular, petiolate, the blades 4.5–7.5 cm long, 3.5–6.5 cm wide, apex truncate, base obtuse, the midrib and secondary veins as in leaves, the petioles ca. 1 cm long, the adaxial pit strongly marginate; bracteoles 2, carnose, suborbicular, 1–1.5 cm long and wide, apex broadly rounded, prominently carinate, the margin narrowly scarious, subentire, with occasional incisions; pedicel 3–10 mm long. Staminate flowers; sepals 8–10, decussate, the outer stiffly chartaceous, oblate, 1.2–1.5 cm long, 2–2.5 cm wide, apex broadly rounded, the margin very narrowly scarious, entire but undulate when dried, the inner acropetally thinner, more orbicular and larger, 2–2.5 cm long and wide, the scarious margin progressively wider; petals 8–10, contorted, coriaceous, oblong, contorted, 4.5–5 cm long, 1.5–2 cm wide, not gradually tapering toward base, apex very broadly rounded to truncate, the margin scarious, opaque, entire; stamens numerous, 1.5–2 cm long, the androphore cubic, 8–10 mm long, the filaments united basally, linear but fleshy, 3–5 mm long, the anthers linear, 3–5 mm long, apex muticous, dehiscent by introrse , wide longitudinal slits; pistillode absent. Pistillate inflorescence unknown, except floral bracts 2, cartilaginous, suborbicular, 1.2–1.5 cm long and wide, the apex broadly rounded, prominently keeled, the margin opaque, somewhat scarious; pedicels obsolete to 4 mm long. Pistillate flowers (from mature fruit); sepals 8, persistent in fruit, as in staminate but 1.5–1.8 cm long, 2–2.5 cm wide, apex broadly rounded, the margin widely scarious, irregularly incised, acropetally larger and more suborbicular to 2.5 cm long, 2.3 cm wide; petals 6, very widely oblong to suborbicular, 2.5–3 cm long and wide; staminodes 12–16, 6–10 mm long, barely connate by filaments basally, the filaments 3–5 mm long, the anthers ovate, 5–7 mm long, apex obtuse, latrorsely dehiscent by a long longitudinal slit, devoid of pollen or producing small amounts of deformed pollen; pistil unknown; carpels 10–12, deeply sulcate along the sutures, the stigmas sessile, subapical, corniculoid, the angles rounded, 4–5 mm long, 3–4 mm wide. Fruit subglobose, 5–6 cm long, 6–8 cm wide.

Distribution.—Endemic to the western portion of the state of Amazonas of Venezuela, known from Cerros Sipapo and Cuao, at 1,500–1,580 m.

Ecology and conservation status.—*Clusia duartei* occurs in low scrub forest along river margins. It is known from only four collections, and should be considered rare, but not enough is known of its population biology to determine if it is threatened.

Specimens examined: **VENEZUELA. Amazonas:** Depto. Atures, Cerro Cuao, Caño Cabeza de Manteco, 73 km SE of Puerto Ayacucho, 05°06'N, 67K 24'W, 1,580 m, Sep 1989 (fr), *A. Fernández et al. 6271* (MO, PORT, VEN); Cerro Sipapo, Campo Grande, 1,500 m, 10 Dec 1948 (stam. fl), *B. Maguire & L. Politi 27543*, (fr), *28683* (NY, VEN).

Clusia duartei appears to be most closely related to *C. pachyphylla*, but can immediately be distinguished by its thicker branchlets, longer petioles, massive leaf blades and fewer, longer floral bracts. Cursory comparison of vegetative parts may result in intial confusion with some individuals from populations of *C.* (sect. *Clusiastrum*) *crassifolia* Planchon & Triana, but the yellow latex, minute stigmas on thin, finger-like styles, and antheriferous staminodes with dehiscence *via* subterminal pores (characteristics of all members of sect. *Clusiastrum*) clearly differentiate *C. crassifolia.*

ACKNOWLEDGMENTS

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BOOK NOTICE

POTTER, C.S., J.I. COHEN, and D. JANCZEWSKI (Eds.). 1993. **Perspectives on Biodiversity: Case Studies of Genetic Resource Conservation and Development.** (ISBN 0-87168-512-4, pbk) American Association for the Advancement of Science, Washington, DC 245pp.

From the prologue, by Ehrlich and Wilson to the many case studies covering such subjects as agroecosystems, fisheries and wildlife, managed forest ecosystems and conservation and regional development, this volume is full of literature reviews, republication of previously published key works, and original, site-specific research.

The book is divided into two parts: Themes in species and genetic resource conservation, and case studies of biodiversity conservation in natural habitats. The first section consists of four papers, which include: tactics and conflicts in preserving genetic resources (Soule), theoretical concerns regarding detection of congruent phylogenetic patterns among radiating lineages, and thus, detection of centers of evolutionary radiation (Erwin), balance of species preservation vs. economic considerations (Morowitz), and finally, biological and socioeconomic factors in conservation of crops and flora (Williams). The second section consists of purely case studies, which deal with every level from the local farmer (Altieria & Montecinos), to conservation of specific crops (e.g., Wilkes, on maize), habitats (e.g. Twilley et al., on mangroves), managed ecosystems (Hartshorn & Pariona on Peru, Padoch & Peters, on forest gardens in West Kalimantan, and Wilcox & Olson) on Pacific forests of the Pacific Northwest.

I was somewhat disappointed that conservation of such pivotal groups as birds, bats, reptiles, and marine mammals, was totally ignored in this volume. It is, nonetheless, useful, the binding is well-done and the reproduction clear. There are several critical papers which will be fodder for citations in our grant proposals, and I anticipate more soon.

In summary, I think every organismic biologist should have access to this book as a model for preservation of case studies, and a source of background reading material.—*John Pipoly III.*

THE STATUS OF *POTAMOGETON PERFOLIATUS* (POTAMOGETONACEAE) IN LAKE PONTCHARTRAIN, LOUISIANA

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ABSTRACT

Potamogeton perfoliatus L. is listed as a sensitive plant in the Louisiana Coastal Zone. Four erratic records from Lake Pontchartrain constitute the southwestern extent of its range in North America. To obtain a better understanding of its current status, aquatic habitats near New Orleans were surveyed. It was found in eastern Lake Pontchartrain at three new localities (Point Platte, Big Point, and Irish Bayou) and at two previously reported localities. The Point Platte bed is large (1.8 ha) and in a remote area. The erratic historic distribution of *P. perfoliatus* in Lake Pontchartrain may be due to the establishment of small, scattered, temporary beds in more accessible areas by dispersal from the large Point Platte population. Its restricted Louisiana distribution appears to be due to the suitable sediment and water quality conditions occurring in eastern Lake Pontchartrain.

RESUMEN

Potamogeton perfoliatus L. se incluye entre las plantas amenazadas de la zona litoral de Louisiana. Cuatro citas erráticas a orillas del lago Pontchartrain constituyen la parte suroeste de su área norteamericana. Con objeto de obtener una mejor comprensión de su estado actual se observaron ciertos hábitats acuáticos cercanos a New Orleans. La especie fue hallada en tres nuevas localidades al este del lago Pontchartrain: Pointe Platte, Big Pointe, e Irish Bayou, así como en otras dos localidades previamente citadas. El lecho correspondiente a Point Platte es extenso (18 $m^{2)}$ y se encuentra en una zona remota. La distribución históricamente errática de *P. perfoliatus* en el lago Pontchartrain puede ser debida al establecimiento de lechos pequeños, dispersos y temporales de zonas más accesibles, debidos a dispersiones que tuvieron lugar a partir de la población de Pointe Platte. Su distribución restringida en Louisiana parece deberse a las condiciones de sedimento apropiado y calidad del agua que se dan en la zona oriental del lago Pontchartrain.

INTRODUCTION

Potamogeton perfoliatus L. (Clasping Pondweed) is a vascular plant that occurs in fresh and low salinity estuarine waters. It is currently listed as "extremely rare" in the Louisiana Coastal Zone by the Louisiana National Heritage Program (Lester 1988) with Louisiana records limited to Lake Pontchartrain. It is considered to be a widely distributed north temperate species that in North America occurs primarily on the northeastern coastal

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plain (Sculthorpe 1967). Ogden (1943) described its distribution to be Newfoundland to Florida, Ontario, Ohio, and Louisiana, but common only in the northeastern area of its range. Godfrey and Wooten (1979) reported that it occurs in calcareous or brackish ponds and streams with a distribution including Mississippi but not Louisiana. Louisiana records represent the southwestern extent of its range in the United States.

Lake Pontchartrain is a shallow, estuarine embayment in the Mississippi River Deltaic Plain in southeastern Louisiana. It encompasses 1,630 km^2 and has an average depth of 3.7 m and an average salinity of about 4 ppt (Sikora & Kjerfve 1985). Submersed aquatic vegetation (SAV) occurs as discontinuous bands along the northeastern and southeastern shorelines and has been documented to be in decline (Burns et al. 1993; Mayer 1986; Montz 1978; Turner et al. 1980). These SAV bands, which are dominated by *Vallisneria americana*, extend as far as 200 m from shore in some areas, but rarely extend beyond a water depth of 1.5 m (Burns et al. 1993).

Past Louisiana reports did not give a varietal form for *P. perfoliatus*. These records are: Riddell, Tchefuncta River lighthouse, 1883 (Ogden 1943); Brown, Mandeville Beach, 1945 (Haynes 1968); Montz, Pointe aux Herbes, 1973 (Montz 1978); and Brantley and Platt, between Goose Point and Bayou Lacombe, 1990 (Brantley & Platt 1991). Biological surveys of Lake Pontchartrain that included submersed aquatic vegetation were conducted by Chabreck (1972), Lester (1988), Mayer (1986), Perret et al. (1971), Suttkus et al. (1954), and Thompson and Verret (1980). Although *P. perfoliatus* was not reported in these general surveys, it may have been present in the estuary and simply overlooked due to its limited distribution. Attempts to find it prior to its being listed were unsuccessful (Lester 1988).

Based on past records, its occurrence in Lake Pontchartrain is erratic and factors affecting its temporal and spatial distribution are unknown. There is a need for more information regarding the environmental factors affecting the distribution of submersed aquatics in estuaries to better understand why populations have declined worldwide (Dennison et al. 1993). Our study of *P. perfoliatus* was conducted to determine the following: (1) its current distribution in Lake Pontchartrain, (2) whether it occurs in other wetland habitats near Lake Pontchartrain, and (3) its habitat requirements.

METHODS

Our study area encompassed the entire shoreline of Lake Pontchartrain, including tidal areas of streams and passes, and aquatic habitats surrounding Lake Pontchartrain (Fig. 1). The study area was bounded by La. Hwy. 36 to the north, Lafitte, La. to the south, La. Hwy 55 to the west and the Pearl River to the east. Field work began in November 1991 and ended in August 1993.

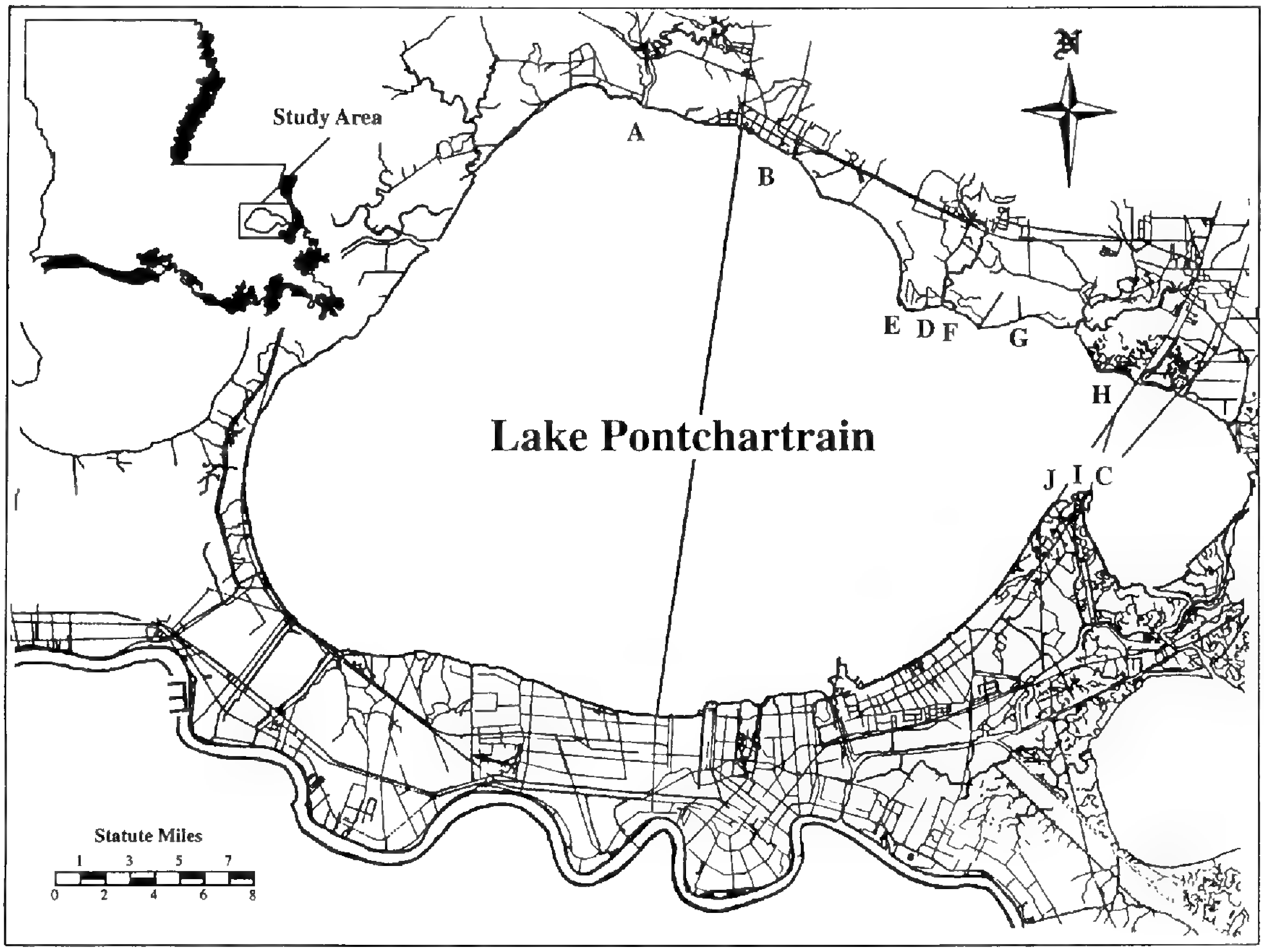

Fig. 1. The historical distribution of *Potamogeton perfoliatus* in the Lake Pontchartrain estuary, LA: Riddell 1838 (A); Brown 1945 (B); Montz 1973 (C); Brantley and Platt 1990 (D); 1991–1993 distribution (Goose Point (E), Bayou Lacombe (F), Pointe Platte (G), Big Point Beach (H), Pointe aux Herbes (I), Irish Bayou (J). This map is modified from NOAA navigational map no. 11369, 33rd Ed.

