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NEW SPECIES AND VARIETIES OF CONIFERS FROM MEXICO

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ABSTRACT

Four new species and six new varieties are described here; three species and two varieties of *Abies*, one species and three varieties of *Pinus*, and one new variety of *Pseudotsuga*. Within the genus *Abies* only one Mexican species was known with consistently more than two resin canals, and five having cones with enclosed bracts. The authors here report two additional (new) species, one from the state of Hidalgo and one from Oaxaca, with more than two resin canals and, including these, altogether three species with enclosed bracts. A new variety of *Abies guatemalensis* Rehd. was found in Guerrero. *Abies lowiana* (Gord.) A. Murr., often unreasonably neglected as a separate species and included in *A. concolor* (Gord. & Glend.) Lind. *ex* Hild. as its variety, is herein reported to be represented by a new variety in the state of Chihuahua. A distinct species of *Pinus*, discovered in Sonora, with five needles in a fascicle, stout branches, and strong scales such as in *P. michoacana* Mart., but with cones clearly placing this species in "*Pseudostrobus*" (like *P. estevezii* [Mart.] Perry or *P. nubicola* Perry). This new pine may play a key role in understanding the process of divergence of "*Montezumae*" and "*Pseudostrobus*" pines. A variety of the new species was also found by the authors in the state of Sinaloa. The southernmost localities of the genus *Pseudotsuga* so far were known from the states of Hidalgo and Puebla. The authors report on the species, as a new variety, further south, in Oaxaca. A new variety of *Pinus lawsonii* Roezl *ex* Gord. and one of *P. oaxacana* (Mart.) Mirov is also reported from the latter area.

KEY WORDS: New taxa, Coniferae, México, *Abies, Pinus, Pseudotsuga*, Hidalgo, Guerrero, Oaxaca, Sonora, Sinaloa

NOTE: the species and varieties described here have been mentioned, along with a concise description and photographs, in the No. 6 issue of the NewsBrief of the International Dendrological Research Institute, Inc. (I.D.R.I.), Sep. 1994. The taxa "*Abies* A-E" are those listed in this article under numbers 1-5, "*Pinus* A-D" are those under 6-9, and "*Pseudotsuga* A" is under 10 in the list below (discussion). For information contact I.D.R.I., as given above.

INTRODUCTION

While documenting the Gymnosperms and their plant communities in México for the Dendrological Atlas project we encountered several conifers which we consider new taxa.

1: ***Abies hidalgensis*** *spec. nov.* (Hidalgo); 2: ***Abies neodurangensis*** *spec. nov.* (Durango); 3: ***Abies zapotekensis*** *spec. nov.* (Oaxaca); 4: ***Abies guatemalensis*** Rehd. var. ***longibracteata*** *var. nov.* (Guerrero); 5: ***Abies lowiana*** A. Murr. var. ***viridula*** *var. nov.* (Chihuahua); 6: ***Pinus yecorensis*** *spec. nov.* (Sonora-Sinaloa); 7: ***Pinus yecorensis*** Debreczy & Rácz var. ***sinaloensis*** *var. nov.* (Sinaloa); 8: ***Pinus oaxacana*** (Mart.) Mirov var. ***diversiformis*** *var. nov.* (Oaxaca); 9: ***Pinus lawsonii*** Roezl var. ***gracilis*** *var. nov.* (Oaxaca); 10: ***Pseudotsuga menziesii*** (Mirb.) Franco var. ***oaxacana*** *var. nov.* (Oaxaca).

For a long time (since 1932), only *Abies hickelii* Flous & Gaussen, a species of southern México, was known to have more than two (typically 8-12) resin canals in its leaves (*A. oaxacana* Martínez is treated here as a synonymous with *A. hickelii.*). A new species was found in the montane "cloud forest" region of Hidalgo (*Abies hidalgensis* Debreczy, Rácz, & Guízar, see below) with (typically 4-5) up to 7 median resin canals in the leaves, and soon after, surprisingly, another species with 4 resin canals was located in the similarly mild and humid habitat of a hidden valley in the state of Oaxaca (*A. zapotekensis* Debreczy, Rácz, & Ramírez, see below). The taxonomic value of the number and position of the resin canals is well discussed in the literature (Orr 1937; Liu 1971; *etc.*). Gaussen (1971) thinks that marginal position of the resin canals is a younger character than median, supported by the observation that leaves on sterile shoots usually have marginal resin canals, while fertile ones of the same specimen are typically median (Ferré 1941). The phylogenetic importance of the resin canal number is little understood. Except for *A. hickelii* in México, only two species: *A. firma* Sieb. & Zucc. of Japan and *A. bracteata* (D. Don) A. Poit. of Pacific North America were known so far occasionally to have more than two, namely 4, resin canals. We suspect that this is either an ancient, "primitive" character or the consequence of rapid changes in climatic circumstances during the history of the species. In the ancient group of Gymnosperms, *Podocarpus* in a broad sense, there are several species with more than two resin canals--*e.g.*, up to 10 in sect. *Eupodocarpus* such as in *P. rostratus* Laurent--and their position is typically median. Further study for the better understanding of the systematic position of these newly discovered relict endemic species, should involve the investigation of questions relating to the number of the resin canals.

There were only a few fir species known in México having enclosed bracts: excluding the southernmost types of *Abies concolor* (Gord. & Glend.) Lindl. *ex* Hild. known from northern México together with *Abies magnifica* A. Murr. in Baja California, only *Abies guatemalensis* Rehd. [not including *A. g.* var. *tacanensis* (Lund.) Mart. and the variety described here (var. *longibracteata* Debreczy & Rácz)], *Abies durangensis* Mart., *A. d.* var. *coahuilensis* (I.M. Johnst.) Mart. and *Abies vejarii* Mart. var. *mexicana* (Mart.) Liu. The first species was described by Alfred Rehder in 1939, the others by Maximino Martínez in 1942. More recently (1992, Biol. Sergio Zaimudo Ruiz of the Instituto de Ecológia, C.R. Del Bajio, Patzcuaro, Michoacán reported (pers. comm.) a species from the state of Querétaro with two resin

canals and short, enclosed bracts. Our recent exploration extended this list by three more species having this character: *Abies hidalgensis*, *A. neodurangensis* Debreczy, Rácz, & Salazar, and *A. zapotekensis* (see below).

Abies guatemalensis, a species with enclosed bracts has an extended population in Guerrero with large cones and exserted bracts. So far only a southern form with fine needles, hairy branchlets, and smaller, narrow cones were known to have bracts exceeding the cone scales (var. *tacanensis*) from the high region of the Volcán Tacana, Chiapas. The variety, seems to be much more extended in México than the species itself, is described here as *A. guatemalensis* var. *longibracteata*.

Abies lowiana (Gord.) A. Murr., a species not consistently recognized by botanists and mistakenly, often included in *A. concolor* (*A. c.* var. *lowiana* [Gord.] Lemm.), is reported here from "south of the Rio Grande", north of the town of Madera, Chihuahua. With its *A. grandis* (Dougl. *ex* D. Don) Lindl. -like pectinate arrangement of the leaves on shade branches and young trees, a character which never appears in *A. concolor*, *A. lowiana* is more related to the previous species than to *A. concolor* in a strict sense. It is important to distinguish this species from the latter taxon, fairly frequent in the northwestern region of México. Found here with a surprisingly lustrous green foliage (always pruinose gray in the north), it is considered a new variety of *A. lowiana*.

Whether a pine species belongs to the "*Montezumae*" or "*Pseudostrobus*" group in classification is often difficult to establish. *Pinus yecorensis* Debreczy & Rácz has characters of both sections or subsections: the strong, thick branches with large, prominent primary scales suggest that it belongs to "*Montezumae*", while the cone is that of "*Pseudostrobus*". At this time, only the discovery of the species and a comparative morphology of this and some of the related species will be discussed. Chemical composition analysis and a more thorough study are still to come.

Pinus oaxacana (Mart.) Mirov is the most common species in Oaxaca between an altitudinal range of 1900-2500 m. With its long pendent, thin/fine shiny green foliage and the fairly large cones close to the apex of the strong branches for most of the year, this species is the most typical element of the "encinar y pinar" belt of the region. During our expeditions the variability of the species was thoroughly studied and a large number of samples collected. These proved a wide range of variability of the species, particularly in their cone morphology. A form with yellow (not purplish red) developing male strobiles is also worth mentioning here. While making this study, distant small populations with *P. montezumae* Lamb.-type elongated, just barely asymmetric cones of much less protuberant scales draw our special attention, particularly when noticing that this type consistently had brown branchlets instead of pruinose, typical for the species. If *P. montezumae* were present in the area, one would easily suspect that this pine is a hybrid between *P. oaxacana* and that species. Here we describe it as a variety of the Oaxacan pine, knowing that this solution may just open this taxonomic problem for further study and consideration.

Pinus lawsonii Roezl is the most common species of the relatively low altitude (1400-2500 m) coniferous forests of southern México. Over one hundred collections were made to observe its natural variability. Several types, which include trees with different growth pattern, color, or other characters of the needles, along with a wide range of the variability in the cones, were observed[1]. We felt that all of them belong to the natural variability of the species and were not worth distinguishing with formal taxonomic epithets except for a type with smaller cones and conspicuously thin needles. This type, growing consistently in the lower limits of the distribution of the species, is treated here as *P. lawsonii* var. *gracilis* Debreczy & Rácz see below.

The distribution of the genus *Pseudotsuga* in North America has been known as far south as the states of Hidalgo and Puebla only. Recent discovery of the genus in the state of Oaxaca has extended the known distribution of the genus to 16° N lat., and the new location with those being discovered since the first report, represent the southernmost location of the genus worldwide. The Mexican Sierras, including the area of the Sistema Norte del Oaxaca, are known to be within an earlier wider range of the distribution of northern conifers including the genus *Picea*, known recently only as far south as the northern states of México. The (by now) isolated distribution of the northern taxa here, is practically just the continuation of their distribution southward (*e.g.*, in *Picea*, that of *Picea pungens* Engelm. and *Picea engelmanii* Parry) with great morphological similarity to those of the northern ones, differing from them only in some characters and typically showing a wide range of infraspecific variability anyway (*e.g.*, the length and thickness of the needles, number of the stomatophorus lines, shape of the cone scales, etc.). The Oaxacan Douglas fir is also just a southern representative of the variable northern *Pseudotsuga menziesii* (Mirb.) Franco segregated to isolated populations during its repeated migrations and survived in a wide range of different habitats representing a wide ecological spectrum. These ecotypes were separated on species rank (*Pseudotsuga flahaultii* Flous in Chihuahua-Durango-Zacatecas in the west, Coahuila-Nuevo León in the east, *Pseudotsuga guinieri* Flous in Chihuahua-Durango, *Pseudotsuga macrolepis* Flous in Chihuahua-Durango and Coahuila-Nuevo León-Hidalgo-Puebla, *Pseudotsuga rehderi* Flous in Chihuahua-Durango and Nuevo León). They are practically distributed throughout the range of the genus with geographic ranges that are close to or even overlapping one another. This "over-splitting" of the major species resulted in such "ridiculous" cases, that (for example) from just in the vicinity of Galeana, Nuevo León, three species of Douglas-fir were reported: *Pseudotsuga flahaultii* and *Pseudotsuga macrolepis* from Cerro Potosí, NW of Galeana, and *Pseudotsuga rehderi* from the Cañon de los Charcos, SE of the town. The extreme variability of the main species (Pacific and continental, Rocky Mountain forms) and the comparison of cultivated trees with wild specimens show the difficulty and weak basis of evaluating them as different species, or even as varieties. Dropping the idea of placing the Oaxacan Douglas fir under a "questionable" and ill-defined taxon such as, most likely, *Pseudotsuga macrolepis*, and considering the distant isolation of our taxon, we propose that it be separated on the level of variety within the main species. We are, however, aware of the fact that cultivation and further investigation which should include cold hardiness tests, may prove that this is not even a variety. Further data on the distribution of the species in Oaxaca (see description #10), reported soon after the first publication of our discovery in a local newspaper, indicate how widely the species was distributed in this region in earlier climatic periods.