Species identification followed Godfrey and Wooten (1979); voucher specimens were deposited in the University of New Orleans Herbarium. Areal cover of monotypic stands of *P. perfoliatus* was determined by direct measure. Percent foliar cover in stands containing other species was determined by the line intercept method (Westman 1985).

Secchi disc (20 cm) transparency, water temperature, and water and sediment samples were taken at each site. Salinity was calculated from chloride values determined by the mercuric nitrate method (Harvey 1957; Standard Methods 1989). Sediment textural classes were assigned by grain size analysis (Folk 1980).

RESULTS

Potamogeton perfoliatus was found at five sites in eastern Lake Pontchartrain (Fig. 1). It occurred in protected shoreline embayments and near the mouths of streams. This plant exhibits a wide range of variation in both morphology and color due to light intensity, sediment type, and water quality differences (Ogden 1943). Specimens from all sites fit the description of *P.*

perfoliatus L. var. *bupleuroides* (Fern.) Farw; a smaller plant that fruits freely and is distinguished from *P. perfoliatus* var. *perfoliatus* by a slender stem (diameter = 0.4–1.5 mm), delicate leaf (width = 0.5–2 cm) and few prominent nerves (7–17 nerves, 1–5 prominent) (Godfrey and Wooten 1979; Ogden 1943). Although our specimens fit the description of *P. perfoliatus* L. var. *bupleuroides* (Fern.) Farw, several authors have not recognized this variety (Kartesz 1994; Thomas and Allen 1993).

Southshore beds were present at Pointe aux Herbes (between the La. Hwy 11 bridge and I-10 bridge behind a cement erosion control structure) and the east side of the Pointe aux Herbes peninsula adjacent to the west mouth of Irish Bayou. Three beds occurred on the north shore between Goose Point and the mouth of Bayou Lacombe (500 m east of Goose Point, 200 m west of Bayou Lacombe and 1500 m west of Bayou Lacombe). Other north- shore beds were found near Point Platte (4.0 km east of Bayou Lacombe) and the swimming beach at Big Point. Physicochemical and habitat data from these sites are presented in Table 1.

Potamogeton perfoliatus bed size ranged from four plants at Big Point to a 1.8 ha bed at Point Platte. Percent foliar cover of *P. perfoliatus* at Point Platte was 28%; and at Pointe aux Herbes, 72%. Total areal cover of *P. perfoliatus* was 2.2 ha and represents ca. 2.5 % of the total areal cover of all submersed aquatic vegetation in Lake Pontchartrain (Burns et al. 1993). No seasonal differences in bed size were noted, although individual shoot lengths were considerably shorter between December and February. A 20 x 30 m section of the Pointe aux Herbes population was found stripped of its leaves during September 1991. Waterfowl are known to feed upon the leaves, seeds, roots, and rhizomes of *P. perfoliatus* and are most likely responsible for the removal of leaves at this site. All populations occurred at water depths between 31 and 122 cm and were rooted in sand and loamy sand substrates. Secchi disc transparency ranged from 30 to 217 cm, temperature from 17 to 32 °C, and salinity from 1.0 to 8.2 ppt in *P. perfoliatus* beds (Table 1).

DISCUSSION

Although the areal cover of submersed aquatic vegetation in Lake Pontchartrain has declined by more than 50% since 1973 (Burns et al. 1993; Mayer 1986; Turner et al. 1980), there may have been an increase in the area occupied by *P. perfoliatus*. Irish Bayou, Big Point, and Pointe Platte are new locality records for *P. perfoliatus*, and it was found at Pointe aux Herbes where it had not been reported since 1973. The largest bed ever reported from Lake Pontchartrain was found at Pointe Platte during our study. The plants found at Big Point on 20 June 1991 disappeared by March 1992 and have not returned. The direct cause for the disappearance

TABLE 1. Habitat data for *Potamogeton perfoliatus* in Lake Pontchartrain, Louisiana.

	Point Platte	Big Point	Irish Bayou	Bayou Lacombe	Pointe aux Herbes
Foliar Stand Size (m^2)	18000	4 plants	1920,180,300	300,119,150	1014
Flower & Fruit	Present	Absent	Present	Absent	Present
Water Depth (cm)	30.5–91.4	30.5–61.0	30.5–91.4	30.5–61.0	61.0–122.0
Sediment Type	Loamy Sand	Sand	Loamy Sand	Sand	Sand
Species Present	P,V,N,M,E	P,V,R	P,V,R,M	P,V,N,M,E	P,V,R
Shoreline Stability	Er	St	Er	Er	St
Historical Record	a	a	a	b	c
Secchi Disk (cm)	210–217	196–206	31–62	30–72	46–81
Temperature (°C)	28–30	26–28	27–31	17–32	26–32
Salinity (ppt)	4.5	7.0–8.2	1.5–3.7	1.0–4.1	1.7–3.8

P=*Potamogeton perfoliatus*; V=*Vallisneria americana*; R=*Ruppia maritima*; M=*Myriophyllum spicatum*; N-*Najas guadalupensis*; E=*Eleocharis parvula*; St=stable shoreline; Er=eroding shoreline; a=first record for this area; b=first record 1990 (Brantly & Platt 1991); c-first record 1973 (Montz 1978).

of *P. perfoliatus* in this area is not known. However, increased wave energy, associated with cement bulkheads along the shoreline, and "eatouts" by waterfowl may be responsible. The relative frequent occurrence and disappearance of scattered *P. perfoliatus* populations suggests that small populations may persist by occasional recolonization rather than regulation of population size.

Beds of *P. perfoliatus* greater than 300 m^2 in size had plants that flowered and produced fruit during March and April. The 1.8 ha bed found at Point Platte might be the source of small temporary beds located elsewhere in the estuary. These beds, which may become extirpated during adverse conditions, could become established through the dispersal of seeds and vegetative propagules from the large Pointe Platte bed by waterfowl and currents. Because *P. perfoliatus* occurs in sand and loamy sand sediments, it is restricted to the sites in northern and southeastern Lake Pontchartrain where these sediments occur. The large Point Platte bed may be important in maintaining the disjunct Lake Pontchartrain populations.

Potamogeton perfoliatus is an inland species found in alkaline or brackish ponds and streams (Godfrey and Wooten 1979); it can also tolerate low-salinity estuarine conditions (Den Hartog 1981). It is present in many Atlantic Coast estuaries including the upper Chesapeake Bay (Orth et al. 1992) and can tolerate salinities up to 12 ppt (Twilley and Barko 1990). The stable, low salinity of Lake Pontchartrain (Sikora and Kjerfve 1985) is within the range of water quality conditions reported by other investigators and is suitable for *P. perfoliatus* growth.

The absence of *P. perfoliatus* from other sites in the study area is probably due to water quality and bottom sediment type. Eastern Lake Pontchartain is the only site in the study area that has low-salinity water and sand sediment combined. Aquatic habitats north of Lake Pontchartrain have sand sediment but unsuitable acidic water low in dissolved solids. Other habitats south of Lake Pontchartrain with alkaline or brackish water have unsuitable silt and clay sediments. Herbivory and competition from other aquatic plants probably also affect its abundance and distribution. *Potamogeton perfoliatus* is an excellent food source for waterfowl; redheads, canvasback, mallard, ring-necked duck, black duck, Canada geese and tundra swans are known to feed on the seeds, leaves, stems and rhizomes (Hurley 1990). Waterfowl are probably responsible for the removal of leaves from *P. perfoliatus* at Pointe aux Herbes and the disappearance of all *P. perfoliatus* from Big Point during our study. Competition with other established aquatic plants, particularly in nutrient-rich floodplain habitats, may also limit its distribution.

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BOOK NOTICES

GRETCHEN D. JONES, VAUGHN M. BRYANT, JR., MEREDITH HOAG LIEUX, STANLEY D. JONES, and PETE D. LINGREN. 1995. **Pollen of the Southeastern United States: With emphasis on Melissopalynology and Entomopalynology.** (ISSN 0160-8843, AASP Contribution Series 30, hbk, "Hidden wire'O" metal spiral binding). AASP Foundation, c/o Vaughn M. Bryant, Palynology Laboratory, Texas A&M University, College Station, TX 77843-4352. $27.00. 76 pp, 616 b/w photographs on 104 photographic plates.

Palynologists are always in need of additional reference materials. As the authors of this book point out, it would be impossible for any one researcher to know the pollen morphology of all of the more than 250,000 flowering plant species. This compilation of 616 scanning electron micrographs of pollen species from the southeastern United States including Texas will serve as a useful aid to anyone working on pollen from this region. Although this book emphasizes pollen of entomophilous plant taxa, the taxonomic coverage is broad enough to be of significant value.

Positive features of this book include a comprehensive listing of other published pollen floras, detailed descriptions of techniques used in scanning electron microscopy, voucher specimen preparation, and collection of pollen from voucher specimens, readily accessible and clear listings by family, genus and aperture type of pollen taxa figured in this book, and lastly, high quality prints of the 616 pollen images.

The authors made the photographs primarily for those who study pollen associated with insects by using scanning electron microscopy. Thus, there are no light micrographs for direct comparison with views of pollen under a light microscope. Nevertheless, the images remain valuable to all palynologists working with southeastern assemblages. There is now more information on which to base pollen identifications, and that's good for us all.—*Bonnie Jacobs.*

REID, WALTER V., SARAH A. LAIRD, CARRIE A. MEYER, RODRIGO GÁMEX, ANA SITTENFELD, DANIEL H. JANZEN, MICHAEL A. GOLLIN, AND CALESTOUS JUMA. 1993. **Biodiversity Prospecting: Using Genetic Resources for Sustainable Development.** (ISBN 0-915825-89-9, pbk). World Resources Institute, P.O. Box 4852, Hampden Station, Baltimore, MD 21211 (1-800-822-0504). No Price Given. 341 pp.

The following chapters are included in the book: Foreword and Acknowledgments. 1) A New Lease on Life; 2) Costa Rica's Conservation Program and National Biodiversity Institute (INBio); 3) Biodiversity Prospecting by INBio; 4) Contracts for Biodiversity Prospecting; 5) Research Management Policies: Permits for Collecting and Research in the Tropics; 6) An Intellectual Property Rights Framework for Biodiversity Prospecting; 7) Policy Options for Scientific and Technological Capacity-Building. Annexes: a) The Role of the Parataxonomists, Inventory Managers, and Taxonomists in Costa Rica's National Biodiversity Inventory, b) Biodiversity Prospecting Contract, c) The Convention on Biological Diversity and Intellectual Property Rights, d) The United Nations Convention on Biological Diversity.

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DOCUMENTED CHROMOSOME NUMBERS 1995:1. CHROMOSOME NUMBER OF *CORNUS SESSILIS* (CORNACEAE): PHYLOGENETIC AFFINITY AND EVOLUTION OF CHROMOSOME NUMBERS IN *CORNUS*

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ABSTRACT

The chromosome number of the Californian cornelian cherry, *Cornus sessilis* Torr., is determined to be $2n=20$, differing from the number ($2n=18$) reported for other cornelian cherries. This is the first report of a chromosome number for *C. sessilis*. The finding of $2n=20$ in *C. sessilis* along with evidence from morphology and molecular data helps clarify the evolutionary trend of chromosome numbers in *Cornus* and suggests an early divergence between the species and its close relatives, *C. mas* - *C. officinalis* - *C. chinensis*.

RESUMEN

El determina el número cromosómico del cornejo de California *Cornus sessilis* Torr. Como $2n=20$, que difiere del número ($2n=18$) citado de otros cornejos. Este es el primer recuento cromosómico de *C. sessilis*. El hallazgo de $2n=20$ en *C. sessilis junto con la evidencia de datos* morfológicos y moleculares ayuda a clarifica las tendencias evolutivas de los números cromosómicos en *Cornus* y sugiere una divergencia temprana entre esta especie y sus parientes más próximos, *C. mas* - *C. officinalis* - *C. chinensis*.

The cornelian cherries, *Cornus* subgen. *Cornus* L. consist of five geographically isolated, red-fruited species (*C. mas* L. in Europe; *C. officinalis* Seib. et Zucc. in eastern China and Japan; *C. chinensis* Wangerin in southwestern China; *C. sessilis* Torr. in California; and *C. volkensii* Harms in Africa). Chromosome numbers of $2n=18$ have been reported for *C. mas* and *C. officinalis* (Dermen 1932). This paper is the first report of a chromosome number for the Californian species *C. sessilis*, and discusses the phylogenetic affinity of the species and the evolutionary trend of chromosome numbers in *Cornus*.

METHODS AND RESULTS

Root-tips from germinating seeds of *Cornus sessilis* were pretreated with saturated *p*-dichlorobenzene for three hours before fixation in a solution of

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[1] Deseased May, 1990.

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3:1 ethanol:glacial acetic acid. Seeds were collected in the field (voucher: *Eyde 134* (US), northern California, May 1989) and germinated in the greenhouse. Chromosome counts were made from 15 mitotic cells of root-tip material using standard squash procedures. All cells were determined to be $2n=20$ (Fig. 1).

DISCUSSION

The distribution pattern of the cornelian cherries suggests an old age for the group. The geographic isolation of the various cornelian species parallels the morphological diversity found in the group. For example, the Chinese cornelian cherry, *Cornus chinensis*, is distinct in the genus in having monopodial axes (i.e., terminal leaf buds and axillary flower buds; Xiang 1987) whereas all other species of *Cornus* have sympodial axes (terminal flower buds and axillary leaf buds). The African cornelian cherry, *C. volkensii*, is unique in the genus in being dioecious, and the Californian cornelian cherry, *C. sessilis*, is distinct from other cornelian cherries in its winter bud morphology. A winter bud of the cornelian cherries (except *C. chinensis*) consists of three buds, two lateral leaf buds each with a scale at its outer side, and one terminal inflorescence bud covered by four bracts. The leaf-bud scales in *C. sessilis* are modified and expand to cover completely the inflorescence bud to form the outer-most layer of protective sheaths for the inflorescence bud. In contrast, the leaf-bud scales in other cornelian cherries are small and not modified. Also, the peduncules of the preformed inflorescence of *C. sessilis* are not precocious as they are in other cornelian cherries (Murrell 1993). As a result of the morphological diversity, the taxonomy of the cornelian cherries has been controversial. *Cornus chinensis* and *C. volkensii* have at times been separated from other cornelian cherries (*C. mas*, *C. officinalis*, and *C. sessilis*) and have been recognized as distinct subgroups within *Cornus* or as a distinct genus, such as, *Cornus* subgen. *Sinocornus* for *C. chinensis* (Xiang 1987), and *Afrocrania* or *Cornus* subgen. *Afrocrania* for *C. volkensii* (Ferguson 1966a; Hutchinson 1942; Murrell 1993; Xiang 1987).

Phylogenetic relationships within the cornelian cherries have been proposed by Eyde (1988). Based on morphological and fossil analyses, Eyde (1988) placed *Cornus sessilis* as the sister of a clade that consists of *C. officinalis*, *C. mas*, and *C. chinensis* with the first two as sisters. Eyde considered *C. sessilis* a line that diverged second in the cornelian cherry group, following the divergence between *C. volkensii* and the remaining cornelian cherries. This hypothesis is supported by molecular data. The result of a recent chloroplast DNA (cpDNA) restriction site analysis of *Cornus* by Xiang et al. (in press) revealed that *C. sessilis* is sister to *C. mas* - *C. officinalis* (*C. chinensis* and *C. volkensii* were not included in the cpDNA restriction site study).

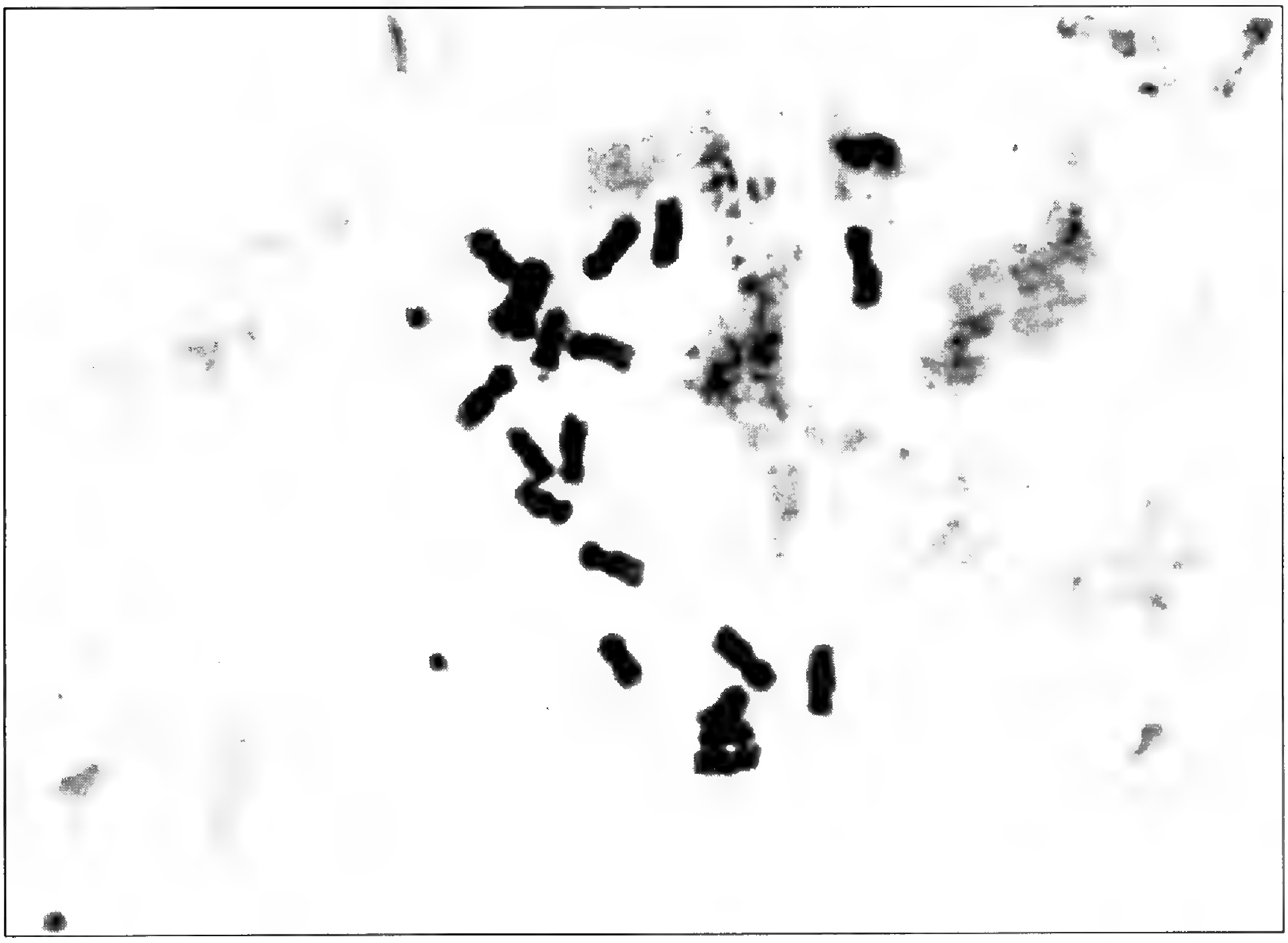

FIG. 1. Mitotic chromosomes of root-tip cells from germinating seeds of *Cornus sessilis* Torr. ($2n=20$, Metaphase).

Furthermore, a phylogenetic analysis of a combined molecular data set of the cpDNA restriction sites and the *rbc*L - *mat*K sequences (Xiang, unpubl.) also recognizes *C. sessilis* as a distinct lineage sister to a clade containing *C. mas*, *C. officinalis*, and *C. chinensis* with *C. mas* and *C. officinalis* as sister species. In addition, a cladistic analysis of *Cornus* using morphological data by Murrell (1993) suggested relationships within the cornelian cherries identical to those proposed by Eyde (1988). A high number of mutations were detected between *C. sessilis* and other cornelian cherries. For example, 11 restriction site mutations between *C. sessilis* and *C. mas* - *C. officinalis*, and a total of 22 mutations (including restriction site mutations and all base substitutions in *rbc*L and *mat*K) between *C. sessilis* and *C. mas* - *C. officinalis* - *C. chinensis* were found (Xiang et al. in press; Xiang unpubl.), suggesting an early divergence of the species in the cornelian cherry group. A different chromosome number in *Cornus sessilis* ($2n=20$ rather than $2n=18$) and the morphological divergence of the species also support a long history of isolation of *C. sessilis* from other cornelian cherries.

The cornelian cherries have long been known to have a chromosome number of $2n=18$, which was reported for *Cornus mas* and *Cornus officinalis* (Dermen 1932; also see Ferguson 1966b). The chromosome numbers of the other three species in this group have remained unknown. In *Cornus*, a chromosome number of $2n=20$ has also been documented in the two alternate-leaved, blue-fruited dogwoods, *C. controversa* Hemsley and *C. alternifolia* L. f.. In addition, $2n=22$ has been reported for the big-bracted dogwoods, the dwarf dogwoods, and the opposite-leaved, blue-fruited dogwoods (Bain & Denford 1979; Dermen 1932). The close relatives of *Cornus*, such as *Alangium*, *Mastixia*, and *Nyssa* have also been reported to have a basic chromosome number of $x=11$ (Goldblatt 1978). Therefore, $2n=22$ might be plesiomorphic in *Cornus*, and $2n=20$ and 18 both represent derived states as proposed by Eyde (1988). The molecular phylogeny of *Cornus* (Xiang et al. in press; Xiang unpubl.) is consistent with this hypothesis. The finding of $2n=20$ in *C. sessilis* provides new insight regarding the evolutionary trend of chromosome numbers in *Cornus*. Given the cpDNA phylogeny, the chromosome number of $2n=20$ could have evolved twice in the genus, once in the alternate-leaved blue-fruited species and once in the cornelian cherries before the divergence between *C. sessilis* and *C. chinensis* - *C. officinalis* - *C. mas*. The chromosome number of $2n=18$ found in *C. officinalis* and *C. mas* was derived from ancestors having $2n=20$ (see discussion in Xiang et al. in press).

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NOTES

NEW REPORTS OF *ERAGROSTIS* (POACEAE: CHLORIDOIDEAE) FROM BRAZIL—*Eragrostis* Wolf is the largest genus in the subfamily Chloridoideae (tribe Eragrostideae) with ±350 species occurring in the tropics and subtropics throughout the world (±120 in the New World and ±225 from southern Africa). There is no modern account of the entire genus and although the species appear very similar to one another, relationships within the genus are only speculative at this time. During preparation of the taxonomic revision of *Eragrostis* in Brazil, we became aware of nine species that were not reported in the literature (Allem & Valls 1987; Braga 1976; Pilger 1902; Usteri 1911). In addition, *Eragrostis paniciformis* and *E. tremula* are new records for the New World.

We consulted the literature for an indication of how common each of the nine species was in other countries. *Eragrostis macrothyrsa* and *E. orthoclada* are reported from Argentina, Bolivia, and Paraguay (Killeen 1990; Zuloaga et al.1994). *Eragrostis barrelieri* is mentioned as being introduced in United States, Mexico, Jamaica, Haiti, Puerto Rico, Dominican Republic, Virgin Islands, Uruguay, Argentina (Adams 1972; Beetle et al. 1991; Hitchcock 1936; Liogier & Martorell 1982), Africa (Gibbs Russell et al. 1991), Burma, India, Somalia (Cope 1995), Pakistan (Bor 196O), Canada, and Panama (Peterson & Harvey in press; Peterson in press). *Eragrostis pastoensis* occurs in Argentina (Zuloaga et al. 1994), Venezuela (Graterol et al. 1989), Colombia, Peru (Brako & Zarucchi 1993), Ecuador (Hitchcock 1927), Bolivia (Hitchcock 1927), Paraguay, and Uruguay (Peterson & Harvey in press; Peterson in press). *Eragrostis gangetica*, *E. lehmanniana*, *E. mokensis*, *E. paniciformis*, and *E. tremula* are primarily African species (Clayton 1972; Clayton et al. 1974; Gibbs Russell et al. 1991; Ibrahim & Kabuye 1987; Koechlin 1962; Zon 1992). In the New World, *E. gangetica*, *E.mokensis*, and *E. lehmanniana* are reported in Venezuela (Graterol et al. 1989). *Eragrostis gangetica* and *E. lehmanniana* are also found in the United States (Correll & Johnston 1970; Davidse 1994; Peterson & Harvey in press), with the latter species extending into Mexico (Lebgue & Valerio 1986) and the former found in Belize (Davidse 1994).

The following section lists the nine new records and includes information taken from the specimens.

Species Citations

1. **Eragrostis barrelieri** Daveau, J. Bot. (Morot.) 8:289. 1894. BRAZIL. No specific location,1892, *A.F.M.Glaziou 20119* (US 55412, 1162998).

2. **Eragrostis gangetica** (Roxb.) Steud., Syn. Pl. Glumac. 1:266. 1854. BRAZIL. Paraiba:

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Campina Grande, 24 Jun 1935, *B.Pickel 3832* (NY,US). Pernambuco (3 km to Jurema-Fazenda Boca da Mata), 780 m, 26 Jul 1966, *E.Tenorio 66-138* (NY,US).

3. **Eragrostis lehmanniana** Nees, Fl. Afr. Austral. Ill. 402. 1841. BRAZIL. Ceara: Fortaleza (Mostruario vivo do Instituto de Zootecnia), collector unknown (SP 165964).

4. **Eragrostis macrothyrsa** Hack., Repert. Spec. Nov. Regni.Veg. 8:47. 1910. BRAZIL. Mato Grosso: Miranda (a 6 km da sede da Fazenda Bodoquena, no Rumo ESE—Serra da Bodoquena), 12 Jun 1973, *T.S.Silva 100.107* (SP,US), *T.S. Silva 101* (SP).

5. **Eragrostis mokensis** Pilg., Bot. Jahrb. Syst. 51:419–420. 1914. BRAZIL. Minas Gerais: Ouro Preto (Vila Rica), 100 m, 7 Apr 1925, *A.Chase 9358* (NY,SP,US).

6. **Eragrostis orthoclada** Hack., Bull. Herb. Boissier ser.2, 4(3):281. 1904. BRAZIL. Mato Grosso do Sul: Anastacio, 22.Apr 1985, *Valls et al. 8657* (CEN); Aquidauana, 5 Apr 1986, *J.F.M.Valls et al. 9891* (CEN); Bela Vista, 18 Jun 1946, *J.Swallen 9469* (US), 21 Apr 1984; *J.F.M.Valls et al. 7654* (CEN); Corumba (on Rio Paraguai), 200–250m.,31 Apr 1930, *A.Chase 11124* (US). Miranda, 11 Jun 1973, *Silva 85B* (SP).

7. **Eragrostis paniciformis** (A.Br.) Steud., Syn. Pl. Glum. 1:268. 1854. BRAZIL. Sao Paulo: Caraguatatuba (3 km ao sul do Rio Mococa), 50 m, 27 May 1983, *J.F.M.Valls 7385, 7386* (CEN, ICN); 28 May 1986, *J.F.M.Valls 10270* (CEN, ICN). Sao Luiz do Paratinga, 940 m, 29 May 1986, *J.F.M.Valls et al. 10280* (CEN, ICN).

8. **Eragrostis pastoensis** (Kunth) Trin., Mem. Imp. Acad. Sci. Saint-Petersbourg, Ser. 6, Sci. Math., Seconde Pt. Sci. Nat. 2 (1):71. 1836. BRAZIL. Maranhao: Grajau to Porto Franco, 8–13 Mar 1934, *J.Swallen 3870* (US). Mato Grosso: Caceres, 25 Oct 1985, *J.F.M.Valls 9381* (CEN); Campo Grande, *E.F.Nienstedt 149* (US); Sao Paulo: Perus, 25 Mar 1907, *A. Usteri s.n.* (SP 10129).