1. ***Abies hidalgensis*** Debreczy, Rácz, & Guízar[2], *spec. nov.* Figure 1: c1-c3; Plate I:1; "*Abies* A" in NewsBrief No. 6 of I.D.R.I. (Sep. 1994). TYPUS: MEXICO. eastern Hidalgo: 4-5 km north of Metepec, 2300 m, June 12, 1994, *Debreczy, Rácz, Biró et al. #40323* (HOLOTYPUS: BP; Isotypi: A,CHAP,E, MEXU,NA).

Arbor ad 18 m alta, trunco simplici; **habitus** columnari-conicus; **cortex** rasilis, in arboribus juvenilibus pallide cinereus, postea in laminas irregulares magnas ruptus, in arboribus vetustis valde crassus et suberosus, pars interior

corticis sanguinea; **rami** fusci, vel cinereo-fusci, usque ad 5-6 annos pilosi; **ramuli** validi, rasiles, pilis 0.2-0.3 mm longis, densis, flavo-brunneolis diaphanis cooperti; **gemmae** (partim foliis brevibus, incurvatis, terminalibus occultae) rotundato-desectae, tenuiter resinosae, squamis usque ad 15 triangularibus vel saltem apicibus squamorum tectae; **folia** pectinatim distributa, (1-)3-5(-6) cm longa, abrupte abbreviata (usque ad 1 cm longa) in ramulis externis leviter deorsum et/vel versus apicem ramulorum inclinata, aciebus parallelis, apicibus rotundata et breviter (0.2-0.4 mm), sed conspicue emarginata vel subtiliter bifida, in positione umbrosa mollia flexibilia vel in acumine arboris aliquantum quasi succulenta; pagina dorsalis eorum atroviridis vel glauco-viridis, lineis stomatum usque ad 14, in ramulis ad lucem expositis deorsum medium folii attingentibus, sed in positione umbrosa plerumque 6 lineis brevibus, ad apicem folii litteram "V" formantibus; pagina ventralis argenteo-cinerea cum margine angusto (0.2 mm), viridi et costa media 0.2-0.4 mm lata, saepe cum lineis stomatum infractis; limitibus lateralibus bilateraliter singulis argenteis, lineis stomatum typice 14-15 (in positione umbrosa in foliis angustis 5-6) instructis; lineis stomatum cum stomatibus 9 pro 1 mm; stomata 0.06 mm longa, elongato-ovata, intense pruinosa; folia ramulorum infernorum in sectione transversali plano-triangularia, sed ramulorum fertilium triangularia cum canalibus resiniferis medianis usque ad 7(!); **strobili feminei juveniles** 2.5-3.0 cm longi, bracteae eorum initio adpressae postea reflexae (4-5 mm), rotundato-triangulares, irregulariter serrato-incisae, pallide virides; **strobili masculini** 12 mm longi, pedunculo 3 mm longo, squamis pilosis circa 100 (20 × 5), 1.8 mm latis; **strobili maturi** 6.5-8.0 cm longi, 3.5-4.0 cm lati, pedunculo 0.4-1.0 cm longo, cylindracei, apice rotundati, leviter umbilicati; **squamae** 130-170 (25-34 × 5) pro strobilis, flabellatae, virides, glauco-virides, dense velutinosae, pili 0.2 mm longi, albidi, adpressi; **bracteae** 0.5-0.8 cm longae, sessiles, leviter spathulatae, cum ala acute inciso-serrata, rotundata, sine apice protrudenti; **axis** anguste-conicus; **semina** anguste-triangularia, resino-vesicularia cum ala cinereo-straminea.

DESCRIPTION: tree with straight, typically single trunk, columnar-conical crown, first ascending, later descending branches, shiny- (or in sunny and dryer places) dull grayish-green, pruinose foliage; **bark:** smooth, light gray in young trees, later ruptured to irregular large plates, very thick and suberous on old trees with blood-red inner bark; **branches:** light brown, later grayish brown, hairy (up to 5-6 years); **branchlets:** rather strong, smooth, slightly prominent below the leaves on strong shoots, densely pubescent with 0.2-0.3 mm long yellowish brown, semi-clear hairs; **buds:** (partially hidden by short, incurving terminal leaves) flat, covered by up to 15 triangular scales or their tips, thinly resinous; **leaves:** pectinately arranged, "distichous", abruptly shortened (to 1 cm) on the upper (dorsal) side of the branchlets, slightly downward and/or forward curving, (1-)3-5(-6) cm, parallel sided, rounded and shortly (0.2-0.4 mm), but markedly, emarginate or finely bifid, soft flexible (shade) or rather fleshy (upper crown), shiny dark- or dull grayish-green with up to 14 stomatophorus lines on the upper (dorsal) side reaching below the middle of their length on stronger exposed stems, usually 6 short lines form a (0.6-1.0 mm long) "V" below the apex on shade leaves; lower (ventral) side is silvery gray with narrow green margins (0.2 mm) and midrib (0.2-0.4 mm, often with broken lines of stomata), two broad silvery stripes typically with 14-15 (in narrower shade leaves 5-6) stomatophorus lines with 0.06 mm long, elongated ovate, intensively pruinose,

densely set (9/mm) stomata; leaves in cross section flat triangular on lower, triangular on fertile branchlets *with up to 7(!) median resin canals*; **strobiles:** female- 2.5-3.0 cm long with short, first appressed later reflexed (4-5 mm) rounded-triangular, irregularly serrate-incised pale green bracts; male- strobile 12 mm long on 3 mm peduncle, consists of about 100 (20 × 5) 1.8 mm wide, hairy fertile scales; **cones:** 6.5-8.0 × 3.5-4.0 cm, short (0.4-1.0 cm) stemmed (peduncled), cylindrical with about 130-170 (25-34 × 5) cone scales; rounded, slightly impressed (umbilicate) at apex, pruinose green at maturity; **cone scales:** flabellate (wide cyathiform), green, grayish green, densely velutinous with short (0.2 mm), white, appressed hairs; bracts (0.5-0.8 cm) short, enclosed (sessile), slightly spathulate with sharply incised-serrate, rounded wings and without a protruding tip; axis narrow conical; **seeds:** narrowly triangular with resin blisters and narrow, light yellowish gray wings (not fully developed at the time of the description).

NAMED: after the central Mexican state of Hidalgo, where the species was found. The name also recalls Miquel Hidalgo y Costilla (1762-1811), a prominent personality of the post-Columbian Mexican independence movement, after whom the state itself was named.

DISCUSSION: this rare and distinct tree with 5-7 resin canals in the needles and green cones with short, enclosed bracts was located in the state of Hidalgo in an area where (in the wider region) only *Abies religiosa* (H. B. K.) Schltdl. & Cham. was known. The latter is completely different with its strongly curved, pointed (not bifid) leaves with two resin canals (not up to 7) and 2-3 times larger cones with long exserted, recurved bracts of prominent tip. *Abies guatemalensis*, a southern species with (typically) "bractless" cones not known as far north as Hidalgo, has twice as many leaves on an equal length of (shade) branchlet with straight needles curving to almost a right angle from the stem (not curved, directed forward), with two resin canals (not up to 7). In *A. guatemalensis* the cones typically pruinose blue (not pruinose green changing to light brown), have wide cyathiform "wing shaped" (not flabellate) cone scales with elongated (not short) basal section and slightly enclosed or finely exserted (not short, sessile) bracts with finely protruding (not absent) tip. Other species such as *A. vejarii* Mart. of northeastern México (with short, curved, succulent needles with two resin canals, close to or exserted bracts) are too distinct even to be compared with the new species.

DISCOVERY: the species was found in a deep canyon running eastward, 3 miles above the small village of Metepec. The first tree was seen on April 3, 1994 on the upper rim of the canyon just where the road makes a sharp turn downward toward Poza Rica and Tampico at an elevation of 2350 m. The tree, old and struggling with only a few upper branches alive, had no cones or cone axils, but the distinct foliage and bark immediately suggested that it does not belong to any species known. In this extremely cloudy area we had no opportunity to continue the exploration at that time. Sterile branches were transferred to the Division de Ciencias Forestales, Universidad Autónoma Chapingo (DCF/UACH) to preserve the (possibly sole) tree under *#38672*.

We returned to the area on June 12. This time we saw more trees deep in the canyon along with old cypress trees (*Cupressus lusitanica* Mill.). In spite of an early start, we had only a few minutes before the clouds filtered up and hid the valley. Realizing the difficulty of reaching the trees from our position and having no evidence of cones, we went to the section of the canyon where the lonely tree was found a few months earlier. We had good fortune for a few seconds and located a tree on a nearly vertical slope, 20 m above the right side of the river. The tree has had many cones which were not ripe yet but seemed to be fully developed in size. Soon we found it to be identical to our *#38672*, but it was much younger with different bark and less

glaucous needles (*DRB #40323*; type). Conifers associated with this fir are *Pinus patula* Schltdl. & Cham., *Pinus apulcensis* Lindl. (*P. pseudostrobus* Lindl. var. *apulcensis* [Lindl.] Shaw), and *Pinus teocote* Schltdl. & Cham. in its upper distribution, and (a few) *P. patula* in the evergreen cloud forest in the canyon. At the site of the specimen we found 36 accompanying species among which the dominating were *Quercus laurina* H. & B., *Ternstroemia pringlei* Rose, and *Cestrum fasciculatum* (Schltdl.) Miers. /*purpureum* (Lindl.) Standl. with *Alnus firmifolia* Fernald, *Buddleia cordata* H. B. K., *Ptelea trifoliata* L., *Sambucus mexicana* Presl., and *Syngonium podophyllum* auct.

PRESERVATION: Declaring the entire canyon as conservation land was proposed. Further study and conservation was planned in collaboration with Dr. Enríque Guízar Nolazco, DCF/UACH.

PARTICIPANTS IN FIELD WORK: Dr. Gyöngyvér Biró, Dr. Zsolt Debreczy, Dr. István Rácz, (I.D.R.I. and Hung. Nat. Hist. Museum, Budapest, Hungary), Eva Kertész (Botanical Collection, Munkácsy Mihály Múzeum, Békéscsaba, Hungary), Vince Zsigmond (University of Horticulture, Budapest, Hungary), Yinghao Zhao (Botanical Garden of the Chinese Academy of Sciences, Beijing, China).

2. ***Abies neodurangensis*** Debreczy, Rácz, & Salazar[3], *spec. nov.* Figure 1: a1, a2 Plate I:2; "*Abies* B" in NewsBrief 6 of I.D.R.I. (Sep. 1994). TYPUS: MEXICO. southwestern Durango: near Los Bancos (Ejido la Victoria Paraje, San Antonio, Ejido El Brillante Paraje, Santa Barbara, Arroyo del Infierno), 2500 m, May 13, 1994, *Debreczy, Rácz, Biró et al. #39936* (HOLOTYPUS: BP; Isotypi: A,CHAP,E,MEXU,NA).