9. **Eragrostis tremula** Steud., Syn. Pl. Glum. 1:269. 1854. BRAZIL. No specific location, 21 Nov 1952, *Camargo 6* (US 2205753).

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CAREX CONJUNCTA (CYPERACEAE) VERIFIED FOR ARKANSAS, AND NOTES ON THE RANGE OF *CAREX OKLAHOMENSIS*—Species of *Carex* subgenus *Vignea*, section *Vulpinae*, are plants of swampy sites, buffalo wallows, open-hydric roadside ditches, and wet meadows. Section *Vulpinae* is composed of about 17 species, eleven of which are widely distributed in North America (Mackenzie 1931).

Smith (1994) marked *Carex conjuncta* W. Boott as a possible addition to Arkansas but had no verifiable specimen. Its distribution has been given as New York and New Jersey to the District of Columbia, and westward to South Dakota and eastern Kansas (Mackenzie 1931). Gleason and Cronquist (1991) gave a similar distribution, New York to Minnesota and South Dakota, south to Virginia and eastern Kansas. Our collections verify *C. conjuncta* as occurring in Arkansas.

Until recently, the range of *Carex oklahomensis* was considered to be from SW Missouri (Steyermark 1963) and adjacent Kansas (Great Plains Flora Association 1991) south through western Arkansas and eastern Oklahoma to northeastern Texas (Mackenzie 1931; Jones et al. 1991). *Carex oklahomensis* was considered a hybrid by Smith (1988, 1994), and not mapped for Arkansas, but many Arkansas records for *C. stipata* belong here. This species is now known from Mississippi (Bryson et al. 1992, 1994). Reported here are recent collections extending its range to southeastern Missouri and into the "Boot Heel," and one isolated collection from western North Carolina. Almost all of the recent eastern records, including all the Mississippi records, are from along roadsides, suggesting that the species has recently spread eastward, rather than having been merely overlooked. *Carex oklahomensis* should be watched for in other southeastern states.

Both of these species are members of subgenus *Vignea* section *Vulpinae* and are characterized by distigmatic flowers, lenticular achenes, compound sessile androgynous spikes, and bidentate perigynia with beaks no more than half the length of the perigynial body.

Carex conjuncta grows to over one m tall with cespitose, erect but soft and easily crushed, somewhat spongy, winged, scabriously margined culms. It grows in damp woods and shady creek banks. The dorsal leaf sheaths are green with septate nodules; ventral leaf sheaths fragile, white with scattered red dots, and cross rugulose.

Carex oklahomensis is a loosely cespitose, stout, erect sedge growing to over one meter tall. Its habitat includes open wet sites, usually in calcareous or basic soils, and it is a facultative to obligate heliophyte. Its blue-green dorsal leaf sheaths with conspicuous white dots without septate nodules are characteristic. The perigynia are relatively short beaked in contrast to most species of section *Vulpinae.* In western Missouri, where some native prairies have been preserved, this taxon is frequently found in what appears to be historic buffalo wallows, however, it can also be found in open-hydric roadside ditches and along streams through prairies. In southeast Kansas, we found this plant along open-hydric roadsides.

As used in the following key, incomplete veins are veins that do not extend from the base of the perigynia to the apex. A heliophyte is a plant that is normally found in full sun; a sciophyte is a plant normally found in the shade. Although, all taxa are not in all states the following artificial dichotomous key is for section *Vulpinae* in the southeastern United States.

KEY TO *CAREX* SECTION *VULPINAE* IN THE SOUTHEASTERN UNITED STATES

1\. Beaks of perigynia shorter than the body
    2. Perigynia somewhat abruptly contracted into a beak ca. 1/2 the length of the perigynia body, ventral surface of perigynia with several incomplete veins basely; culms sharply triangular and narrowly winged, somewhat spongy and easily crushed; dorsal leaf sheath green; ventral leaf sheath with scattered red dots, transversely rugose; sciophytes .... *C. conjuncta*
    2. Perigynia tapering into a beak, much shorter than the perigynia body, ventral surface of perigynia with several inconspicuous complete veins; culms inconspicuously triangular to roundish without wings, not spongy and not easily crushed; dorsal leaf sheath dark blue-green with conspicuous white dots; ventral leaf sheath without scattered red dots, not transversely rugose; heliophytes .... *C. oklahomensis*
1\. Beaks of perigynia as long as or longer than the body
    3. Ventral leaf sheath margins with orange-red dots; achenes ovate-lanceolate; perigynial wall adhering to achene .... *C. crus-corvi*
    3. Ventral leaf sheath margins without orange-red dots; achenes broadly ovate to ovate-orbicular; perigynial wall little to not at all adhering to achene
        4. Ventral leaf sheath transversely rugose, ± convex at apex and prolonged upward past the base of the blade, friable; [this includes *C. uberior* (C. Mohr) K. Mackenzie = *C. stipata* var. *maxima* A. Chapman] .... *C. stipata*
        4. Ventral leaf sheath not transversely rugose, ± concave at apex and not prolonged upward past the base of the blade, thickened, not friable .... *C. laevivaginata*

Specimens collected: (*Carex conjuncta*) ARKANSAS. **Benton Co.**: NE side of Osage Creek and US 412/AR 68, E of Siloam Springs, mesic woodland edge along berm of creek, elev. ca. 335 m, 26 May 1994, *S. & G. Jones 11139* and *A. A. & S. A. Reznicek* (BRCH, MICH, UARK). N side I-412, on E side of Osage Creek, ca. 9 mi E of Siloam Springs, sect. 33, T18N, R32W, 4.1 mi W of the Washington Co. line, wet creek bottom pasture meadow, elev. ca. 335 m, 26 May 1994, *A. A. Reznicek 9792* and *S. A. Reznicek. S. D. Jones*, and *G. D. Jones* (BRCH, MICH, MO, UARK). Associated species included other *Carex* spp., *Elymus* spp., *Juncus*, *Scirpus*, *Scleria*, *Plantago*, *Laportea*, *Festuca*, and *Verbesina*.

Specimens collected: (*Carex oklahomensis*) MISSOURI. **Dunklin Co.**: E side Co. rd 203, NW, sect. 22, T22N, R82, ca. 7 mi NW of Campbell, 22 May 1993, *A. A. Reznicek et al. 9432* (BRCH, ctb, KNK, MICH, MO). **Stoddard Co.**: Dudley, Crowley Ridge Roadside Park, along N side rte. 50, 22 May 1988, *Naczi 1962* (MICH); S side of US 60, 1.4 mi W of jct with Co. rd TT at Dudley, 22 May 1993, *Reznicek et al. 9420* (BRCH, ctb, KNK, FTG, GENT, MICH, MO, VDB, VPI). NORTH CAROLINA. **Graham Co.**: along road to Joyce Kilmer Memorial Forest, 7.6 mi from jct with Hwy 129 at Robbinsville, 15 May 1984, *Reznicek & Reznicek 7339* (MICH, NCU, NY).

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NOTEWORTHY PLANT SPECIES FROM THE OKEFENOKEE SWAMP, GEORGIA—The Okefenokee Swamp is located on the Atlantic Coastal Plain in southeast Georgia and northeast Florida. The swamp surface area of 3826 km^2 includes parts of Ware, Clinch, Charlton, and Echols counties, Georgia, and Baker County, Florida. There are a number of distinct habitat types within the swamp, including swamp forests, tree and shrub islands, grass-sedge marshes, emergent macrophyte marshes, and open lakes (Greening & Gerritsen 1987). Sand and peat are the two soil types in the swamp. Marine or lacustrine sandy soils occur in large islands, uplands, and immediately east of the Suwannee River Sill, i.e. a low earthen dam impounding the Suwannee River (Parrish & Rykiel 1979). The majority of the swamp substrate is peat (96% organic matter) up to 5m deep (Cohen 1973).

The flora of Okefenokee has been of interest to botanists since the early 1900s when Roland M. Harper made the first extensive investigation of the swamp vegetation (Trowell 1988). Over the following years further description of the swamp flora has been provided by Wright and Wright (1932), Cypert (1961; 1972; 1973), and Schlesinger (1978). The most comprehensive checklist of the vascular plants of Okefenokee was compiled by Loew and Jones (1984) from plant surveys conducted during the growing seasons of August 1978–September 1980. Their checklist documents 101 species of vascular plants representing 53 families.

The large surface area and inaccessibility of remote regions of the Swamp have hindered comprehensive botanical surveys. As a result a few species, particularly sedges, have been overlooked. This manuscript documents species which should be added to the checklist of vascular plants occurring in the Okefenokee Swamp, Georgia.

The observations reported herein result from more than two years (July 1992–December 1994) of collecting and observations made in conjunction with a project entitled "The Effects of Hydrologic Alterations on the Ecology of the Okefenokee Swamp" (Loftin et al., unpublished data). Plants were collected by various methods. Many specimens were collected during species composition, biomass, and cover estimates along 80 permanent transects established in four emergent macrophyte prairies (Chesser, Durdin, Floyd's, and Sapling Prairies), and the Suwannee River floodplain near the Sill. Some specimens were obtained as seedlings germinating from soil cores collected along the permanent transects. These soil cores were used in seed bank experiments, and seedlings were germinated from the cores under greenhouse conditions near the Suwannee Canal Recreation Area (Charlton Co., Georgia). Before harvesting the sample, the seedlings were grown until an inflorescence was produced. Many specimens were also collected during routine forays in and around the swamp.

NOTEWORTHY SPECIES

The following is a list of nine noteworthy species collected from the Okefenokee Swamp during the course of our investigations. Although most specimens (except *Rhynchospora alba)* are fairly common species reported previously in Georgia, there is no documentation for these species from the Okefenokee Swamp. These species should be added to the checklist of vascular plants of Okefenokee. Voucher specimens for those species described herein have been donated to the herbaria of the University of Georgia, Athens (GA), and the University of Florida, Gainesville (FLAS). As noted previously, some specimens were obtained from soil cores during seed bank experiments. For these specimens, the locality stated is the site were the soil core was obtained. Although all species described herein were observed in the field, the soil core specimens were of herbarium-quality. Nomenclature follows that of Godfrey and Wooten (1979a, b).

Poaceae

Erianthus giganteus (Walt.) Muhl. Georgia. Charlton Co.: 1.6 km N of Dinner Pond, 500 mi E of Sapling Prairie boat trail, 15 Dec 1994, *Loftin & O'Neill 138* (GA); Floyd's Prairie, Okefenokee NWR, 28 Oct 1992, *Williges & Loftin 20a* (FLAS); *Williges & Loftin 20b* (GA). *Erianthus giganteus* is a cool season grass flowering September–October (Radford et al. 1968). It is fairly common and found growing throughout most prairies of the swamp. Although Loew and Jones (1984) reported collecting *E. brevibarbus* Michx. during their surveys, we have yet to observe this species in the field. Because Loew and Jones (1984) collected during the growing season, they may have overlooked *E. giganteus* since it is most conspicuous in the fall. It is questionable whether *E. brevibarbus* actually occurs in the swamp. *E. giganteus* has been previously reported from Charlton County (Jones & Coile 1988).

Cyperaceae

Carex verrucosa Muhl. Georgia. Ware Co.: 650 m E of Craven's Hammock Island, 300 rn S of Craven's Lake, 14 Jan 1993, *Williges & Loftin 46* (FLAS); Suwannee Creek Bridge on Swamp Perimeter Road, ca 200 m S of Piney Woods Lake, 200 m N of Suwannee Lake, 31 Aug 1993, *Williges & O'Neill 2.09* (GA). Because this species prefers sandy sites in the refuge, it is not found in the "swamp proper," i.e. where peat soils predominate. For this reason, it has been excluded from previous swamp studies. Since this species is common in relatively shallow water east of the Suwannee River Sill, it should be included in the flora of Okefenokee. These specimens represent new records for Ware County (Jones & Coile 1988).

Cyperus erythrorhizos Muhl. Georgia. Charlton Co.: ca 900 m E of the Suwannee River Sill, 900 m S of Mack's Island, 16 Sep 1993, *Williges, Loftin & O'Neill 111* (GA), *Williges, Loftin & O'Neill 1.12* (FLAS). Although these voucher specimens were grown from soil cores, this species has been observed growing in disturbed swamp sites, such as floating peat recently dredged from the canoe trails of Chesser Prairie. These specimens are new records for Charlton County (Jones & Coile 1988).

Eleocharis vivipara Link. Georgia. Charlton Co.: ca 20 m E of the Sapling Prairie Boat Trail, 2.4 km N of Dinner Pond, 25 May 1993, *Williges, Loftin, & O'Neill 68* (FLAS); Georgia. Ware Co.: ca 3.5 km *NE* of Suwannee River Sill, on Craven's Hammock Canoe Trail, 19 Apr 1994, *Williges & O'Neill 127* (GA). These specimens represent the few *E. vivipara* we observed with mature spikelets. *Eleocharis vivipara* is one of four spikerush species that reproduce vegetatively by shoots produced from sterile spikelets at the culm apex (Ward & Leigh 1975). Submersed mats of vegetatively reproducing *Eleocharis* are common directly east of the Suwannee River Sill. Most of our collections in this area are either *E. vivipara* or undetermined species. Loew and Jones (1984) reported collecting *E. baldwinii* (Torr.) Chapm., also a submersed, vegetatively reproducing species. We suspect that both *E. vivipara and E. baldwinii* are found in the swamp, and possibly a third species, *E. microcarpa* Torr., with species dominance determined by hydrologic conditions.

Rhynchospora alba (L.) Vahl. Georgia. Charlton Co.: Durdin Prairie ca 1.5 km S of Flag Lake, 100 rn W of boat trail, 16 Sep 1993, *Williges, Loftin & O'Neill 110* (FLAS); Durdin Prairie ca 300 rn SE of Durdin Lake, 100 m NE of boat trail, 24 Sep 1993, *Williges, Loftin & O'Neill 114* (GA). These specimens represent the first records of this species from Southeast Georgia and are the southernmost records in the U.S. Prior records of *R. alba* exist for Rabun County in the Blue Ridge province of northeast Georgia (Duncan & Kartesz 1981). Of interest is that the habitat of *R. alba* in Okefenokee is not what is commonly associated with this species in other regions. According to Gale (1944), *R. alba* is considered rare in Virginia, and found southward only in scattered mountain bogs of West Virginia, North Carolina, and Puerto Rico. Godfrey and Wooten (1979a) state this species is found in open, sphagnous bogs from Newfoundland to Maryland, and south in the mountains to North Carolina. Radford et al. (1968) report this species is very rare in North Carolina. Our voucher specimens were germinated from soil cores collected from Durdin Prairie. Although it is not common, we have observed *R. alba* growing in the southern edge of Durdin Prairie, where the white scales of this species make it fairly conspicuous. Durdin Prairie is one of the least studied regions of the swamp. The unstable floating vegetation mats characteristic of the prairie make travel in this area extremely difficult without the aid of air boats. For this reason few plant investigations have been done in this region, which may explain why this species has been overlooked. We have also found this species reproducing in Southeast Chesser Prairie. Although this prairie in general has a more solid, submersed peat substrate, the prairie fringe consists of floating peat mats similar to those found throughout Durdin Prairie. The Chesser Prairie samples were found in this floating peat mat fringe.

Rhynchospora cephalantha Gray. Georgia. Charlton Co.: Floyd's Island Prairie, 700 m E of Suwannee River, 100 m N of Floyd's Prairie Canoe Trail, 20 Jul 1993, *Williges & Loftin 88* (FLAS); *Williges & Loftin 89* (GA). Loew and Jones (1984) reported collecting four species of *Rhynchospora: R. fascicularis* (Michx.) Vahl, *R. inundata* (Oakes) Fern., *R. microcephala* Britt. ex Small, and *R. wrightiana* Boeck. *Rhynchospora cephalantha* and *R. microcephala* are similar in general features and are not always distinguishable (Godfrey & Wooten 1979a). Records of *R. phalantha* have been reported from Charlton and Echols counties (Jones & Coile 1988). Although we have not observed *R. microcephala* in the swamp, it is possible both species are present. Therefore, it is likely that six species of *Rhynchospora* occur in the Okefenokee Swamp.

Scleria reticularis Michx. Georgia. Charlton Co.: Floyd's Island Prairie, ca 700 m E of Suwannee River, 100 rn N of Floyd's Prairie Canoe Trail, 18 Aug 1993, *Williges, Loftin & O'Neill 102* (FLAS). Ware Co.: Chesser Prairie, ca 700 m W of Seagrove Lake, 700 rn E of boat trail, 4 Aug 1993, *Williges, Loftin & O'Neill 100* (GA). These specimens were germinated from soil cores and represent new records for Ware and Charlton counties (Jones & Coile 1988). *Scleria reticularis* has also been found on exposed, floating peat mats in south Chesser Prairie. Its occurrence in the field corresponds to periods of summer drawdown, when the peat surface becomes exposed.

Juncaceae

Juncus repens Michx. Georgia. Charlton Co.: Suwannee River Sill area, ca 300 m E of Middle Island, 24 May 1993, *Williges, Loftin & O'Neill 62* (FLAS); Suwannee River Sill area, ca 1100 m SE of Pine Island, 24 May 1993, *Williges, Loftin & O'Neill 63* (GA). These voucher specimens were germinated from soil cores in which they produced a diagnostic inflorescence.

This species is commonly found in relatively shallow water and sandy soils near the Suwannee River Sill and the Craven's Hammock canoe trail. We have observed only the submersed form in the field, spreading by rooting at the nodes, without flowering stems. It usually does not flower unless exposed during a drawdown (Godfrey & Wooten 1979a). This species is not found in the swamp proper, but should be included in the Okefenokee flora due to its commonness within the refuge. *Junucs repens* has been previously collected from Charlton and Ware counties (Jones & Coile 1988).

Onagraceae

Ludwigia alata Ell. Georgia. Charlton Co.: Suwannee River Sill area, ca 300 m E of Middle Island, 19 Jul 1993, *Williges, Loftin & O'Neill 83* (FLAS); *Williges, Loftin & O'Neill 84* (GA). This species is frequent in sandy soils near the Suwannee River Sill. *Ludwigia alata* is usually found along the edge of canoe trails in relatively shallow water, frequently established on floating logs, and produces numerous, submersed, basal stolons. Previous field collections consisted of the stoloniferous form only, and it was not until our voucher specimens germinated from soil cores that we obtained specimens with mature flowers. It is a frequently occurring plant in the western portions of the refuge on sandy sites. These specimens are new records for Charlton County (Jones & Coile 1988).

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DESMODIUM LINDHEIMERI (LEGUMINOSAE) IN MEXICO AND TEXAS—When first described, *Desmodium lindheimeri* Vail (1891) was known from only four collections: three from Mexico and one from Texas. Since then, many more collections have been made, making it possible to draw conclusions about the range and habitat of this species.

Label data on the sheets in the University of Texas collection (LL, TEX), combined with the localities cited by Vail, indicate that the primary range of *D. lindheimeri* lies in Mexico in the states of Coahuila, Nuevo Leon, San Luis Potosi, and Tamaulipas (Fig. 1). *Desmodium lindheimeri* is usually found at an altitude of 1,000–2,000 m in Mexico. Of 27 Mexican collections in the University of Texas herbarium, only four were found below 1,000 meters. These were in Nuevo Leon at 985, 800, 600, and 450 meters. A majority of the collections were made in pine or oak forests and sometimes in a mixed pine/oak association. Plant associates include *Quercus muhlenbergii* Engelm., *Quercus gravesii* Sudw., *Quercus glaucoides* Mart. & Gal., *Colubrina greggii* Wats., *Ungnadia speciosa* Endl., *Acacia berlandieri* Benth., *Zanthoxylum fagara* (L.) Sarg., *Fraxinus cuspidata* Torr., *Ostrya virginiana* (Mill) K. Koch, *Acer grandidentatum* Nutt., *Carya ovata* (Mill) K. Koch, *Juglans major* (Torr.) Heller, and *Populus tremuloides* Michx. The bloom period is apparently from early August through October, possibly into November. Flower color is usually whitish to pale pink, though occasionally rose-pink to purple. The stems are up to 2 m long.

In contrast to the situation in Mexico, the passage of time has not produced numerous collections of *D. lindheimeri* from a similarly broad area in Texas. Until recently, this taxon had not been collected at all in Texas since Lindheimer's Comal County collection in November 1850. On March 12, 1992, the author found a population of *D. lindheimeri* in Comal County, Texas, distributed along the rocky bed of a dry ravine, here designated Locality 1 (precise locations of all Texas populations withheld). On October 15, 1995, populations were found at two other localities. Locality 1 lies on the midpoint of a line drawn between Locality 2 and Locality 3, which are 10 km apart. Distribution along this 10 km line, which crosses several separate ravine systems, is probably more or less continuous. The populations are at an altitude of about 270 m.

At Locality 1, the majority of plants are distributed along the rocky bed of a ravine with a few found among brush on the banks 0.3–1.3 m above the dry ravine bed. The author has walked a little over one kilometer of this ravine and found the plants scattered throughout, as well as along one-third kilometer of a side ravine. It is apparent that *D. lindheimeri* is a favorite of the local deer population, with about 80% of the plants suffering

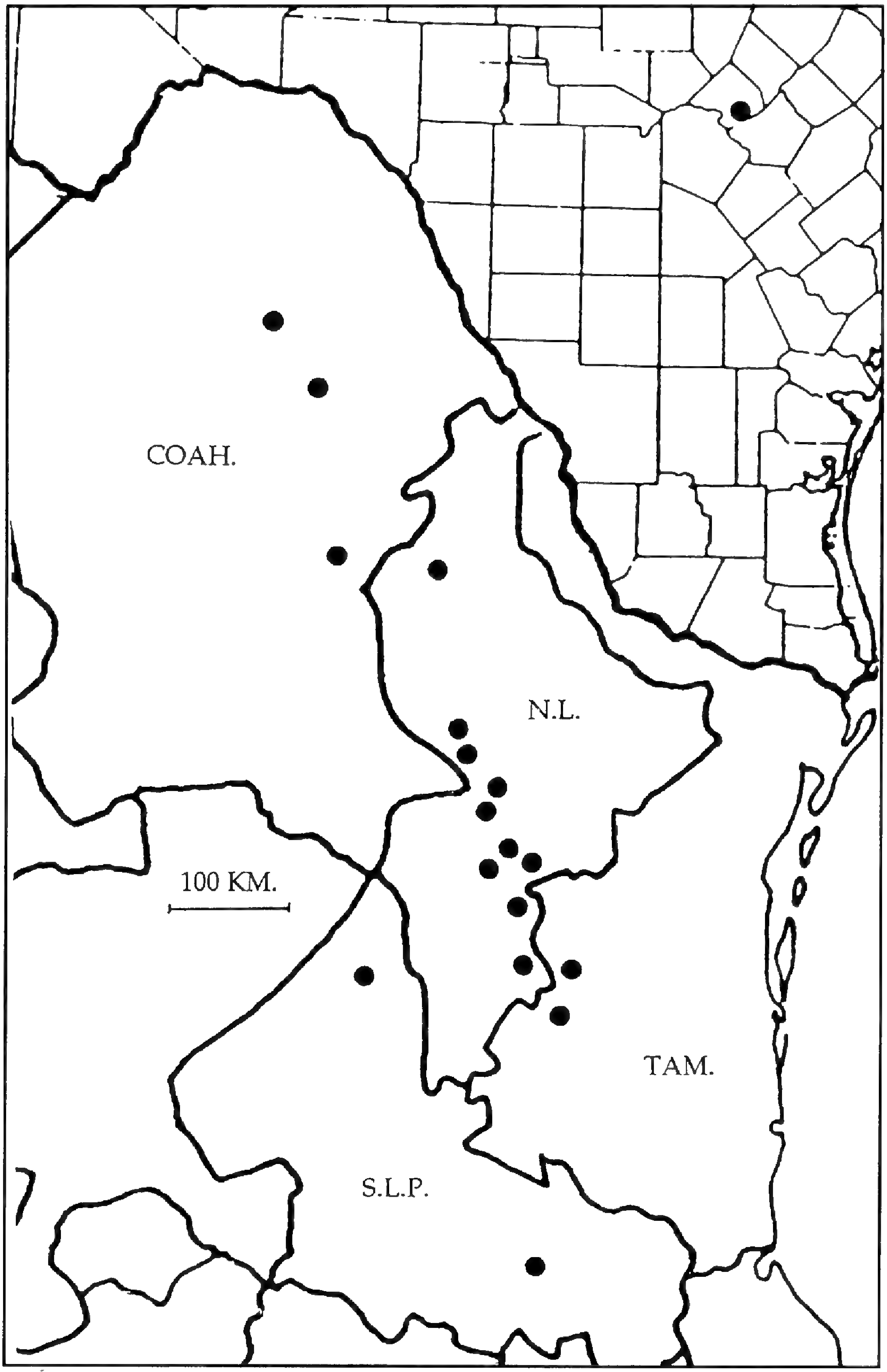

FIG. 1. Documented distribution of *Desmodium lindheimeri* Vail.

browsing severe enough to prevent successful flowering and fruiting. At Locality 2, the plants occur on the very steep, tree-covered, 6–12 m high bank of a ravine but not in the bed of the ravine. At this site, the steep bank and uncertain footing combine to protect the plants from deer. Here, for 0.4 kilometer, about 90–95% of the plants are flowering and fruiting unmolested. At Locality 3, the plants are distributed in three clusters along the roadway for 200 m. They grow on flat ground in dry caliche, protected from the afternoon sun by the shade of the treeline. This right of way was probably colonized by plants from adjacent ravines. Whether due to nearby homes or a high volume of road traffic, the plants at this locality are almost untouched by deer and are producing an abundance of fruit. At all three sites, the plants range from 0.5 to 1.3 m tall, often with partially decumbent stems to 2 m long.

There does not appear to be anything remarkable about the habitat in which these Texas plants are found. It is a live oak/juniper association found throughout much of the Edwards Plateau consisting of *Quercus fusiformis* Small and *Juniperus ashei* Bucch. with *Quercus texana* Buckl., *Ungnadia speciosa* Endl., *Ulmus crassifolia* Nutt., *Croton fruticulosus* Torr., *Rhus toxicodendron* L., *Aloysia gratissima* (Gill. & Hook.) Troncoso, *Pavonia lasiopetala* Scheele, *Forestiera pubescens* Nutt., and *Bernardia myricifolia* (Scheele) Wats. In Texas, *D. lindheimeri* is abundant where found and seems to be a weedy, adaptable species which does well in a variety of habitats. It is surprising, then, to find it apparently restricted to a small area of Comal County.

Members of this genus are known by the common name "tickseed" because of the tenacity with which the hooked hairs of the loments attach themselves to clothing and animal hair, and, are well-known for ensuring seed dispersal through animal transport. Although it is possible that the Comal County material represents a disjunct relictual population (Nesom 1993), it is also possible that *D. lindheimeri* was one of the first plant invaders of Texas. Northeastern Mexico was the natural trading partner of the San Antonio region of Texas through the Eighteenth Century into the early Nineteenth Century. There was no shortage of candidates, animal or human, for seed transport.

In 1689, Alonzo de Leon, the governor of Coahuila, reached the general area of present day San Antonio (Williams 1979). Only two years later, in 1691, Don Domingo Teran de Los Rios left the main body of his expedition behind, and with four companions, visited the Comal Springs in what is present day Landa Park in New Braunfels. The Espinosa-Olivares-Aguirre Expedition, in 1709, discovered the San Pedro Springs and the San Antonio River and then passed through present day New Braunfels. The Domingo

Ramon Expedition, in May of 1716, camped at the site of present day New Braunfels.

While on a trading trip to Saltillo, Coahuila, a resident of San Antonio de Bexar wrote in a letter dated January 6, 1827, "To me there is nothing more agreeable than to wake in the morning, when among the mountains, and listen to the bleating of the calves and lambs, the lowing of the cows, the braying of the mules and donkies, and to behold the bakharas herding the cattle, the horses and mules, while on every cliff and rock, sheep and goats may be seen sporting from rock to rock, and leaping over every dangerous cliff. .... The exports of this country are wool, cochineal, and fruits; besides this a vast number of mules are driven into the States for sale." (Dewees 1852). Certainly, there were opportunities for seed dispersal from Mexico to Texas and colonization by *D. lindheimeri* prior to Lindheimer's collection of 1850.