Arbor ad 35-40 m alta, trunco simplici; **habitus** initio laxe conicus, postea densior, vertice rotundata; **cortex** rasilis, in arboribus juvenilibus pallide cinereus, postea in arboribus vetustis in laminas irregulares magnas ruptus, pars interior corticis sanguinea; **rami** ferruginei, usque ad 5-6 annos sporadice pilosi, pilis subtiliter pellucidis; **ramuli** pallide virides ad cinereo-brunnei, dense vel in positione umbrosa parce pilosi, pilis pellucidis 0.10-0.15 mm longis; **gemmae** in ramulis vegetativis typice subglobosae, 2-3 mm longae, non-resinosae, gemmae in ramulis terminalibus planae (6-7 × 3 mm) cum 12-18 squamis triangularibus, 3 mm longis, nitidis, brunneis costa prominenti et margine eroso instructis; **folia** dichotoma, late distantia, leviter ascendentia, in latere superiori ramulorum prorsus inclinata, aciebus parallelis, apicibus rotundata et leviter (0.1 mm) emarginata; flexibilia, in pagina dorsali viridia, lineis stomatum usque ad 7 paene apicem attingentibus et lineis aliquot prope basin foliorum praeter costam impressam; in pagina ventrali argenteo-alba, cum margine angusto viridi (0.1 mm) et costa (0.25 mm lata), et limitibus lateralibus bilateraliter singulis argenteis, lineis (6-)9(-10) stomatum instructa; stomata 0.03 mm, ovata; folia in ramulis fertilibus saepe asymmetrice acuta, aliquantum succulenta cum limite pruinoso 0.2 mm lato superne lineis stomatum usque 8; costa crassa usque 0.7 mm lata, praeter costam lineis 6-8 stomatum angustis 0.35 mm latis; folia ramulorum infernorum in sectione transversali elliptico-avicularia, obovata, folia ramulorum fertilium in sectione transversali obovata (elliptica), canalibus resiniferis marginalibus 2, latero-ventralibus; **strobili** breves, columnares, 6.5-8.5 cm longi, 3.0-3.6 cm lati, initio virides, postea virido-brunnei, umbone prominenti; strobili velutini, pilis 0.10-0.13 mm longis, pellucidis,

erectis; **squamae** 150-200 (30-40 × 5), flabellatae; **bracteae** sessiles, 0.5-0.8 cm longae, ala angulari, protrudenti, apice 3-4 mm longo; **axis** angusteconicus; **semina** 0.8-1.0 × 0.8 cm, ala 1.0-1.4 cm longa, obtusatotriangulari instructa.

DESCRIPTION: tree up to 35-40 m tall with single trunk, loose conical, later dense, round-topped crown with first ascending, later descending branches; **bark:** smooth light gray first, later ruptured, in old trees very thick, suberous with blood-red inner bark; **branches:** reddish brown, sporadically hairy with fine clear hairs up to 5-6 years; **buds:** vegetative buds typically subglobose, 2-3 mm long, terminal one flat (6-7 × 3 mm) on strong fertile shoots with 12-18 triangular, 3 mm long, wide, shiny brown scales with prominent midrib and eroded margin, not resinous; **branchlets:** light green to grayish brown, densely or sparsely (shade) hairy with 0.10-0.15 mm long clear hairs; **leaves:** on stem, "dichotomous", widely spreading, slightly ascending, forward curving on the upper side, 3-5 cm long, 1.5-2.2 mm wide, parallel sided, rounded and slightly (0.1 mm) emarginate at apex, flexible, shiny dark green above with up to 7 stomatophorus lines near the apex and a few lines down near the base of the leaves along the impressed midrib, the ventral side is silvery white with narrow green margins (0.1 mm) and midrib (0.25 mm) and two silvery stripes with (6-)9(-10) stomatophorus lines, stomata 0.03 mm, ovate, leaves on fertile shoots often asymmetrically (on one side) acute, more succulent with wide (0.2 mm) pruinose stripe above, with up to 8 stomatophorus lines, midrib strong, up to 0.7 mm wide, the stomatophorus stripes are narrower (0.35 mm) with 6-8 lines of stomata. In cross section the leaves are ellipto-aviculate to obovate (elliptical) on lower, obovate on fertile branchlets with 2 marginal latero-ventral resin canals; **cones:** short, columnar (6.5-8.5 × 3.0-3.6 cm) with prominent umbo, consist of 150-200 (30-40 × 5) conescales, bright light green first, greenish brown later, velutinous with 0.10-0.13 mm long upright clear hairs, conescales are flabellate with short (0.5-0.8 cm), enclosed (sessile), bract with protruding angular wings exceeding the 3-4 mm long apex; axis narrow conical; **seeds:** 0.8-1.0 × 0.8 cm with 1.0-1.4 cm long, rounded-triangular wing; fully developed but not mature when studied.

NAME: after the state where the species was found with *neo-* (Lat. prefix = new-) as anterior is to distinguish it from *Abies durangensis*, the well known and widely distributed (although not common) species of the region.

DISCUSSION: this fir with "*Abies grandis* (Dougl. *ex* D. Don) Lindl.-like" appearance is characteristically with two resin canals in its needles, the early appearance of the strobiles, and green cones with enclosed, sessile bracts. It was found in a canyon on the Pacific side of the sierra close to the Durango-Sinaloa border. Although enclosed bracts and two resin canals exist in the leaves of both, it can readily be distinguished from *A. durangensis* by its densely hairy, dark purplish brown (not subglabrous-glabrous yellow or pruinose) branchlets, glabrous (not thickly resinous), straight (not curved), green (not gray pruinose), rounded-emarginate (not pointed) leaves with median (not marginal) resin canals, cones with very short, enclosed (sessile) bracts with prominent, laminal wings forming a "V" exceeding the shortly protruding tip (not subsessile), nearly reaching the "exposure line" (the inner limit of the exposed part, "scale head" of the conescale) and triangular-acute at end. It has cones almost fully developed in size by the time *A. durangensis* "blooms". It is very distinct from and not even comparable to *A. concolor* or *A. lowiana.*

DISCOVERY: On May 13, 1994, while heading from Capilla Textla, Sinaloa to El Salto, Durango, just 3 miles before reaching the plateau, that is on the warmer, western side of the sierra (identified later as Ejido la Victoria Paraje, San Antonio and

Ejido El Brillante Paraje, Santa Barbara, Arroyo del Infierno), suddenly a fir with fully developed, although not mature, green cones came into sight. Traveling to document the cone-inflorescences (strobiles) of *Abies durangensis*, we were surprised to see a species in cone. Having the samples in hand, we realized that it was a completely different species, at first sight most similar to *A. grandis*, a species of the Pacific North. At an altitude of 2500 m, the trees are growing in the margin and upper part of deep canyons and associated with the dominating *Hydrangea seemannii* Riley and twelve other species such as *Alnus firmifolia*, *Cornus disciflora* DC., *Garrya laurifolia* Hartw., *Litsea glaucescens* H. B. K., and *Quercus magnoliifolia* Nee.

CONSERVATION: We found only a few mature trees. Although the difficult site seems to secure the species, the preservation of the habitat(s) is immediately necessary. Young plants are present, but not many. We reported to Dir. Tec. Felipe Norberto Coria Quinone and Biol. Rosalva Miranda Salazar at Unidad Conservación y Desarollo (UCODEFO) No-6, El Salto, and proposed at least a few hectares of conservation land in the canyon. The protection seems to be secured and further studies are ongoing.

PARTICIPANTS IN FIELD WORK: Dr. Gyöngyvér Biró, Dr. Zsolt Debreczy, Dr. István Rácz, (I.D.R.I. and Hung. Nat. Hist. Museum, Budapest, Hungary), Eva Kertész (Botanical Collection, Munkácsy Mihály Múzeum, Békéscsaba, Hungary), Vince Zsigmond (University of Horticulture, Budapest, Hungary).

3. ***Abies zapotekensis*** Debreczy, Rácz, & Ramírez[4], *spec. nov.* Figure 1: d; Plate I:3; "*Abies* C" in NewsBrief No. 6 of I.D.R.I. (Sep. 1994). TYPUS: MEXICO. Oaxaca: Sierra de Juárez, near Portillo, 2700 m, June 30, 1994, *Debreczy, Rácz, Biró, et al. #40675a* (HOLOTYPUS: BP; Isotypi: A,CHAP,E,MEXU,NA).

Arbor ad 20 m alta, trunco simplici; **habitus** laxe-conicus; **cortex** rasilis, arboris juvenilis pallide cinereus, postea in laminas irregulares ruptus; **rami** castaneo-brunnei, usque ad 5-6 annos sporadice pilosi; **ramuli** virides-flavovirides, tenuiter pubescentes, pilis 0.10-0.13 mm longis, leviter infuscato-subpellucidis, basin versus leviter contractis; **gemmae** (foliis brevibus, incurvatis, terminalibus partim occultae) rotundato-desectae, squamis usque ad 15 triangularibus tectae; externe non-resinosae; **folia** subdisticha, ascendentia, ad apicem leviter inclinata, litteram "V" patentem formantia, in ramulis lateris dorsalis aliquantum breviora et conspicue reflexa, 3-5 cm longa, 2 mm lata, aciebus parallelis, apice rotundata et breviter (0.14-0.20 mm) emarginata; flexibilia, aliquantum coriacea nitide atroviridia; folia cum/sine lineis stomatum usque ad 5, 2-3 mm longis, prope apicem folii, vel in ramis crassis lineis 2-3 deorsum infra medium folii; pagina ventralis argenteo-cinereus cum margine angusto (0.15-0.20 mm) viridi et costa media 0.2-0.4 mm lata, saepe cum lineis stomatum infractis vel a stomatibus omnino tecta, limitibus bilateraliter singulis argenteis, lineis stomatum typice 14-18 (in positione umbrosa in foliis angustis 10-12) instructis; stomata 12-13 pro 1 mm, 0.03-0.04 mm longa, anguste elongata; folia in sectione transversali plana, avicularia usque epsilon-formia cum canalibus resiniferis medianis 2-4(!); **strobili feminei juveniles** 3-4 cm longi, bracteis brevibus, initio adpressis postea reflexis (4-5 mm), rotundatis, irregulariter serratis, pallide viridibus, sine costa protrudenti marginem excendenti; **strobili masculini** 1.2 cm longi, squamis pilosis circa 100 (20 × 5) 1.8 mm latis; **strobili maturi** 8-9 cm longi, 3.6-4.2 cm lati, cylindracei, rotundati, virides, glauco-

virides, pedunculus 0.4-0.8 cm longus; **squamae** 150-190 (25-38 × 5) pro strobilis, aliformes, subtiliter velutinosae, pilis 0.03-0.06 mm, erectis; **bracteae** 0.8-1.0 cm longae, sessiles, apice leviter litteram "V"-formantes cum alis 2 inciso-serratis, fimbriatis costam non-prominentem excendentibus; **axis** anguste-conicus; **semina** 11 mm longa, 3 mm lata, ala 21 mm longa, 12 mm lata, cucullo 7 mm longo.

DESCRIPTION: tree with straight, usually single trunk, loose conical crown, ascending and horizontally spreading, later slightly descending branches, with shiny dark green foliage; **bark:** thin, smooth, light gray in young age, later ruptured to irregular plates; **branches:** chestnut brown, sporadically hairy up to 5-6 years; **bud:** (partially) hidden by short, incurving terminal leaves, flat, covered by a few, up to 15 triangular scales, not resinous outside; **branchlets:** green, yellowish green, thinly pubescent with fine (0.10-0.13 mm long), faintly brownish subclear hairs, slightly contracted toward their base; **leaves:** on stem "subdistichous", ascending, and slightly forward directed, forming an open "V" on the upper (dorsal) side of the branchlets, somewhat shorter and conspicuously reflexed when (in helical order) they reach or leave their uppermost position on the branchlets, 3-5 cm long, 2 mm wide, parallel sided, rounded and shortly (0.14-0.20 mm) emarginate, flexible and rather leathery, shiny dark green with or without up to 5 (2-3 mm long) stomatophorus lines on the tip of the leaves or on stronger branches with 2-3 lines reaching below the middle of the length of the leaves, their ventral side silvery gray with narrow green margins (0.15-0.20 mm) and midrib (0.2-0.4 mm), often with broken lines of, or completely covered by stomas and two broad silvery stripes, typically with 14-18 (in narrower shade leaves 10-12) stomatophorus lines with densely set (12-13/mm), fine (0.03-0.04 mm) narrow elongated stomata; leaves in cross section flat, "avicular" to "epsilon" shaped *with 2-4(!) median resin canals*; **strobiles:** female- 3-4 cm long, with short (4-5 mm), first appressed, later reflexed, rounded, irregularly serrate, pale green bracts with sessile midrib exceeded by the margins; male- 1.2 cm long on 3 mm peduncle, consist of about 100 (20 × 5), 1.8 mm wide, hairy fertile scales; **cones:** 8-9 × 3.6-4.2 cm, short (0.4-0.8 cm) stemmed "peduncled", cylindrical, rather smooth in outline with 150-190 (25-38 × 5) cone scales; rounded at apex, green, grayish green before fully ripened, cone scales are "wing-shaped", finely velutinous with very short (0.03-0.06 mm), upright hairs; bract short (0.8-1.0 cm), enclosed (sessile), slightly "V" shaped at end with incised serrate, fimbriate wings exceeding the non-prominent midrib; axis narrow conical; **seeds:** 11 × 3 mm, wing 21 × 12 mm with 7 mm long hood.