The University of Texas collection of this taxon was greatly augmented several years ago when Dr. Guy Nesom reviewed the Mexican *Desmodium* and found numerous misidentified sheets of *D. lindheimeri.* These collections, combined with the recent Texas collections, make it possible to update and modify the description of the species.

Desmodium lindheimeri Vail, Bull. Torrey Bot. Club 18: 120. 1891.

Meibomia lindheimeri (Vail) Vail, Bull. Torrey Bot. Club 19:111. 1892.

Erect branching perennial herb 4–15(–18) dm tall; stem angulate, grooved, uncinulate-puberulent and -pubescent and sparsely scattered-pilose with slender white trichomes; stipules ovate, long-attenuate, densely pilose on the outer surface with long white trichomes, reflexed at maturity, not long persistent, 6.5–8 mm long, 1.5–2 mm wide; stipels slenderly lance-attenuate, 1.5–2 mm long; petioles densely uncinulate-puberulent and -pubescent and somewhat long spreading-pilose, 14–35(–45) mm long; leaf rachis similar, 6–15(–19) mm long; leaflets acute at apex, cuneate to obtuse at base, uncinulate-puberulent and more or less soft white-pilose above, densely long and soft white-pilose or tomentose below with prominent venation; terminal leaflet ovate to mostly rhombic in outline, 5–9(–10.5) cm long, 3–5.8(–7) cm wide; lateral leaflets more nearly ovate or elliptic, somewhat asymmetrical, 4.3–6(–7) cm long, 2–4 cm wide; inflorescence paniculate, the rachis ridged and grooved, uncinulate-puberulent and -pubescent; primary bracts ovate-attenuate, striate, long appressed pilose on outer surface, ciliate, glabrous within, not long persistent, 4.5–9 mm. long, 2–3 mm wide; secondary bracts essentially glabrous but ciliate, 0.8–3 mm long, 0.8–1 mm wide; pedicels rather finely pilose with multicellular trichomes which are glandular at base; flowers pinkish-white to pale pink, occasionally rose-pink to purple; calyx finely puberulent, somewhat ciliate, the long white trichomes along central tooth of lower lobe reaching 3 mm in length; corolla to 7 mm long; loment stipitate, to 7-articulate; stipe 3–8 mm long; articles subrhombic to semiovate in outline, the isthmi slightly excentric, the articles appearing somewhat contorted because of the infolding of their margins, surfaces glabrous, reticulate at maturity, the suture densely uncinulate-puberulent, 7–11(–13) mm long, 5–8 mm wide; seeds 4–5(–6) mm long.

The relationship of this species is with *D. canescens* and its relatives, especially *D. ochroleucum* M.A. Curtis of southeastern United States, which it resembles particularly in the characters of the loments (Description adapted from Correll & Johnston 1970).

Specimens examined: MEXICO. Coahuila: Musquiz swamp, 15 Sep 1936, *E. G. Marsh, Jr. 917* (TEX); Musquiz Palm Canyon, 19 Sep 1936, *E.G. Marsh, Jr. 987* (TEX); Sierra de la Gloria, Canon El Cono, a side canyon of C. Chilipitin draining in from N near El Chilipitin, at lowest pouroff in steep-walled limestone canyon, 6 Sep 1976, *T. Wendt & D. Riskind 1610 & 1618* (TEX); Mpio. de Musquiz, In sheltered moist drainage of next spring WNW of "slump" spring, 24 Aug 1975, *T. Wendt, E. Lott, & D. Riskind 1313* (TEX). **Nuevo Leon**: Ejido Santa Rosa, Mpio. Iturbide, 29 Aug 1989, *A. Eduardo Estrada C. 1648* (TEX); Mountains near Monterrey, JUL 1933, *C.H. & M.T. Mueller 491* (TEX); Rio Ramos en el municipio de Allende, 17 Sep 1983, *A. Rodriguez, M.A. Carranza, & Grupo ICCAC 958* (TEX); Mpio. Villaldama, Sierra Gomas, in Canyon El Alamo on limestone talus, 15 Aug 1988, *T.F. Patterson 6757* (TEX); Galeana, Haciendo Pablillo, 26 Aug 1936, *M. Taylor 243 & 219* (TEX); Areas cercanas a Cola de Caballo, cercana a corrientes de agua, no date, *J.A. Villarreal, M.A. Carranza & M. Vasquez R. 2861* (TEX); Mpio. Linares, near Ejido Los Alamos, 7.2 mi S of Mex. 60, 28 Oct 1982, *J. Grimes with K. Nixon, L. Dorr, & S. Sundberg 2370* (TEX); Mpio. Iturbide, in a gully NW of Ejido Santa Rosa, 4.1 mi S of Iturbide, Loma la Banderra, 25 Oct 1982, *J. Grimes with K. Nixon, L. Dorr, & S. Sundberg 2334* (TEX); Iturbide to Camarones, 6 Sep 1991, *Hinton et al. 21392* (TEX); Mpio. de Montemorelos, La Trinidad, 19 Aug 1939, *C.H. Muller 2833* (TEX); Iturbide to Camarones, 17 Sep 1991, *Hinton et al. 21545* (TEX); N of Aramberri, 9 Sep 1990, *Hinton et al.* 20589 & 20556 (TEX); North of Mpio. Villa de Santiago, Canon la Boca, camino a Cola de Caballo-Laguna de Sanchez, 10 Sep 1983, *J.A. Villareal, M.A. Carranza, & M. Moreno 2360* (TEX); Mpio. Montemorelos, 5 km SE of La Trinidad, on eastern side of Sierra Cebolla, near Ojo de Agua, 7 Aug 1988, *T.F. Patterson 6278* (TEX); Monterrey, in canyon above El Diento, Oct 1961, *R. F. Smith M581* (TEX). **Tamaulipas**: Mpio. Hidalgo, road from Sta. Engracia toward Dulces Nombres, N.L., 0.3 road mi W of Paraje de Los Caballos, 11.4 road mi E of Dulces Nombres, 4.6 road mi from crossing of deep canyon of Arroyo Ramirez Luna, N-facing slope, 21 Sep 1994, *G. Nesom with M. Mayfield & J. Hinton 7462* (TEX); Hidalgo, Puerto Purificacion, 23 Sep 1994, *Hinton et al. 24837* (TEX); Hidalgo, Los Caballos, 21 Sep 1994, *Hinton et al. 24812* (TEX); 11 mi by road W of Victoria toward Jaumave, 29 Sep 1959, *M.C. Johnston & J. Graham 4120* (TEX).

U.S.A. **TEXAS: Comal Co.**: New Braunfels, NOV 1850, *F. Lindheimer 765a (= L. 499)* (LL); Locality 1, 12 Mar 1992, *M. Enquist 2089* (TEX), 19 Mar 1992, *M. Enquist 2116*

(ANSM, BRIT, GH, MEXU, MO, SRSC, TAES, TEX, UVST), 28 Oct 1994, *M. Enquist 2593* (ANSM, BRIT, GH, MEXU, MO, SRSC, TAES, TEX, UVST), cultivated in Texas Tech Greenhouse, material from Locality 1 in Comal County, 31 Oct 1994, *M. Enquist 2596* (BRIT, GH, MEXU, MO, TAES, TEX); Locality 2, 15 Oct 1995, *M. Enquist 2890* (ANSM, BRIT, GH, MEXU, MO, SRSC, TAES, TEX, UVST); Locality 3, 15 Oct 1995, *M. Enquist 2892* (BRIT, GH, MEXU, MO, TAES, TEX).

ACKNOWLEDGMENTS

I would like to thank Janet Atyia, Cynthia McKenney, and Kevin Mitchell of the Plant & Soil Science Department of Texas Tech for their expert cultivation of *D. lindheimeri* from Comal County. The Comal County material cultivated in the Texas Tech greenhouse was, in December 1994, placed in the care of Paul Cox of the San Antonio Botanical Gardens. My thanks to Paul and the staff of the San Antonio Botanical Gardens for accepting these plants and continuing their cultivation.

—Marshall Enquist, 11511 Metric Blvd. #1033, Austin, TX 78758, U.S.A.

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VALIDATION OF *TACHIGALI MICROPETALA* (DUCKE) ZARUCCHI & PIPOLY (FABACEAE: CAESALPINIOIDEAE)—An inadvertent error caused the recently published new combination of *Tachigali micropetala* (Ducke) Zarucchi & Pipoly to be invalid (Pipoly 1995). The International Code of Botanical Nomenclature (Greuter et al. 1994) Article 33.2 clearly states, "A new combination or avowed substitute (nomen novum), published on or after 1 January 1953, for a previously and validly published name is not validly published unless its basionym or the replaced synonym is clearly indicated and a full and direct reference given to its author and place of valid publication with page or plate reference and date." The article mistakenly left off the volume, page number and date of the article in which the basionym was published.

The correct combination is validated below:

Tachigali micropetala (Ducke) Zarucchi & Pipoly, comb. nov. BASIONYM: *Sclerolobium micropetalum* Ducke, Bol. Tech. Inst. Agron. Norte Belém 2:20. 1944. TYPE. BRAZIL. AMAZONAS: Manaus, without date, *A. Ducke 1219* (SYNTYPES: K, MO, NY).

I thank Dr. K. N. Gandhi of the Gray Herbarium of Harvard University for kindly pointing out this unfortunate error.

—*John J. Pipoly III, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, Texas 76102-4060 U.S.A.*

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GREUTER, W., F.R. BARRIE, H.M. BURDET, W.G. CHALONER, V. DEMOULIN, D.L. HAWKSWORTH, P.M. JØRGENSEN, D.H. NICHOLSON, P.C. SILVA, P. TREHANE, and J. MCNEILL (eds.). 1994. International code of botanical nomenclature (Tokyo Code). Regnum Veg. 131:1–389.

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ANNOUNCEMENT

THE BARBARA J. HARVILL BOTANICAL RESEARCH FUND FOR FLORISTIC RESEARCH IN VIRGINIA

Small research grants for floristic field work in Virginia and/or travel to herbaria are available to botanists without an institutional base of support for such work. This fund was endowed by friends and family of the late Barbara J. Harvill to encourage floristic and revisional work in Virginia. Most awards requested to date have been for mileage costs, but other expenses, such as lodging and certain kinds of field equipment (plant presses, for example) can also be covered.

Please send your letter of application for 1996 awards by May 15 to Donna M.E. Ware, Sec., Virginia Botanical Associates, Department of Biology, College of William and Mary, Williamsburg, VA 23187. Awards will be made by June 15, 1996.

SIDA 16(4): 788. 1995

BOOK NOTICES

Catalogue of the Library of the Massachusetts Horticultural Society. 1994? Facsimile of the 1918-1920 first editon. Maurizio Martino Publisher, 746 Mansfield City Road, Mansfield, CT 06268. $150.00. 587 pp, hbk.

The catalogue is divided into two parts. Part I consists of the Preface, Explanation of Abbreviations and Signs, Author Catalogue, Additions, and Further Additions. Part II is Table of Subjects, Subject Catalogue, Corrections, and Index. Included in the Table of Subjects are the following subjects: 1) Works of Reference, 2) Horticulture, 3) Trees and Shrubs, 4) Agriculture, 5) Economic Plants, 6) Soils, 7) Entomology, 8) Plant Pathology, 9) Botany, 10) Natural History, 11) Rural Life and Plant and Garden Lore, 12) Voyages and Travels, 13) Evolution, 14) Addresses, 15) Color and Design, and 16) Miscellaneous Publications.

GARRETT, J. HOWARD. 1995. **The Dirt Doctor's Guide to Organic Gardening: Essays on the Natural Way.** (ISBN 0-292-72780-1, hbk; 0-292-72781-x, pbk). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819. $14.95 (pbk), $35.00 (hbk). 232 pp, 5$^1/_2$" x 8$^1/_2$".

From the Introduction: "A truly organic program, on the other hand, is built around a 'healthy' philosophy and has the primary goal of establishing a natural balance of soil, water, air and biology. Looked at in the simplest terms, an organic program increases the air and the organic matter in the soil, uses naturally balanced fertilizers, keeps all bare soil mulched, and increases soil life and insect life."

If you want to go natural with your gardening, then this is the book for you. "Plant growers of all kinds are turning to organic products and procedures for vigorous, healthy plants. Since 1988, J. Howard Garrett has been in the forefront of the organic gardening movement, dispensing well-tested advice through 'The Natural Way,' his radio program and column in the *Dallas Morning News*. In this expert guide, he offers a complete program for organic gardening."

The book is a compliation of revised versions of some of the author's past columns, stories, articles, speeches, and thoughts on what he calls 'The Natural Way.' However, the book reflects new concepts, new science, and new techniques. These 'new essays' have been rewritten to be clearer, more accurate, and more up-to-date.

Here is what you will find in those 232 pages of essays: 1) Basics of Organics, 2) Soil Management, 3) Fertilization, 4) Pest Control, 5) Organic Landscaping, 6) Food Crops, 7) Wildlife, and an Index.

BOOK REVIEWS

BENJAMIN, DENIS R. 1995. **Mushrooms: Poisons and Panaceas.** (ISBN 0-7167-2600-9, pbk). W. H. Freeman and Company Publishers, 41 Madison Avenue, New York, NY 10010. $34.95. 422 pp, 32 color photographs, 27 b/w illustrations, 6" x 9".

This is a must buy book for libraries, poison control centers, mushroom clubs, mycologists, toxicologists, hospital emergency room physicians and staff, and amateur and professional naturalists. The book is divided into three major parts: 1) mushrooms and health; 2) mushroom poisoning, and 3) mushroom poisoning syndromes. The reader will also find four appendices: 1) a discussion of the chemistry of mushroom toxins and methods of their analysis; 2) a listing of national and regional field guides for mushroom identification; 3) a geographical listing of mycological associations and consultants; and 4) a reference list of mushroom cookbooks.