NAMED: after the indigenous people living in the area where the species was found. Zapotecs (here Zapotek to avoid the sound modification in Latin of "c" before "e") are the largest native nation of Oaxaca, with a macro-otomangue language and old culture (Monte Alban). They are by nature friendly and excellent in forest management and conservation.

DISCUSSION: this rare species with two to four resin canals in the leaves, green cones with short (sessile), inserted bracts, was found in a hidden valley of the cloud forest region northeast of the town of Ixtlán de Juárez, Oaxaca, in an area where only *Abies hickelii* and (very locally in the wider region but not near the site) *A. guatemalensis* was known. Although crown and foliage is similar at first sight, *Abies hickelii* is completely different with its slightly emarginate (not bifid) and very dark green leaves with up to 13 resin canals (not 2-4) and larger (10-12 cm long), blue-pruinose (not pruinose green) cones with long exerted, upright, pointed (not enclosed, sessile) bracts with prominent tip. *Abies guatemalensis* has similarly "bractless"

cones, but it has a denser foliage (close to twice as many leaves as it is in this species on equal length of comparable shade branchlets), straight and vertical (not subdistichous, partially ascending on the stem) and has two (not 2-4) resin canals. The cones of that species are typically pruinose blue (not green) with wide cyathiform "wing shaped" (not flabellate) cone scales with elongated (not short) base section, its bracts are slightly enclosed or occasionally finely exserted, (not short, "sessile"), with finely protruding (not absent) tip.

DISCOVERY: The species is known so far only from a wide valley about 10 km directly northeast of Ixtlán de Juárez, toward the place called Portillo, at an altitude of about 2700 m. We first visited this site in December 1991 and later on February 4, 1992. Faced with logging roads, often muddy and with many divisions, we asked the help of Mr. Gustavo Santiago Ramírez, a native of Ixtlán (then a biology student at the Instituto Politécnico Nacional, Ciudad de México) to help us in exploring the area. During our second trip with the local commissariat and with the guidance of Sr. Ignacio Crisoho, we made collections of a fir we considered to be *Abies hickelii* from a distance, but curious because of its green cone-inflorescences (DRB #32957a). On the basis of the different shape of the bracts and green color of the strobiles, we suspected that it was a new species and decided to make a new collection later. On June 30, 1994, we made a third trip to the area and we obtained full size cones which proved it to be a new species to science. Finally, in October, Mr. Gustavo Santiago Ramírez (*DRB #41300*) collected fully developed cones for further study. The cones this time of the year seemed to be mature, but still green. This new fir of the humid cloud forest ("bosque mesófilo de montaña") region grows on steep slopes in rich, mixed evergreen forests, associating with 65 (or more) species, including *Alnus glabrata* Fernald, *Arbutus xalapensis* H. B. K., *Clethra mexicana* (Lindl.) DC., *Comarostaphylis conzattii* Small /*arguta* Zucc., *Cornus disciflora*, *Crusea coccinea* DC., *Gaultheria hirtiflora* Benth., *G. acuminata* Schltdl. & Cham., *Quercus castanea* Nee, *Q. crassifolia* H. B. K., *Q. laurina*, *Senecio andrieuxii* DC. Completion of a vegetation profile of the habitat is in progress. More study is necessary to establish the full distribution of the species.

CONSERVATION: the habitat of this distinct, rare species is very important to preserve. Mr. Ramírez, in collaboration with Dr. Enríque Martínez y Obeja (Instituto Tecnológico de Oaxaca), works to secure conservation land around the habitat of the species and conduct further investigation of the distribution and habitat of the species. Seeds will be distributed from Ixtlán later.

PARTICIPANTS IN FIELD WORK: Sr. Ignacio Crisoho (Commissariat, Ixtlán de Juárez), Dr. Gyöngyvér Biró, Dr. Zsolt Debreczy, Dr. István Rácz, (I.D.R.I. and Hung. Nat. Hist. Museum, Budapest, Hungary), Vince Zsigmond (University of Horticulture, Budapest, Hungary), Mr. Gustavo Santiago Ramírez (SERBO Inc., Oaxaca).

4. ***Abies guatemalensis*** Rehd. var. ***longibracteata*** Debreczy & Rácz, *var. nov.* Plate I:4; "*Abies* D" in NewsBrief No. 6 of I.D.R.I. (Sep. 1994). TYPUS: MEXICO. Guerrero: Sierra Madre del Sur, near Yextla, 2400 m, January 10, 1994, *Debreczy, Biró, Rácz, et al. #34763* (HOLOTYPUS: BP; Isotypi: A, CHAP,E,MEXU,NA).

A specie typica strobilis maturis 10-12 cm longis, 4 cm latis et bracteis 2.0-2.2 cm longis, excertis differt.

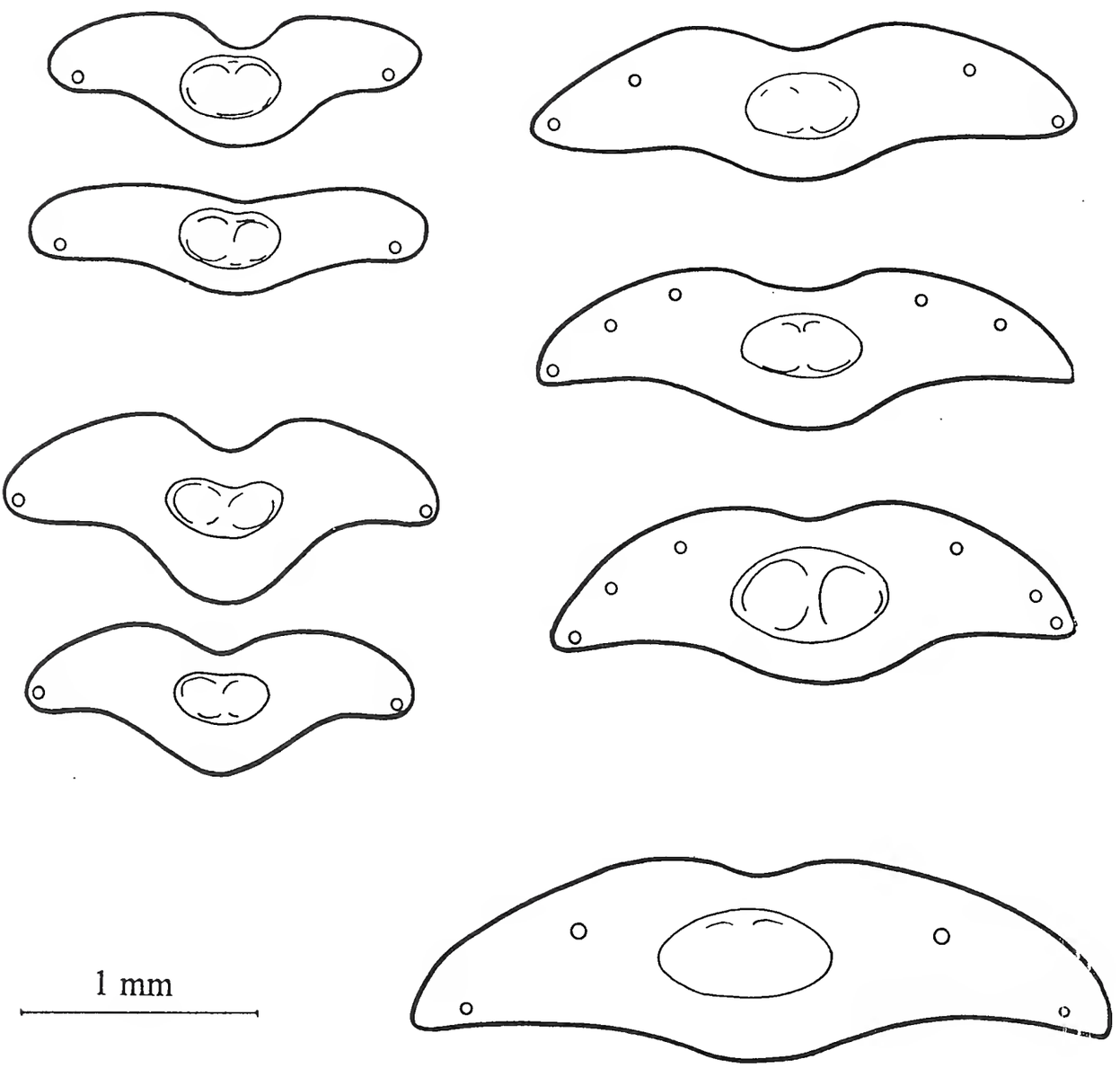

Fig 1. Analytical sketches of leaf cross sections of the new Abies species, partly in comparison with other species.

a1, a2: Abies neodurangensis sp. nov.

b1, b2: Abies durangensis Mart.

c1, c2, c3: Abies hidalgensis sp. nov.

d: Abies zapotekensis sp. nov.

Plate I

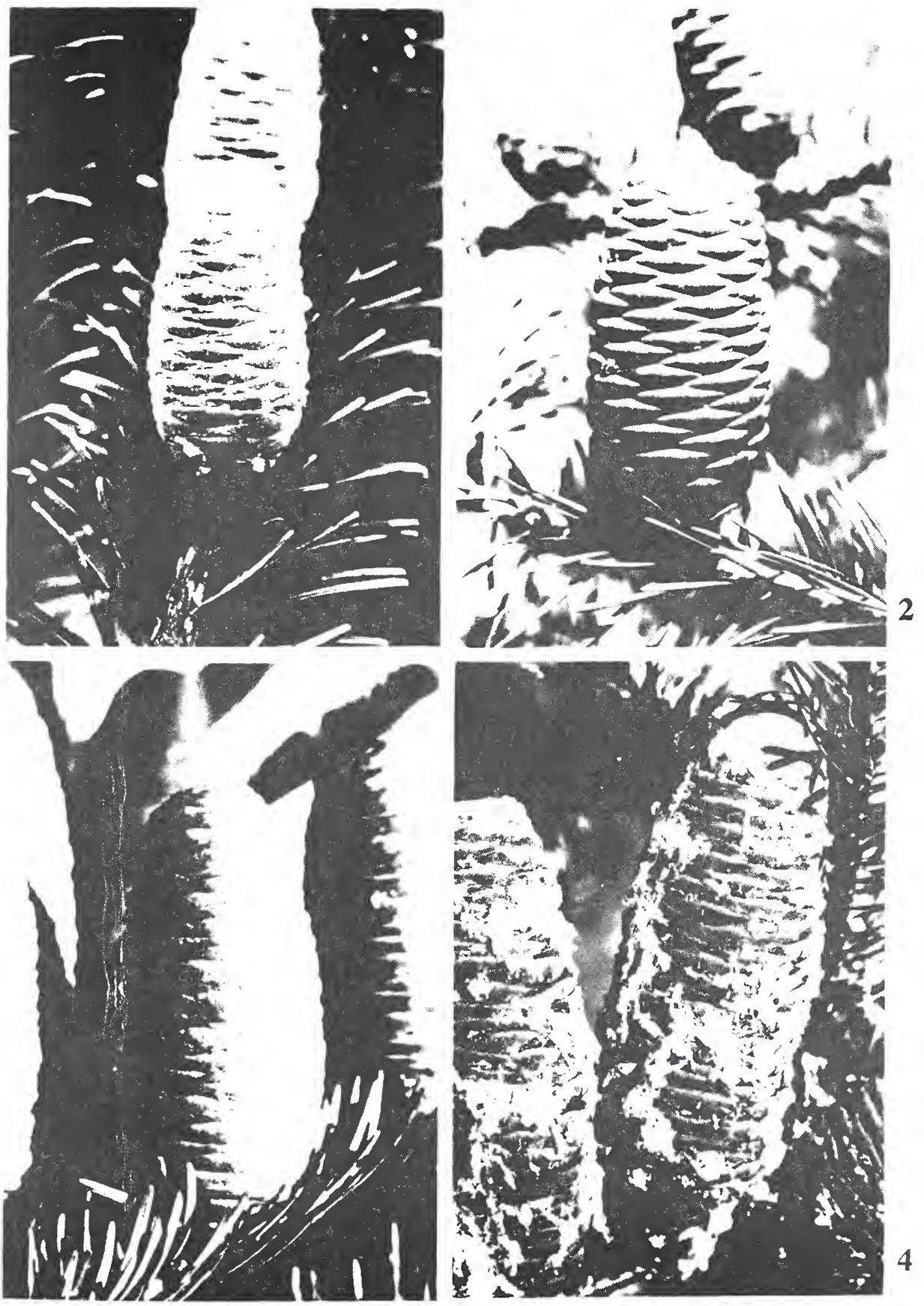

Plate I: cones of the newly described *Abies* species and varieties. 1: *A. hidalgensis* (resin canals 5, up to 7); 2: *A. neodurangensis* (resin canals 2); 3: *A. zapotekensis* (resin canals 4); 4: *A. guatemalensis* var. *longibracteata* (with its long exserted bracts).