The author covers the history of mushroom consumption and differing cultural attitudes towards mushrooms in a delightful, engaging, and humorous way. He has not only selected fascinating anecdotal examples of cultural attitudes but is a good storyteller. He then goes on to discuss the signs, symptoms, and treatment for mushroom poisoning, and suggests the right questions to ask in order to arrive at a proper diagnosis. The book contains color photos of high quality to aid in picture keying toxic mushroom species, as well as clear tables and schematic diagrams to aid in understanding the mechanisms of intoxication. However, this is not a field guide with keys and the photographs are limited to deadly poisonous and toxic fungi. The author's style and the layout of the book makes it easy and enjoyable to read and yet it is most educational at the same time. The work is well referenced after each chapter and it is clearly evident that the author has carried out an extensive search of the current international literature, in order to include the most up-to-date knowledge on the subject of mycetism.

Some of the chapters deserve special mention since the information is up-to-date and especially informative: Health Benefits and Medicinal Properties of Edible Mushrooms; Mushroom Poisoning Not Caused by Mushroom Toxins; Spectrum, Incidence, Sociology, Diagnosis and Management of Mushroom Poisoning; Amatoxin Syndrome; Gryomitrin Poisoning; 'Antabuse' Syndrome; Hallucinogenic Syndrome; Muscarine Poisoning; Gastrointestinal Syndrome; Miscellany of Toxins. These are just examples but there is far more in this book that will interest the general naturalist such as the chapter on the Introduction to the Biology of Mushrooms and the valuable resource information in the appendices.

If I could afford to buy only one book about mushroom poisoning, this would be it. When one measures the amount of important information available in this book against price, one can only conclude: What a bargain!—*Harold W. Keller, Research Associate, BRIT.*

BESSETTE, ALAN E., ORSON K. MILLER, JR., ARLEEN R. BESSETTE, and HOPE H. MILLER. 1995. **Mushrooms of North America in Color, A Field Guide Companion to Seldom-Illustrated Fungi.** (ISBN 0-8156-0323-1, pbk). Syracuse University Press, 1600 Jamesville Avenue, Syracuse, NY. 13244-5160. $17.95. 188 pp, 74 color photographs, 5 1/4" x 8 1/2".

A book like this one is long overdue. Congratulations go to Syracuse University Press for publishing a book that fills a mycological and scientific need by adding to the iconography of fungi but avoids duplicating the common edible species that adds pagination and higher costs. The authors estimate that of the more than 5,000 species of mushrooms that occur in North America less than half have been illustrated with color photographs. Most monographic publications use either line drawings or black and white photographs or rarely color paintings or photographs. In any case the species descriptions are highly technical and have limited value for a more general readership. The objective of this book is to provide an accurate but nontechnical, species description, a color illustration of high quality, and a discussion of its distinguishing characteristics. Each species is given a morphological description that highlights the fruiting body (cap, gills, stalk, flesh, technical features and spore print color). Under the topical heading fruiting is noted the habit, habitat and seasonality of occurrence. And lastly, the edibility, observations, and notes give a better understanding of the edibility, distinguishing characters and geographic distribution of each species. Each color photograph is about 2 1/2" x 3 3/4" and occupies about one-third of a page. The photographs are of high quality and show the necessary gross morphological characters for identification There is a glossary, works cited and index that concludes the book. There are no keys. The author's state that "The species selected are those which are uncommon, rare or not well illustrated in the current literature." This book is intended to be a companion to other popular field guides. I highly recommend this book for any serious student of the fungi.—*Harold W. Keller, Research Associate, BRIT.*

JONES, MICHAEL. 1994. **Flowering Plants of the Gambia.** (ISBN 90 5410 197 0, pbk). A.A. Balkema Publishers, Old Post Road, Brookfield, VT 05036 (fax 802-276-3837). $40.00. 132 pp, 160 color photographs, 6 1/2" x 9 1/2".

Gambia is located in West-Central Africa and is one of the most densely populated countries of Africa. Much of the true forest has been destroyed by human encroachment and deforestation. This book will help document the need for preservation and greater appreciation for what is left of the original flora. There are introductory topical sections that briefly describe the geography, climate, geology and topography, soils, vegetation and phytogeography, botanical exploration, exsiccata, and botanical literature. These sections give a good general survey of the flora of The Gambia.

The species descriptions, mostly four to a page, are nontechnical and understandable by the general public. Flowering dates, habitats and local names and uses are given. The taxa are arranged into two classes: the Dicotyledoneae and Monocotyledoneae, and then into families, followed by introduced and well-known taxa. The color plates are arranged so that five photographs of varying size fill most of the page, with the scientific binomial of the plant and cross referenced page numbers where the species descriptions can be found, as a caption at the bottom. The photographs are of good quality and show the general habit of the plant with flowers. The flowers are not shown in enough detail to discern the floral parts and familial characters.

The book is concluded by a short glossary, a list of about 35 references of mostly Gambian origin, and an index. It should appeal especially to foreign tourists who visit Gambia in ever increasing numbers.—*Harold W. Keller, Research Associate, BRIT.*

GUARINO, LUIGI, V. RAMANATHA RAO and ROBERT REID (Eds.). 1995. **Collecting Plant Genetic Diversity.** (ISBN 0-85198-964-0, hbk). The University of Arizona Press, 1230 N Park Avenue, Suite 102, Tucson, AZ 85719. $120.00. 748 pp, 6$^{1}/_{2}$" x 9$^{1}/_{2}$".

This is a compendium of generic, specific, theoretical and practical information that is aimed at both new and experienced collectors of plant germplasm. It is a comprehensive treatment published on behalf of the International Plant Genetic Resources Institute in association with the Food and Agriculture Organization of the United Nations, The World Conservation Union and the United Nations Environment Programme.

There are 39 chapters, each prepared by different authors and each with a set of extensive references. The contents are organized around several themes: the introduction covers a brief history of plant germplasm collection, legal issues, and methods and procedures of collecting.

Before setting out includes: assessing the threat of genetic erosion, sampling strategy theory and practice, collecting wild species, classification of intraspecific variation in crop plants, published sources of information (on existing germplasm collections, on natural and human environments, on wild plant species), aids to taxonomic identification, bibliographic databases, ecogeographic surveys, mapping distribution of biodiversity, geographic information systems and remote sensing for plant germplasm. There is a wealth of information in this section that would be useful as a reference source for anyone working on and interested in the preservation of plant germplasm.

In the field includes: collecting plant genetic resources; gathering and recording data in the field; collecting seeds; collecting vegetatively propagated crops, collecting grasses, legumes, woody perennials, pollen, *Rhizobium, Frankia* , mycorrhizal fungi, and herbarium vouchers. These sections contain detailed information on how to collect various plant sources of germplasm but also provide more general information on how to handle plant structural parts. Plant collectors interested in field procedures and collections in a broader application than just germplasm would do well to read this section.

Back at base includes: processing and reporting germplasm data and collecting missions. A series of case studies, for example, collecting the rice gene pool, collecting rare species in Florida, and collecting Andean root and tuber crops, among others. There is far more information than can be covered briefly in a single review but anyone seriously interested in plant field collecting will benefit from reading this book.—*Harold W. Keller, Research Associate, BRIT.*

McDADE, LUCINDA A. KAMALJIT S. BAWA, HENRY A. HESPENHEIDE, AND GARY S. HARTSHORN (Eds.). 1994. (ISBN 0-226-03952-8, pbk). **LA SELVA, Ecology and Natural History of a Neotropical Rain Forest.** The University of Chicago Press, 5801 S Ellis Avenue, Chicago, IL 60637. $28.95. 486 pp, 8½" x 11".

La Selva is a nature reserve and field station in Costa Rica that represents one of the most intensively studied tropical field sites in the world. This area has been a major focus of research on rain forest ecology, flora, and fauna for the last 30 years. This book covers La Selva's climate, soils, and physical setting, its plant and animal life, and agricultural development and land use in nearby areas.

Part 1 summarizes research on the physical setting and environment of the rain forest, as well as the history of the research station. Chapters in this part focus on climate, geomorphology, aquatic systems, soils, nutrient acquisition and cycles of energy. Part 2 emphasizes the plant community with sections on vegetation types, plant diversity and demography, spatial patterns of trees, the impact of treefall gaps on forest structure and dynamics, physiological ecology and plant reproductive systems. Part 3 covers the animal community summarizing information on butterflies, fishes, amphibians, reptiles, birds, and mammals. Part 4 addresses interactions between plants and animals, focusing on herbivory and frugivory. Part 5 considers the impact of land use and agricultural development on La Selva and other areas of Costa Rica. One chapter examines land colonization and conservation in Sarapiqui, the county in which La Selva is located; another covers subsistence and commercial agricultural development in Atlantic lowland regions; and a third treats forestry research priorities in Costa Rica. A final chapter highlights the prospects for a comparative tropical ecology. The appendixes address research productivity at La Selva, the administration and governance of the field station and checklists of vascular plants and vertebrate groups. The bibliography is extensive covering 57 pages in length and located at the end of the book instead of following each chapter. In the hands of conservation-minded people, this book will be a valuable resource of information for anyone interested in tropical biology.—*Harold W. Keller, Research Associate, BRIT.*

LINDEN, PETER J. VAN DER and DONALD R. FARRAR. 1993. **Forest and Shade Trees of Iowa.** Second Ed. (ISBN 0-8138-0734-4, hbk). Iowa State University Press, 2121 South State Avenue, Ames, IA 50014-8300. $22.95. 150 pp, 325 plus b/w photographs, line drawing illustrations, 8½" x 11".

This second edition contains updated information on the characteristics, origins, location, and uses of trees found in Iowa. It is a guide to the identification, distribution, natural history, and uses of Iowa trees. It is profusely illustrated with aerial black and white photographs of landscapes, groundshots of habitats, habits of individual tree species and structural parts used in identification: leaves, twigs, bark patterns, and fruits. The photography is outstanding and illustrates the essential key characters used in the identification of species. The large-page format includes the photographs, which occupy about half the page, and species descriptions on the same page. Keys to trees in both summer and winter conditions are included. Some of the chapter headings include: Iowa's forests; selecting and transplanting trees; identifying trees (an explanation of key characters used to identify trees). The largest chapter is Trees of Iowa that covers 95 pages and over 140 species of mostly trees and a few shrubs. For each species there is a nontechnical description of distinguishing characteristics, a list of similar trees, distribution, and several paragraphs that give interesting information about the tree, for example, their use in landscaping and woodworking, advantages and disadvantages of planting a particular tree species, growth patterns, fall coloration, and problems with diseases. Chapter 5, Key to Trees of Iowa, has a general, dichotomous, one-way key to selected species of trees with key characters illustrated with line drawing illustrations. The key in most cases is simple to use and user friendly. The general key is followed by keys to pines, spruces, willows, poplars, hickories, oaks (the greatest number of species at 14), elms, maples and dogwoods as examples. There is s separate winter key to common deciduous trees. This section is followed by a bibliography of about 100 references. There is an index organized alphabetically by generic and common names. This book should appeal to the lay public who venture into our midwestern forests to enjoy springtime walks or marvel at the brilliant display of fall colors, who may have use of forest trees in landscape design, and to answer the question, What tree is that?, in the course of their daily lives.—*Harold W. Keller, Research Associate, BRIT.*

ORTIZ DE MONTELLANO, BERNARD R. 1990. **Aztec Medicine, Health, and Nutrition.** (ISBN 0-8135-1563-7, pbk). Rutgers University Press, 109 Church Street, New Brunswick, NJ 08901. $15.00. 308 pp, 40 b/w illustrations, 6" x 9".

The first chapter briefly summarizes pre and post-Columbian Aztec history, culture, and religion as well as the Spanish Conquest and colonial organization. Aztec medicine was holistic. Illness and disease were seen as the interactions of the supernatural, magical, and natural causes. Evaluation of Aztec medicine demonstrates that the Aztecs correctly observed the physiological effects of plants . The Aztecs were clearly very accurate observers of nature and used empirically derived remedies. The chapter on Aztec religion, world view, and medicine discusses Aztec religious beliefs, concepts, practices, and structure with emphasis placed on human physiology, health, and medicine; the duality of the cosmos; creation, destruction, and human sacrifice; man as microcosm; complexes of deities; the preservation of cosmic order as a justification for social controls; multiple souls; social and religious stratification; and shamanism. Moderation in diet, exercise and behavior was an essential component of a balanced body. Good health was based on equilibrium, moderation, and performance of duty.

Why was a small force of Spaniards led by Hernán Cortés able to defeat and overthrow the Aztec Empire in such a short period of time from 1519 to 1521? There are chapters to support the case that at the time of the conquest by Cortés the Aztecs were a thriving, well-nourished, and healthy people. They had a highly sophisticated and productive agricultural system, a coherent set of medical beliefs and effective health measures and no need to rely on cannibalism for protein. To support the author's ideas evidence is provided from anthropology, folklore, pharmacology, ethnobotany, geography, demography, linguistics, history of medicine, religious studies and psychoneuroimmunology. Some of the chapters that support these ideas are: Population and Carrying Capacity of the Basin of Mexico; The Aztec Diet: Food Sources and Their Nutritional Value; Epidemiology; Diagnosing and Explaining Illness; Curing Illness; Syncretism in Mexican Folk Medicine.

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The book concludes with two appendixes: Nutritional Values and Amino Acid Composition of Aztec Foods; Empirical Evaluation of Aztec Medicinal Herbs and a section of notes and an extensive bibliography of over 450 references and an index. This book will be fascinating reading for anyone interested in the fall of the Aztec Empire and also the use of herbal medicines by peoples of Mesoamerica.—*Harold W. Keller, Research Associate, BRIT.*

ISELY, DUANE. 1994. **One Hundred and One Botanists.** (ISBN 0-8138-2498-2, hbk). Iowa State University Press, 2121 S State Avenue, Ames, IA 50014. $32.95. xiv + 351 pp, 6" x 9".

With a talent for edutainment, an academic vernacular speaking and writing style, and often poking into deep crevasses of colleagues' lives, Isely has produced a readable book on a variety of botanists through the development of that science. Starting with Aristotle (384 B.C.–322 B.C.) and ending with Winona Hazel Welch (1896–1991), one would expect that the development of this science would be well traced and reflected by the discussions on discoveries and developments made by each individual. In a large part, this is true, the development of taxonomy of vascular plants, mosses and fungi being fairly well reflected; ecology, plant physiology and even horticulture also receiving coverage by choice of pertinent participants. However, as will always be true of such books where the selection of characters discussed is subject to individual bias, there are huge gaps in botanical science that are hardly mentioned or not covered at all. Algae, the basic plant type, and often the recipient of such neglect by large segments of the botanical community, are hardly mentioned in this book. The only person discussed who could be classified as a phycologist is N. Pringsheim, whose contributions to this discipline are relatively insignificant.