Plate II

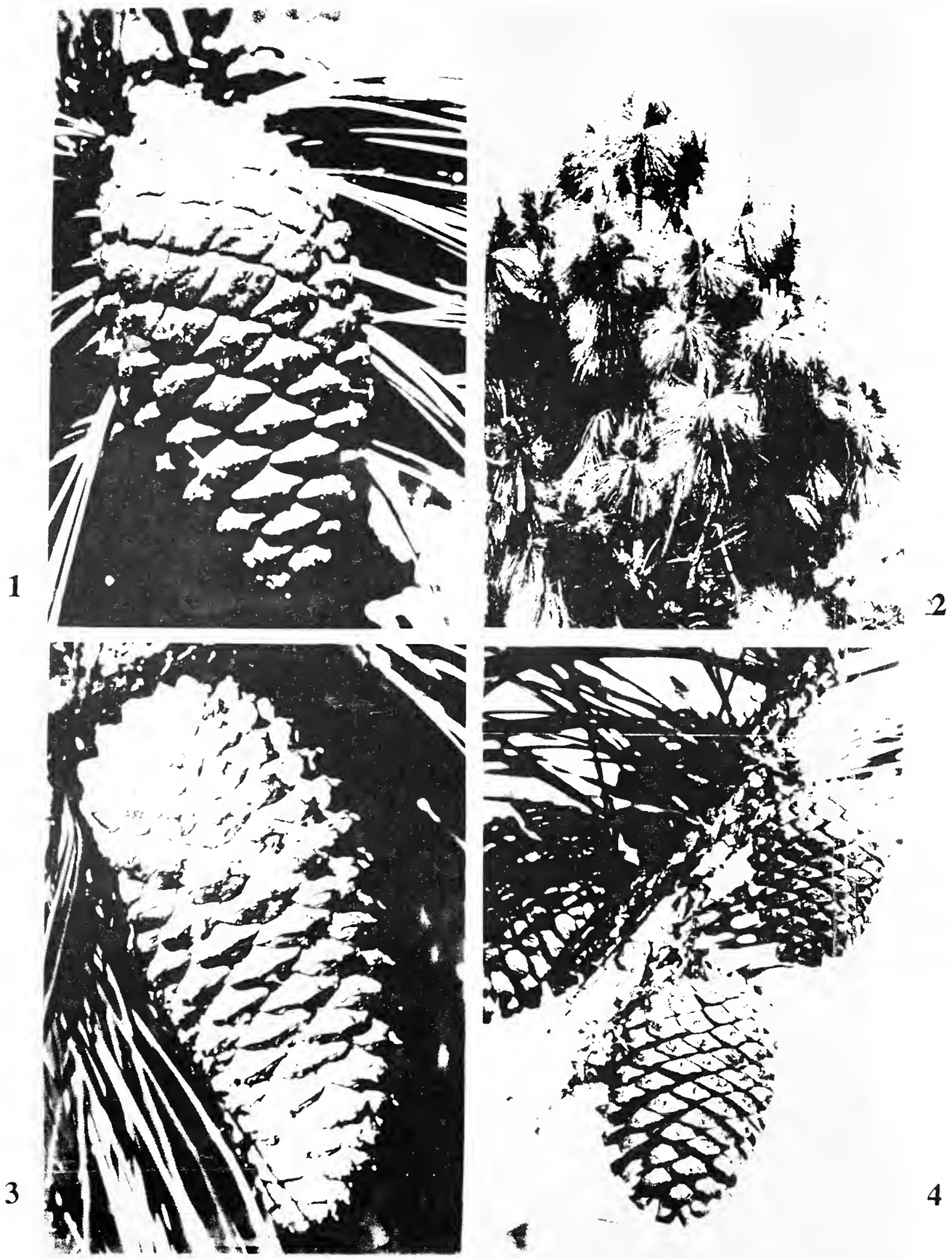

Plate II: newly described *Pinus* species and varieties. 1-2: cone and details of the crown of *P. yecorensis* (Sonora). 3: cone of *P. oaxacana* var. *diversiformis* (Oaxaca). 4: cones of *P. lawsonii* var. *gracilis* (Oaxaca).

NAME: *longus* (Lat. adj.) = long; *longibracteata* = long bracted; refers to the differentiating character of the variety in comparing the species.

DESCRIPTION: tree, identical with the species except for the larger cone (10-12 cm), the wider and longer cone scales (3.0-3.2 × 2 cm) with longer (2.0-2.2 cm) and prominently (4 mm) exserted, acuminate, upcurving bracts, and the wider, more angular, flabellate seed scale, wing.

DISCUSSION: comparing the variety with the typical *Abies guatemalensis*, it differs from the type in the size of the cones (10-12 × 4 cm; not 8-11), in the wider, longer (3.0-3.2 × 2 cm) cone scales with 2.0-2.2 cm (not 1.5-1.7 cm) long, acuminate bracts with long (4 mm) exserted, upcurving tip (not short, enclosed, abruptly acute or rounded at apex or with lateral wings, exceeding the tip) and by the more angular and flabellate (not rounded) wings. Other characteristics are equal with those of the species. *Abies guatemalensis* var. *tacanensis* (Lund.) Mart., reported from Volcán Tacaná from the state of Chiapas from between 3500-3800 m is similar, but the branchlets of var. *longibracteata* are glabrous or faintly hairy (not densely hairy), its leaves are longer, 3.5-5.5 cm (not 1.2-3.6 cm) long, the cones larger (not 10 × 4 cm), the cone scales larger (3.0-3.2 × 2 cm, not 2.7 × 1.5 cm) with consistently long exserted (not subequal to slightly exserted bract). The tree is fairly common in the Yextla area associating with over 65 higher plant species. Its plant communities are dominated by *Cupressus lusitanica*, *Quercus* spp. (4), *Chiranthodendron pentadactylon* Larreategui; among shrubs, *Dahlia excelsa* auct., *Mahonia lanceolata* Fedde, *Oreopanax xalapense* (H. B. K.) Decne. & Planch., *Philadelphus mexicanus* Schltdl., and *Solanum cervantesii* Lag. are frequent.

CONSERVATION: The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) lists *Abies guatemalensis* among the most protected conifers. This will not save the species itself: for example, logging in most areas where this conifer grows is common. Taking further steps toward full protection are needed, including preservation of the beautiful conifer stands with var. *longibracteata*. It is doubtful whether the new variety will be recognized as "CITIES 1" and distinguished from *Abies religiosa* (H. B. K.) Schltdl. & Cham., frequent in the area.

PARTICIPANTS IN FIELD WORK: Dr. Gyöngyvér Biró, Dr. Zsolt Debreczy, Dr. István Rácz, (I.D.R.I. and Hung. Nat. Hist. Museum, Budapest, Hungary), Eva Kertész (Botanical Collection, Munkácsy Mihály Múzeum, Békéscsaba, Hungary), Yinghao Zhao (Botanical Garden of the Chinese Academy of Sciences, Beijing, China).

5. ***Abies lowiana*** (Gord.) A. Murr. var. ***viridula*** Debreczy & Rácz, *var. nov.* "*Abies* E" in NewsBrief No. 6 of I.D.R.I. (Sep. 1994). TYPUS: MEXICO. Chihuahua: Sierra Madre Occidental, near Ciudad Madera, 2700 m, May 6, 1994, *Debreczy, Biró, Rácz, et al. #39711* (HOLOTYPUS: BP; Isotypi: A, CHAP, E. MEXU,NA).

A specie typica foliis ramulorum sterilium conspicue regulariter dichotomice ordinatis, in latere dorsali lucide viridibus; illis ramulorum fertilium prorsum directis et parum declinatis differt.

DESCRIPTION: tree with straight, usually single trunk, loose conical crown, ascending and horizontally spreading, later slightly descending branches, with shiny light green foliage; **bark:** thin, smooth, light gray in young age, later ruptured to

irregular thick plates; **branches:** brownish yellow, sporadically hairy up to 5-6 years; **bud:** ovate, thickly covered by resin; **branchlets:** yellowish green when mature, thinly pubescent with fine (0.08-0.13 mm long) brownish, faintly brownish or subclear hairs, often long pointed widened at their base; **leaves:** on stem "subdistichous", spreading, slightly forward directing (shade) or upcurving (exposed) at right angle, forming an open "U" on the upper (dorsal) side of the branchlets, slightly shorter when (in helical order) they reach or leave their uppermost position on the branchlets, 3-5 cm long, 2.2 mm wide, parallel sided, rounded (fertile) pointed or very finely (0.04 mm) emarginate on shade leaves; leathery, shiny dark green above with up to 10 stomatophorus lines all along on middle of leaves, their ventral side greenish gray with narrow (0.2-0.3 mm) green margins and wider midrib (0.5 mm), often with few broken lines of stomas and two broad silvery stripes, typically with 9 (in narrower shade leaves 4-6) stomatophorus lines with moderately densely set (9/mm), fine (0.03-0.04 mm) oval stomata; leaves in cross section elliptical, with 2 median resin canals; **strobiles:** female- 5-6 × 0.8 cm with first appressed, later reflexed, short (4 × 5 mm), rounded triangular, irregularly serrate bracts with slightly prominent tip of the bract-needle (midvein), pale green or less often reddish green; **cones:** not seen, cone scales regular, as in the species.

NAME: *viridulus, viridula* (Lat. adj.) = greenish; refers to the color of the foliage, markedly distinguishes this geographically isolated variety from the northern type with gray, pruinose needles.

DISCUSSION: *Abies lowiana* was not distinguished and recorded in México so far. The species, mistakenly considered as a variety of *A. concolor* (*A. c.* var. *lowiana* [Gord.] Lemm.), should be considered as the "continental vicariant" of the Pacific species *A. grandis*. It is easy to separate it from *A. concolor* in the strict sense even by some prominent, easily available outer morphological characters: in *A. lowiana* the shade branches and branchlets are rough and hairy (not smooth and glabrous), the winter branchlets are brownish yellow (not greenish gray or gray); the leaves, positioned in regular helical order are spreading evenly out to horizontal position appearing "dichotomous" or "pectinate" on sterile, or pectinately upcurving in right angle to both sides of the branchlet on fertile shoots (not diverging in all directions according to the helical order and often curving back- and forward when in upper position). On primary terminal shoots, "leaders", the leaves are abruptly upcurving to parallel the shoot such as in *A. grandis* (not spreading or ascending up to 45°). They are 3-5 cm long, rounded at apex on regular shoots (not up to 10 cm or more, acute and abruptly pointed); the stomata arranged in two silvery stripes below, with up to 9 stomatophorus lines in each and in a defined central stomatophorus band near the central longitudinal groove above the midvein, with up to 11 lines (not evenly spread in both sides); in cross section the shade leaves are elliptical (not rectilinear); the cones of *A. lowiana* are typically conspicuously uneven in outline, light reddish brown, rarely green (not more or less even in outline, purplish, less often green). The variety (var. *viridula*) differs from the northern type by having less pruinose leaves above and shiny green leaves below. This could be a result of the ecological differences in the habitat of the two plants: such as the canyon environment with shorter dormancy period in the southern type, while exposed high mountain slopes with long winter and hot, dry summer in the northern one.