Having established the importance of Schleiden's discoveries on plant cell structure, Isely missed a grand opportunity for continuing the fascinating plant cell story by failing to follow through with later discoveries by individuals showing progress in modern plant cytology. The beginnings of the realization that symbiosis was involved in development of eukaryotic plant cells would have been especially interesting through discussions of the work and hypotheses of Famintzin and/or Mereschkovsky in the early part of this century.

The chapters are often peppered with amusing comments such as the statement that many botanists are "odd ducks" (p. 124) which, I hope, will not offend most of us professional botanists who will accept it in the jocular mood in which it was probably intended. Describing Charles Deam as "correspondence-incontinent," however, is a bit unkind, particularly not knowing whether or not the recipients of his letters were appreciative. Also, on a less amusing note, the revelation is fascinating that Mary Agnes Chase was jailed twice as a suffragette.

There are a few errors that should be noted, namely the family name 'Proteraceae', instead of Proteaceae, on page 111 for the family in which *Banksia* is placed. Also, on page 227 the 'Bradypods' are mentioned in reference to an animal group which I feel sure should be the brachiopods (Brachiopoda).

In general, however, the book is commendable by providing concise surveys of a selected 101 botanists, and it is hoped that Isely will follow through with a second book covering a similar number of other botanists, those forgotten in this first volume.
—*Richard E. Norris.*

PILBEAM, JOHN 1995. **Gymnocalycium, A Collector's Guide.** (ISBN 90-5410-192 X, hbk). A.A. Balkema, P.O. Box 1675, 3000 BR Rotterdam, Netherlands (fax +31-10-4135947); A.A. Balkema Publishers, Old Post Road, Brookfield, VT 05036 (fax 802-276-3837). $70.00. ix + 191 pp, 124 color photographs, 98 figures, 10 maps, 8" x 11".

Gymnocalycium is a favorite genus for amateur as well as professional collectors of cacti. It well meets the qualifications of an almost 'perfect' cactus in having many spines, often quite long, that are beautifully arranged in areolae, flowers that are often large, fragrant and very attractive and, most importantly, plant sizes and shapes that are easily accommodated in most collectors' facilities. This volume will be heartily welcomed by English speaking enthusiasts who, to this time, have had similar treatises available mostly in foreign languages.

Included in the book is a fine section on cultivation of these cacti, a review of the classification of *Gymnocalycium* species, mainly including a review of Schütz (1986) and Krainz (1968), but also providing, in Chapter 7, an annotated checklist of species and synonyms according to Hunt (1992). The discussion in the section on seed, fruit, flowers, and spines is very brief. I would have liked to have had a more detailed discussion on the fruit and seeds of *Gymnocalycium*, particularly the latter because of the importance placed on seed characters in formulating subgenera and sections of the genus. Scanning electron microscope photographs of seeds of a few species are provided but without much comment. Perhaps light microscope photographs of seeds of species showing differences in different subgenera would have been more useful.

The chapter on Geography and Distribution of *Gymnocalycium* is written by Metzing and translated by C. Walton. It is erroneously stated in this section that "The area inhabited by the genus *Gymnocalycium* is entirely in South America, and extends roughly from 18° N to 45° S......". It is made clear, however, that the genus occurs no farther north than central Bolivia in South America, and does not occur as far north as the latitude 18° N which passes through Mexico, Jamaica and Puerto Rico. Locations of different species in each of the subgenera are illustrated on full-page maps.

A very short chapter is provided on "Discovery and collection of species in the wild" in which the maintenance of collectors' numbers by growers of *Gymnocalycium* is emphasized so that their origin is clearly identifiable. Chapter 8 lists 23 pages of numbers of collectors, giving localities for most in variable detail.

The glossary is aimed primarily at etymology of the species names, but the roots *gymno* and *calycium* are not explained. Books important to the taxonomy of *Gymnocalycium* are itemized in the Bibliography, but publishers names are not provided, making it difficult for the uninitiated to find them.

Chapter 6, containing a "Commentary on species," provides a description of each accepted species as well as those species that are 'provisional'. Two types of 'provisional' species are designated, those that may have been accepted in the past but now, for various reasons, "await resolution," i.e. *G. bayrianum*, and those that are previously undescribed or illegally described, i.e. *G. altagraciense*. Species that are considered in this volume to be synonyms are also listed and discussed. All itemized species in this section are well referenced, although some of the references are not listed in the Bibliography section. Each accepted and provisional species is illustrated with a color photograph of a flowering plant as well as a close-up black and white photograph of areolae. Each accepted species is assigned to one of Schütz's subgenera and also to the series in which Buxbaum placed it. The descriptions include details of plant form and growth habits as well as flowers, fruits, and seeds. Comments on related species or past confusion of plants in cultivation are often made. Location of wild collections are listed and collectors numbers provided for each species.

My curiosity stimulated, and becoming a very small scale collector, I purchased seven unidentified plants, without flowers, appearing to be the genus *Gymnocalycium* from a local nursery, and have attempted to identify them using this book. The identification process required leafing through the book and comparing the descriptions and photographs with my plants. In about an hour and a half I have probably accurately identified two species, possibly three, but I must await flowering of the remaining plants to be able to try placing them in a species. A key to the subgenera and species would have made my task much easier and possibly more accurate.

Despite these limitations, this beautifully produced book is one that collectors of succulent plants, especially cacti, will require.—*Richard E. Norris.*

HENDERSON, ANDREW, GLORIA GALEANO, and RODRIGO BERNAL. 1995. **Field Guide to the Palms of the Americas.** (ISBN 0-691-08537-4, hbk). Princeton University Press, 41 William Street, Princeton, NJ 08540. $75.00. 352pp, 256 color illustrations on 64 plates, 42 line drawings, 554 maps, 6"x 9".

As the guest author of the forward to *Field Guide to the Palms of the America*, Robin Foster makes two bold statements: "Amazing. I thought it would be another twenty years before something as useful as this came out … " and "This book is a shot in the arm of the study of palms." I could not agree more. This field guide will impact the taxonomy, ecology and ethnobotany of palms well into the twenty-first century.

"But a field guide?" you say, "After all, the authors state at the outset, 'The Guide is not a taxonomic treatment but a field guide for nonspecialists'". However, the term "nonspecialists" is not restricted to school children and casual tourists; it includes anyone who is not involved in systematic research on a particular group, even the *Bactris* specialist who has never delved into *Copernicia* or other genera. It is intended to be used by *anyone* who needs to provide rapid, reasonably accurate identifications of palms seen, studied, or collected in the field: the ecotourist wanting to appreciate the ecosystem, the palm enthusiast collecting seeds for distribution through the International Palm Society, the tropical ecologist inventorying biodiversity and plant-animal interactions, the natural resource manager evaluating habitats, and the conservationist cataloguing endangered species for a worldwide database. What makes this Guide so significant is that, until now, the taxonomy of American palms had never been synthesized and simplified to bring order to all species in all genera and provide standard names among countries. In fact, only a handful of genera have been treated in modern comprehensive monographs and, thus, are not readily accessible to the nonspecialist.

Placing the species level taxonomy of American palms in historical perspective, the authors state in the Introduction: "It had been left by Barbosa Rodrigues, Burret, Bailey, and others in a chaotic state with literally hundreds of names and no way to apply them to real species in nature. … Over the last decade a new generation of botanists, many of them natives of tropical countries, has become interested in palms, and our knowledge of the taxonomy of American palms is now based on extensive field work, well-collected specimens, appreciation of variation in nature, and realistic species concepts. Our Guide is based on the work of these botanists." Indeed, the three authors are themselves part of the new generation of palm biologists, representing research centers in both North and South America and a total of over 30 years of extended periods of field experience throughout the neotropics.

However, making sense and order out of the American palm species for nonspecialists comes at a cost in terms of some "cherished" names and popular conceptualizations of species in horticultural use. The authors explain it this way: "Our species concept in this field guide is necessarily a broad one. … We have tended to combine closely related and doubtfully distinct species and also groups of species that we consider to be part of species complexes. … Many species are thus quite 'messy' and not easy to understand. Herbarium taxonomy does not have the methodology (and certainly not the number of specimens) to fully understand this kind of variation … [which] falls more into other fields. … Our particular concept means that in several instances we have not accepted species of previous botanists. We do not imply that we are 'right' and the others are 'wrong' but stress we have a different concept … often the difference in opinions are merely a question of ranking." For example, the authors' concept of *Coccothrinax miraguama* is expanded to encompass all the variation denoted by all the species with loosely, coarsely woven but non-spiny leaf sheaths. Likewise *Coccothrinax jamaicensis, C. litoralis, C. proctorii,* and *C. readii* are all placed in synonymy under the more familiar *C. argentata.*

By accounting for all known variation of all neotropical palms within a simplified hierarchy of conceptually clear-cut, easily distinguished species, this guide accomplishes something unique to the American palm literature: Any palm specimen can be quickly identified correctly to species (i.e. species complex), quickly plugged into the research network and become a vital resource for eventually understanding the biological basis of species variation in palms. This is the crux of the book's impact.

A successful field guide must also be easy to use and well organized. By any standards, the Field Guide to the Palms meets these criteria, as well. Twenty-two pages of introductory material (taxonomic concepts, palm geography, morphological structures, and conventions used in the book) precede an illustrated key to the genera. The genera and species accounts occupy the next 200 pages. Each species is consistently treated to list common names, field characters, distribution, uses, and notes on taxonomic problems or recent research. The next section includes a distribution map for each species. Appendices include country by country checklists and lists of complete synonymy, which provide an easy way to compare species concepts without the species accounts becoming cluttered. The book ends in a spectacular display of 256 color photographs illustrating the more common, evolutionarily significant or structurally beautiful species.

Because this is intended to be used in the field or with field collections, the authors make extensive use of distributions and habitats to distinguish species, as well as highlighting diagnostic field characters in the species accounts. Within the generic accounts, keys are provided for genera exceeding ten or so species. For smaller genera, the combination of distribution, habitats/elevation, and diagnostic features are sufficient to readily distinguish species. For example, of the eleven species of *Ceroxylon,* only five occur in the central region of the Eastern Cordillera of the Colombian Andes. *Ceroxylon alpinum* and *C. quindoense* both have horizontally held leaves and regularly arranged, horizontal or pendulous leaflets. *Ceroxylon parvifrons* has arched leaves and regularly arranged leaflets held in a

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"V" formation. *Ceroxylon vogelianum* and *C. sasaimae* both have arched leaves and clustered, multi-ranked leaflets. *Ceroxylon alpinum* occurs below 1800 m and has pebbled fruits, whereas *C. quindoense* occurs above 2000 m and has smooth fruits. *Ceroxlyon sasaimae* occurs below 1800 meters and has smooth fruits, while *C. vogelianum* occurs above 2000 m and has grooved fruits.

Although, some palm specialists and knowledgeable enthusiasts may grumble at the radically expanded species limits, the Field Guide is still *the* book to use by anyone wanting to understand neotropical palm species. It is not only a field guide; it is a unified summary of our current understanding of American palm species and exposes the taxonomic problems that will provide research subjects for years to come. My congratulations to Henderson, Galeano and Bernal.—*Roger W. Sanders, Research Associate, BRIT.*

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The following individuals have kindly supported SIDA through their time and expertise in reviewing manuscripts submitted and/or published in volume 16. Without your interest and support, SIDA would not be the journal you have come to expect.

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We thank all authors, reviewers, subscribers, and readers for your continued interest and support.—*Barney Lipscomb (BRIT), Editor; John W. Thieret (NKU), Associate Editor; Félix Llamas (LEB), Contributing Spanish Editor.*

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Titles of Articles with Authors

BOTANICAL NAMES

New names are in **bold face.**

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AUTHORS INDEX

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Every paper should include both an English and Spanish, or another major language abstract. SIDA is has a subscription base of 850 individuals and institutions in 90 countries with over half outside the United States.

Specimen Citations

Use the collector's last name and number or (s.n.) and underline. Abbreviate the months of the year by the first three letters of the month without a period. Example: Texas. Jeff Davis Co.: 1 mi W of Fort Davis, 3 Jan 1972, Smith 118 (BRIT).

Author Citations

Use the author abbreviations as given in the *Author Abbreviations* compiled at the Herbarium, Royal Botanic Gardens, Kew (1992). Use et or the ampersand (&) between two authors; for more than two authors, restrict to the first one followed by et al. Do not *italicize* or underline in the manuscript the terms et, et al., ex, or in.

Latin Descriptions or Diagnoses

A description or diagnosis of a new taxon should mention the taxonomic characters that distinguish the taxon from its allies. These diagnostic characters should be underlined in the description. Since a diagnosis of a new taxon refers only to the taxonomic characters distinguishing it from other taxa, no underlining in the manuscript is necessary. The ICBN (Rec. 32B.1) recommends that the main points in which the taxon differs from its allies should be mentioned; italicizing (ms) these in the description is in accord with that recommendation.

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Figures

A scale should be in or on the illustration or photograph; reduction will automatically reduce the scale and subject proportionately. When this is not feasible, the proofs will be returned with the galleys for the author to determine the magnification of the final reduction. In half-tones, sharp glossy photographs with good contrast are necessary for good reproduction. Please do not mount illustrative material (half-tones, line drawings, etc.) on stiff boards. This prevents scanning with high quality equipment.

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Abbreviations

When the following abbreviations are used the period is omitted. Distance: mm, dm, cm, m, km, ft, mi; directions (in caps): S, N, E, W, months: first 3 letters only, Jan, Feb, etc. Example: Potter Co.: 2 km W of Dot, 5 Jun 1971, Smith 118 (SMU).

Notes

When references are few in number, cite them in the text and omit reference section. Text citations of literature are in parentheses and should state the journal abbreviation, volume, pages, and year. The citation of a book includes the last name of the author, if not mentioned previously, the full unabbreviated title of the book, and the year published in parentheses.

Documented Plant Chromosome Numbers

The year and number of each is assigned by the editor. Refer to SIDA 16:765–768. 1995.

Notes

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