DISCOVERY: the species, represented here by the variety, is found in a canyon north of Madera, Chihuahua. We saw several specimens in the shady north-northeastern side of the wide valley about 10 km northeast of Madera, Chihuahua at an altitude of about 2700 m. We visited this site on May 4, 1994 and found the tree with

well developed female and male cone-inflorescences (strobiles). We asked the help of Mr. Leonel Iglesias Quitierrez, Director Forestal NC Chihuahua, Chihuahua, and M.C. Raul Narvaez Flores, Jefe del Campo Experimental Madera, associates of INIFAP (Instituto Nacional de Investigaciones Forestales y Agropecuarias), CIR (Centros de Investigación Regional del INIFAP) Noroeste to make this exploration possible. The trees formed a mixed stand with *Pseudotsuga menziesii* (Mirb.) Franco *s.l.*, with particularly big (some 120 cm DBH) specimens of the latter along the little stream in a side valley, all cut down in the near past. Other associated species include *Pinus durangensis* Mart., *Pinus ayacahuite* Ehrenb. var. *brachyptera* Shaw, *Acer glabrum* Torrey, *Arbutus glandulosa* Mart. & Gal., *Cestrum nocturnum* L., *Cornus sericea* Michx., *Juniperus deppeana* Steud. var. *robusta* Mart., *Lonicera involucrata* (Rich.) Banks, *Lonicera pilosa* (H. B. K.) Willd., *Mahonia repens* (Lindl.) G. Don var. *pumila* (Greene) Fedde (or a form of *M. eutriphylla* Fedde), *Populus tremuloides* Michx., *Quercus candicans* Nee, *Ribes madrensis* Coville & Rose, *Salix gooddingii* Ball., *Salix* sp., *Symphoricarpos rotundifolius* A. Gray (the other 35 herbaceous or semiwoody species include *Erigeron, Euphorbia, Fragaria, Galium, Gnaphalium, Lupinus, Luzula, Poa, Polypodium, Plantago, Potentilla, Ranunculus, Rubus, Senecio, Thalictrum, Valeriana, Veratrum*, and *Viola*).

CONSERVATION: the habitat of this distinct fir, probably rare in its southern range, would be very important to preserve. Sr. Leonel Iglesias Quitierrez, Director Forestal Noroeste Centro, Chihuahua, Chihuahua, and M.C. Raul Narvaez Flores, Jefe del Campo Experimental Madera had been asked to collaborate in securing the species and to work on the possibilities of the conservation of the land around the habitat, also to conduct further investigation of the distribution and habitat of the species and this variety.

PARTICIPANTS IN FIELD WORK: Dr. Gyöngyvér Biró, Dr. Zsolt Debreczy, Dr. István Rácz, (I.D.R.I. and Hung. Nat. Hist. Museum, Budapest, Hungary), Eva Kertész (Botanical Collection, Munkácsy Mihály Múzeum, Békéscsaba, Hungary), Vince Zsigmond (University of Horticulture, Budapest, Hungary).

6. ***Pinus yecorensis*** Debreczy & Rácz, *spec. nov.* Plate II:1-2 "*Pinus* A" in NewsBrief No. 6 of I.D.R.I. (Sep. 1994). TYPUS: MEXICO. southeast Sonora: near Yécora, 1800 m, May 9, 1994, *Debreczy, Rácz, Biró, et al. #39798* (HOLOTYPUS: BP; Isotypi: A,CHAP,E,MEXU,NA).

Arbor 18 m alta, trunco simplici, recto; **habitus** late conicus ("araucarioideus"); **truncus** juvenilis diametro 10 cm et plus cortice exaratus, dense squamosus cum squamulis facile separabilibus panniculos pallide ferrugineos relinquentibus, postea fuscus usque atrocinereus; in truncis 40 cm diametro 7 costae discontinuae laminarum corticis (25-40 × 5-10 cm), laminis 2 cm crassis, planis, rotundato-angularibus; **rami** crassi (in arboribus vetustis 3 annorum 3 cm diametro), foliis persistentibus 4 annorum; rami conspicue squamati, squamis magnis, aurantiaco-brunneis, ultra 5 annum squamae primordiales cinereae; squamae corticis ultra 8 annum plane evolutae; **ramuli** crassi, dense squamulosi, glabri; **brachyblasti** cum squamis non-deciduis, squamae basales valde carinatae (4 mm), squamae superiores 5, tenues, rugosae, et superius filiferae; in arboribus adultis squamae primordiales primum longe decurrentes, postea basi breve (6 mm), cordata, lucide aurantiaco-brunnea cum apice filifero, longe acuminato; **folia** 5 pro fasciculis, ad basin crassa cum squamis basalis validis, 4.0-4.5 mm longa;

28-35 cm longa, in sectione transversali paene equilatero-triangularia, in latere dorsali 1.2-1.4 mm lata, dense serrata, lucide viridia, in latere dorsali lineis 3-4 stomatum, in lateribus ventralibus 3 lineis, margine tenuissimo (0.06 mm) instructa; dentes in aciebus foliorum densae (4-5 pro 1 mm), effusae, tenues (0.03 mm), pellucidae; **strobili feminei juveniles** ovales, 2.0-2.5 cm longi, 1.5-2.0 cm lati, ex 200 squamis compositi; squamae 3-4 mm longae, ad 2.0-2.5 mm ascendentes, flavo-brunneae, pruinosae (hinc subroseae), in apices 1 mm longos, rectos, obtusos, verticaliter expansos terminatae; pedunculo 1.2-1.4 cm longo; **strobili maturi** 8-12 cm longi, 6-9 cm lati (inclusi), 7.0-9.5 cm lati (aperti), ovati, circa medium latissimi, leviter asymmetrici, quasi sessiles, firmiter affixi, non-serotini, pallide brunnei; strobili ex 130-150 (26-30 × 5) squamis compositi; apophysibus planis vel protuberantibus, retrorse-rotundatis, umbone 3.5 mm longo, 2.2-3.0 mm lato, cum aculeo inconspicuo, obtuso, 0.6 mm longo terminato; **semina** ovata, 6.5-4.0 mm longa, in latere ventrali levia, ordinatione mosaica pallide brunnea, pallido- et atrocinerea, latere dorsali aspero, subtiliter sulcato et variole notato, superius pallide flavo-brunneo; ala 3 cm longa, infra medium latissima, latere interiore recta, semen ad basin circumdans.

DESCRIPTION: tree, 18 m tall, with straight, typically single trunk, broad conical ("araucaroid") crown, with upcurving, ascending, horizontally spreading and upcurving, finally descending or declining thick primary branches with relatively few (usually 25-30) lateral branches with large clumps of heavily pendent, shiny bright green foliage; **trunk:** straight, usually clean, up to 4-10 m; **bark:** ribbed from 10 cm upward, densely scaly with easily attached plates leaving light reddish-brown patches, changing to grayish brown to dark gray (at 40 cm DBH: 7 discontinuous ribs of 25-40 cm × 5-10 cm and 2 cm high flat topped rounded-angular plates); **branches:** thick (mature tree, 3rd year fertile: 3 cm across), leafy for 4 years, prominently scaly with large orange-brown, later, (from year 5), gray, eroded primordial (primary) scales; cortical scales appear from year 8; **branchlets:** strong, densely scaly, glabrous; **brachyblasts:** with non-deciduous scales (sheaths), basal scale pair strongly keeled (4 mm), upper scales 5 in number, thin, wrinkled and filiferous at margin above; **leaves:** 5 in a fascicle thick at base (4.0-4.5 mm at basal scale pair), 28-35 cm long, 1.2-1.4 mm wide on dorsal side, triangular in cross section, densely serrate, shiny bright green with 3-4 stomatophorus lines on dorsal and 3 on the two inner (ventral) sides, margin very narrow (0.06 mm), teeth densely set (4-5/mm), spreading, fine (0.03 mm), clear; primordial leaves of young plants (euphyllum) not studied; on adult plants the scales are first long decurrent, later the base is short (6 mm), cordate, shiny orange brown with filiferous, long acuminate apex; **conelets:** large to the genus (2.0-2.5 × 1.5-2.0 cm), oval, on 1.2-1.4 cm long stem, subtended with recurved or revolute entire budscales, consist of about 200, 3-4 mm wide 2.0-2.5 mm high, elevated, yellowish brown, pruinose (hence pinkish) scales, terminated in 1 mm long vertically spreading straight blunt tips; **cones:** medium sized, 8-12 × 6-9 cm when closed, 8-12 × 7.0-9.5 cm when open, ovate, widest in the middle of its height, slightly asymmetrical, nearly sessile, firmly attached, non-serotinous, pale brown, the 130-150 (26-30 × 5 developed) scales have flat or protuberant, slightly retrorse, rounded apophysis with 3.5-5.0 × 2.2-3.0 mm umbo terminating in inconspicuous (0.6 mm) blunt prickles; **seeds:** small, ovate, 6.5 × 4 mm, smooth with pale brown, light- and dark-gray mosaic pattern on lower/ventral side, uneven, finely grooved and warty, pale yellowish brown above. The wing is 3 cm long,

broadest below the middle, straight on inner side, light yellowish brown with some dark shade and lines toward the edge.

NAME: after the mountain village Yécora in western Sonora, above which the species was found.

DISCUSSION: This very distinct new pine from the high mountains of Sonora has five needles in a fascicle and, in general appearance, it is very much like *Pinus michoacana* Mart., but with conspicuous, shiny light green (not dull grayish green) needles and very different cones, somewhat similar to the northeastern species *Pinus estevezii* (Mart.) Perry or to its close ally, *Pinus apulcensis* of central México. The cone is also comparable to *Pinus nubicola* Perry of the very south. It differs from *P. estevezii* with much thicker branches (3 cm; not 1.4 cm in third year), green (not pruinose) branchlets, larger primordial (scale) leaves (1.4 × 0.4 cm, not 0.8 × 0.2 cm), longer and thicker (28 × 6 mm, not 16.0 × 3.8 mm) enclosed (basal) section of the stronger (1.3 mm, not 0.8 mm) and less densely serrate (40 teeth, not 50 teeth/cm) needles. The cones of *P. yecorensis* are somewhat smaller (10-12 × 7-9 cm, not 12-14 × 8-10 cm), widest in the middle (not toward base), with rigid (not flexible) cone scales, light brown (not reddish-chestnut brown) around the seed print with light (not reddish brown) attachment zone below the more rounded-protuberant apophysis on the dorsal (abaxial) side, with larger umbo ended in short (0.7 mm) and blunt (not 1 mm, pointed) arista. The seeds have a brown (not black) pattern on the ventral side, with wings more gradually (not abruptly) narrowing toward the tip. Easy to distinguish *P. yecorensis* from *P. engelmannii* Carr. common in the lower region of the area with its bark (flat, shallow ribs, thin plates change light brown to dark gray, not high, dark gray ribs with conspicuous orange fissures), 5 needles/fascicle with 3 stomatophorus lines on dorsal side and three resin canals in each (not 3 needles, with 7-8 lines, 5-8 resin canals) and shorter, thicker (28 × 6 mm, not 30 × 3 mm) enclosed section of the needles. The tips of the conelet scales in *P. yecorensis* are horizontally spreading and pruinose (not directing downward, not shiny brown), the cones are egg shaped with rounded somewhat flat triangular tip of the scales with short blunt umbo (not long cylindrical with triangular, abruptly elevated scales with prominent, prickly umbo). *Pinus michoacana* with its sparse, thick branches is very similar in habit, but *P. yecorensis* has shiny green needles of thick (7-8 mm) base, 3-4 stomatophorus lines and narrow margin with spreading teeth on dorsal side (not 4.5 mm wide at base, pruinose grayish green with 6-8 lines, margin [0.15 mm] and teeth directing somewhat inward). The cones are very different in *P. michoacana*, they are long (20-30 cm), cylindrical, often curved. Compared to *P. yecorensis*, *P. durangensis* Mart. and *P. maximinoi* H.E. Moore, present in the region, have slender stems, finer needles and much smaller cones with thin, flexible scales, not comparable with our species.

DISCOVERY: On the way from Barranca del Cobra on May 8, 1994, we turned on the road leading to the town of Obregon. Just 12 miles before reaching the mountain village of Yécora, we saw a few strange, long needled, young pines in the dark along the roadside. They were neither *Pinus durangensis* nor *Pinus maximinoi*. Next morning, we returned to the area and found adult trees forming scattered stands in a dry canyon, associated with *Pinus herrerai* Mart., *Arbutus arizonica* (A. Gray) Sarg., *A. glandulosa*, *Quercus candicans* Nee, *Q. coccolobaefolia* Trel., *Q. magnoliifolia*, *Quercus* spp., *Prunus serotina* Ehrh. subsp. *capuli* (Cav.) McVaugh, and *Rhamnus betulaefolia* Greene. The altitudinal range of the species, around 1800 m, seemed to be very narrow, a hundred meters below *P. leiophylla* Schiede *ex* Schltdl. & Cham. var. *chihuahuana* (Engelm.) Shaw and *P. lumholtzii* B.L. Rob. & Fernald to just above Yécora, where *P. engelmannii* Carr. takes over the area. Leaving Yécora, a few miles toward Obregon, we again came across scattered stands

of this species, but for only a few miles along the road. Interestingly, it was found again 100's of miles south of there, in the mountains of Sinaloa, along the road from Mazatlán to El Salto, Durango. With its distinct characters, we considered the latter to be a new geographical variety (see below).

CONSERVATION: It is located far from cities, so there was no opportunity to make steps in this matter. In the same area, other conifers such as *Pinus durangensis*, *P. engelmannii*, *P. herrerai*, *P. leiophylla*, *P. l.* var. *chihuahuana*, *P. lumholtzii*, *P. maximinoi*, and *P. oocarpa* Schiede *ex* Schltdl. are common, but do not appear in distribution maps, suggesting that the area is not yet well explored. The tree seems to be restricted to the localized sites and protection of some populations should be considered.

PARTICIPANTS IN FIELD WORK: Dr. Gyöngyvér Biró, Dr. Zsolt Debreczy, Dr. István Rácz, (I.D.R.I. and Hung. Nat. Hist. Museum, Budapest, Hungary), Eva Kertész (Botanical Collection, Munkácsy Mihály Múzeum, Békéscsaba, Hungary), Vince Zsigmond (University of Horticulture, Budapest, Hungary).

7. ***Pinus yecorensis*** Debreczy & Rácz var. ***sinaloensis*** Debreczy & Rácz, *var. nov.* "*Pinus* B" in NewsBrief No. 6 of I.D.R.I. (Sep. 1994). TYPUS: MEXICO. Central Sinaloa, Capilla Textla, 1200 m, May 9, 1994, *Debreczy, Rácz, Biró, et al. #39896* (HOLOTYPUS: BP; Isotypi: A,CHAP,E,MEXU,NA).

A specie typica strobilis maturis (apertis) 4.5-6.5 cm longis, 4.5-6.0 cm latis et pedunculis 0.5-1.2 cm longis differt.

DESCRIPTION: general character is identical to that of *Pinus yecorensis* (above), but the trees are usually smaller (12-16 m tall); **needles:** narrower (1 mm; not 1.2-1.4 mm wide) with more dense serration (6-7/mm; not 4-5/mm) and with 3 stomatophorus lines on the dorsal sides, 2-3 lines on the two ventral sides (not 3-4 stomatophorus lines on the dorsal and 3 on the two ventral sides); **conelets:** about half in size (1.2 × 1.1 cm; not 2.0-2.5 × 1.5-2.0 cm) with smaller scales (1.8 × 1.2 mm; not 3.5-5.0 × 2.2-3.0 mm) and shorter (0.5-0.7 mm; not 1 mm) but often sharper prickles; **cones:** smaller (4.5-6.5 cm long, 4.5-6.0 cm wide when open; not 8-12 × 6-9 cm, or 8-12 × 7.0-9.5 cm when open), consisting of 80-110 (not 130-150) developed scales with elevated, usually rounded, occasionally conical and pointed apophyses (up to 7 mm) on one side, flat and rhombic on the side, facing to the branches, along with a peduncle of 5 to 12 mm; **seeds:** smaller (with wing, 1.4 × 0.4 cm), densely shaded with dark lines (not 3 × 0.9 cm and light brownish yellow).

NAME: after the Mexican state of Sinaloa in which the species was first found.

DISCOVERY: While traveling from Mazatlán, Sinaloa to El Salto, Durango we were surprised to see a similar (unknown) pine we found on the slopes around Yécora hundreds of miles north. It is fairly common on hot, dry, rocky slopes between 1,100 and 1,300 m altitudes for just a few miles above and below Capilla Textla, Sinaloa, 74 miles east of Mazatlán. It associates with *Pinus durangensis* and *P. maximinoi*, and as in around Capilla Textla, with *P. oocarpa* and *Quercus magnoliifolia*. The cones often remain on the branches for several years and, from a distance, the trees can easily be mistaken for *P. oocarpa*.

CONSERVATION: Steps will be taken in collaboration with the UCODEFO in El Salto.

PARTICIPANTS IN FIELD WORK: as with the above species.

8. ***Pinus oaxacana*** (Mart.) Mirov[5] var. ***diversiformis*** Debreczy & Rácz, *var. nov.* Figure: Plate II:3; "*Pinus* C" in NewsBrief No. 6 of I.D.R.I. (Sep. 1994). TYPUS: MEXICO. Oaxaca: south of the village of Ixtlán de Juárez, 2000 m, Feb. 26, 1994, *Debreczy, Biró, Rácz, et al. #37897* (HOLOTYPUS: BP; Isotypi: A,CHAP,E,MEXU,NA).

A specie typica ramulis olivaceo-brunneis, strobilis maturis angustioribus (12 cm longis, 6 cm latis), apophysi busque potius aequaliter protuberantibus differt.

NAME: (Lat. adj.: diverse = different; diversiformis = different form) to express its divergent characteristics, comparing it with the species, *Pinus oaxacana* (Mart.) Mirov.

DESCRIPTION: large tree, 20 m tall or probably more, with broad, rounded crown, very similar if not identical with that of *Pinus oaxacana.* The needles, 5 in a fascicle, long (25-30 cm) and fine, just like in the species but with a slightly different shade with less shiny bright green color. The branchlets are green first, soon yellowish green and brown, not bluish white pruinose as is typical in the species. The cones (just like those of *Pinus attenuata* Lemm. from a distance) are elongated ovate to cylindrical, typically twice as long as wide (12 × 6 cm) with elevated, but not strongly protuberant, spiny umbos (as it is in the species) and with slightly elevated scales with strong transverse keel toward the apex.

DISCUSSION: this pine, occurring sporadically above the Río Grande valley in Central Oaxaca, typically intermingled with the species and with other pines, is distinct with its narrower, more symmetrical cones (not strongly asymmetrical ovate) with short, evenly protuberant apophyses toward the base of the cone (not with 1.5-2.5 cm long, strong projection of the apophysis particularly toward the base on the dorsal [abaxial] side). The young branchlets are shiny green, later yellowish-greenish brown and finally brown, not pruinose bluish white.

DISCOVERY: while studying the variability of *Pinus oaxacana*, we encountered single trees and small groves of this variety, intermingled with the species and other trees between and around Ixtlán and Guelatao, Oaxaca, at 1,800-2,000 m. The natural association in the region of this conifer had been destroyed, and its occurrence by now is likely restricted to secondary grasslands and scrubs with scattered stands of *Acacia, Quercus*, woody *Verbesina*, and *Vernonia* species. Among conifers, besides *P. oaxacana*, only *P. leiophylla*, *P. lawsonii*, and *P. michoacana* was found to grow nearby.

CONSERVATION: as described above, this rare variety, found on both private and community lands, is an important pine from a phylogenetic aspect. Its scattered specimens and groups, intermingled with other species, can be preserved only after careful survey and mapping the specimens in collaboration with the local commissariat and conservancy personnel.

PARTICIPANTS IN FIELD WORK: Dr. Gyöngyvér Biró, Dr. Zsolt Debreczy, Dr. István Rácz, (I.D.R.I. and Hung. Nat. Hist. Museum, Budapest, Hungary), Eva Kertész (Botanical Collection, Munkácsy Mihály Múzeum, Békéscsaba, Hungary), Vince Zsigmond (University of Horticulture, Budapest, Hungary), Yinghao Zhao (Botanical Garden of the Chinese Academy of Sciences, Beijing, China) and Earthwatch volunteers.

9. ***Pinus lawsonii*** Roezl var. ***gracilis*** Debreczy & Rácz, *var. nov.* Plate II:4; "*Pinus* D" in NewsBrief No. 6 of I.D.R.I. (Sep. 1994). TYPUS: MEXICO. Oaxaca: above the town of Oaxaca, 4 km below El Estudiantes on dry rocky outcrops, northwest facing slope, close to route #175, 1650 m, March 24, 1994, *Debreczy, Biró, Rácz, et al. #38542a* (HOLOTYPUS: BP; Isotypi: A, CHAP,E,MEXU,NA).

A specie typica foliis tenuioribus, multo elasticioribus, 1.0-1.2 mm latis, strobilis maturis lucidioribus, pedunculis eorum usque 1.5 cm longis, squamis strobilorum angustioribus (6-11 mm latis) magis flexibilibus, umboneque prominenti, aculeo brevi instructo differt.

NAME: (Lat. adj. gracilis = thin, slender) was chosen to express its fine foliage and relatively small cones.

DESCRIPTION: small to medium sized tree up to 15 m with typically rounded crown; **bark:** separated to wide, flat, densely scaly ribs, some easily detached plates and others, firmly attached and leaving chestnut brown patches, changing brown to light brown to ash gray with age, fissures orange red, conspicuous on rapidly growing trees when whole sections of the trunk show orange red; **branches:** upward curving, densely scaly, orange to reddish-brown with easily detached scales, the primary scales detach readily, replaced by thin bark scales; **buds:** small (1 cm long), pointed, reddish brown with a few white threads, bud scales (8 × 3 mm) narrow, triangular with wide hyaline margin at base; **branchlets:** thin (6-8 mm in lateral fertile shoots), densely covered with white bloom and narrow, nearly parallel sided scales; **leaves:** 3 in fascicles, 14-16 cm long, 1.2 mm wide on the dorsal side, 0.7 mm on the ventral side, the basal section covered up to 1.4 cm, partially eroded by the following year (0.4 cm) and remaining for 2 years, the initial scale pairs are papery thin with 9 stomatophorus lines on the dorsal side and 4 lines each on the ventral sides, densely serrate (60-68/cm) with small teeth (up to 0.16 mm long, with 0.03 mm clear tip); **conelets:** small (1.4 cm long), oval to ovate, abruptly contracted toward the base, consist of about 180 (56 on the contracted section), small (25 × 1.5 mm) scales, each with 0.5 mm long blunt prickle, directed (axilwise) upward on conspicuous (1.4 cm long), slender, recurved peduncle with easily detached scales; **cones:** developing on recurved, slender peduncle (1.3-1.5 cm long), firmly attached, non-serotinuous, small 3-6 × 2.3-4.0 cm), ovate, widest above base or at the middle of their length, slightly asymmetrical, consist of 80-110 (6-22 × 5 developed) scales, irregularly rounded at upper margin, shiny brown, dark chestnut brown on dorsal side with a gray seed scale print and narrow blackish zone on ventral (adaxial) side around the seed scale, apophysis (5-9 × 2-4 mm at mid-cone) flat or slightly elevated with 3-5 clearly visible keels, umbo (3-4 × 2 mm) terminating in inconspicuous (0.4-10.0 mm long), blunt prickles directing forward (as to continuation of the scale); **seeds:** small (4.5 × 2.5 mm), ovate or rounded quadrangular, evenly brown, black and gray dotted, with small (1.2 × 4.5 mm), shiny purplish gray (light yellowish gray, delineated purplish gray) wing.

DISCUSSION: this interesting rare variety of *Pinus lawsonii*, with typically rounded crown, fine, flexible, gray to grayish green needles in threes and relatively small, shiny, ovate cones with prominent prickles and up to 1.5 cm long peduncle, grows in the lower limits of the distribution of the species. It differs from that with its slender needles (1.0-1.2 mm across), with narrow, 1.5 mm wide, enclosed basal section, at most 2.4 mm across, measured at the papery thin basal scales (not 2.4 mm wide and with conspicuous basal scale pair, 3.5 mm across); the needle is 1.2 mm

wide with 8-9 stomatophorus lines (not 2.2 mm wide with 12 stomatophorus lines), with its smaller (3-6 cm long) peduncled (1.3-1.5 cm long) cones with 80-110, thin, more flexible cone scales and slightly elevated umbo, open shortly after maturing (not up to 8 cm long and nearly sessile or subsessile with sometimes slight serotinous tendency); typically with up to 160 elevated cone scales abruptly prominent below the umbo. The related *P. teocote* which also occurs in the area, is a high altitude species with elongate purplish cones before ripening and with mid-spring (not late autumn-early winter) bloom and cannot be confused with our variety.

DISCOVERY: while documenting the variability of *Pinus lawsonii*, we found small stands and scattered individuals in two locations in the Sistema Montañoso del Norte de Oaxaca. The best trees are in the dry foothills of a wide valley just above the city of Oaxaca, about 4-5 km south of El Estudiantes at an altitude of 1650 m. This is the first conifer which appears while gaining altitude from the dry Altiplano. The other location is near a dirt road leading to the village of Ixtepeji at 1900 m.

CONSERVATION: we reported these locations to the Instituto Tecnológico de Oaxaca (Dr. Enríque Martínez), and the protection of this variety will be handled together with the other species and varieties of conifers in Oaxaca in cooperation with the local communities.

PARTICIPANTS IN FIELD WORK: as with the above variety and Earthwatch volunteers.

10. ***Pseudotsuga menziesii*** (Mirb.) Franco var. ***oaxacana*** Debreczy & Rácz, *var. nov.* "*Pseudotsuga* A" in NewsBrief No. 6 of I.D.R.I. (Sep. 1994). TYPUS: MEXICO. Oaxaca: Sistema Montañoso Norte del Oaxaca 15 km north of the town Oaxaca, Cerro San Felipe, on and below the huge limestone outcrop called Peña Prieta (Peña Piedra), NE slope of Corral de Piedra above the village El Estudiantes, at 2700 m, February 15, 1994, *Debreczy, Biró, Rácz, et al. #37614* (HOLOTYPUS: BP; Isotypi: A,CHAP,E,MEXU,NA).

Arbor, ad 30 m alta; **habitus** anguste pyramidaliter columnaris; **truncus** rectus, diametro usque 80 cm; cortex sicut speciei: crassus, suberosus, costis altis; **rami** dense squamulosi, squamulis primordialibus vel residuis earum usque 8-10 annos persistentibus, postea lucide cinerei, porro concrescentes squamis corticalibus atrocinereis instructi; **ramuli** typice breviter sparsim pubescentes, pallide virides; gemmae 4 mm longae, 2 mm crassae, cylindricae, sanguineo-brunneae, non-resinosae, in siccitate squamis recurvatis; **folia** typice brevia et relative lata (1.0-1.7 cm longa, 1.0-1.2 mm lata), cinerascentia, cinereo-viridia, lateribus parallelis, apice abrupte acuminata, mucronulata, pruinosa, in latere dorsali lineis stomatum nullis, in latere ventrali limitibus 2, uterque lineas 4 glaucas stomatum ferentibus; folia margine conspicuo (1.6 mm lato) et costa media crassa (0.20-0.25 mm); **strobili juveniles** ineunte mensis Martii apparentes, strobili juveniles feminei rosacei vel pallide virides typice pruinosi, 1.5-2.0 cm longi, 0.6-1.0 cm lati, strobili juveniles masculini 8 mm longi, 5 mm lati; **strobili maturi** parvi, 2-4 cm, raro 6.5 cm longi, saepe squamis minoribus quam 10, plerumque 25 squamis rotundatis, squamae 1.5 cm longae, 2.2 cm latae, dense pilosae, in latere externo prominenter venosae; bracteae conspicue longae, in sectione media strobili 2 cm longe exsertae, variabiles; semina pallide brunnea, 4 mm longa, 3 mm lata, alae 7-8 mm longae, 3-4 mm latae.

DESCRIPTION: Narrow columnar tree up to 30 m tall with first upcurving, later ascending-upcurving, short main branches forming a columnar pyramidal habit, with trunk diameter up to 80 cm; **bark:** thick with high ribs, suberous like in the smaller trees of the species; **branches:** densely scaly with primary scales or remnants up to 8-10 years, shiny gray, later replaced by thin, gray to dark gray cortical scales; **buds:** (4 × 2 mm) cylindrical reddish-brown, not resinous, the lower scales recurved in dry weather; **branchlets:** typically short, relatively thick (1st year 3 mm across), sparsely pubescent, first light green, later purplish brown; **needles:** typically short and relatively wide (1.0-1.7 cm × 1.0-1.2 mm), parallel sided, abruptly acute, mucronulate at the end, deeply grooved above the midrib, pruinose without stomatophorus lines above, with two stomatophorus bands below on the upper, adaxial surface, with 4 glaucous lines in each and conspicuous but narrow (0.16 mm) margin and strong (0.2-0.3 mm) midrib; **cone inflorescences (strobiles):** appears in early March, female- (1.5-2.0 × 0.6-1.0 cm) pink or green, typically pruinose; male- (0.8 × 0.5 cm): light yellow to pinkish yellow; **cones:** 2-4 × 1.5 cm, rarely up to 6.5 cm long, with often less than 10, otherwise 25, rounded, relatively small cone scales wider than long (1.5 × 2.2 cm), with dense, appressed, short (0.25 mm) hairs; the cone scales are prominently veined on the abaxial (dorsal) side; there are shorter hairs inside around the two, smooth seed prints (9 × 4 mm); bracts exserted, slightly longer than the midscales, upcurving toward the base (before the cone matures or when wet), 2 cm long at the widest scales, narrow (3 mm wide) and serrate below the middle, usually tricuspidate with short points on the outer edge of the wings forming a short stemmed, often "closed", "V" from 5 mm below the shortly protruding tip, becoming needle-like or nearly so; lateral lobes of the bract are inconspicuous or absent toward the base; **seeds:** (old when observed) 4 × 3.0-3.5 mm, light yellowish gray-pale brown with 9 × 4 mm wing, light grayish yellow in color with or without a few short brownish lines.

NAME: after the state of Oaxaca in southern Mexico, where it was found. The locality is just 15 km as the crow flies from the capital of the state, with the same name, Oaxaca de Juárez.

DISCUSSION: this narrow columnar Douglas-fir (from a distance appearing like cultivated *Cupressus arizonica* Greene) with grayish foliage and small cones, was found around a huge limestone rock, Peña Prieta (Peña Piedra), on the northeastern slope of a valley in the San Felipe Mountains at 2700 m altitude, a few miles north of the town of Oaxaca. Following this, on June 28, 1994, Prof. Boone Hallberg of the Instituto Tecnológico de Oaxaca reported that "Sr. Evodio, consejo de Vigilancia, Ixtepeji and Sr. Alfredo Yescas" located the tree in Rosa Blanca, a few kilometers north of the first location. Since September, the species has also been reported from the (newly identified) highest mountain 3751 m, 12, 303′ [not Cerro Zampoaltepetl, 3395 m(!) known previously as the highest] of Oaxaca (according to Boone Hallberg, "from lat. 15°22′ N, long. 96°06′ W; must be 16°22′ N, 96°06′ W, Cerro Quiexobra, Sierra Madre del Sur(!) 110 km SE of the town of Oaxaca, 35 km SE of Miahuatlán de Porfirio Diaz). All these data indicate how widely the species had been distributed in a cooler, relatively more humid period. Applying *Pseudotsuga menziesii* in a broad sense, this location represents the southernmost distribution of the species and, simultaneously, that of the entire genus worldwide (*P. wilsoniana* Hay. and *P. brevifolia* W.C. Cheng & L.K. Fu grow near the 22nd latitude in Taiwan and in south China, respectively). To understand the systematic position of our variety, it is necessary to evaluate the relationships of all species described from México with those in the north and evaluate this new variety within that relationship. As discussed in the

introduction, species such as the north Mexican *P. flahaultii*, *P. rehderi*, *P. guinieri* and the one, considered the southernmost member of the "*menziesii* group", *P. macrolepis*, are not consistent in their morphological characters and better to be considered a synonym of *P. menziesii*. This is why the Oaxacan Douglas fir is better treated as the southernmost and isolated variety of the main species (see introduction).

DISCOVERY: we found this variety in the San Felipe Mountains at 2700 m altitude, north of the city of Oaxaca. It associates with *Pinus oaxacana*, *Pinus pseudostrobus* Lindl. (including var. *megacarpa* Loock), and *Pinus teocote*, *Arbutus xalapensis*, *Litsea glaucescens*, *Prunus serotina* subsp. *capuli*, *Quercus candicans* /*calophylla* Cham. & Schltdl., *Q. crassifolia* H. B. K., *Q. laurina*, and *Q. castanea* in the upper level and *Comarostaphylis conzattii* /*arguta*, *Senecio angularis* auct., *S. barba-johannis* DC. in the scrub, *Gaultheria hirtiflora*, *Pernettya ciliata* Small, *Vaccinium confertum* H. B. K., with a rich (*Thuidium*, *Polytrichum*) moss level with *Sedum*, *Crassula*, Pteridophytes (*Elaphoglossum*, *Adiantum*) and a few herbaceous plants such as *Heuchera*, in the lower scrub level. High stemmed (2-4 m tall) *Dasylirion lucidum* auct. with nodding terminal is common in the shade of the trees. The small forest in the deeper soil under the big rock is rather poor in the number of species. The associations of the species in this location are distinct from any other location of the Douglas firs.

CONSERVATION: the area was visited by professors from the Instituto Tecnológico de Oaxaca and representatives of the Oaxacan and local governments. With the new discovery of Douglas fir in the nearby Peña Rosa, two patches, each not more than 2-3 hectares has been known. Even if the most recent discovery of Douglas-fir (evidently the same variety) in Cerro Quiexobra, raises the number of the known locations to three, the tree should still be considered rare and very local, necessitating designation of all known locations for strict conservation policy. The protection of two locations of this rare tree, together with other rare taxa found in the larger area, is proceeding as suggested, within the framework of a proposed "San Felipe National Park".

PARTICIPANTS IN FIELD WORK: Dr. Gyöngyvér Biró, Dr. Zsolt Debreczy, Dr. István Rácz, (I.D.R.I. and Hung. Nat. Hist. Museum, Budapest, Hungary), Eva Kertész (Botanical Collection, Munkácsy Mihály Múzeum, Békéscsaba, Hungary), Yinghao Zhao (Botanical Garden of the Chinese Academy of Sciences, Beijing, China) and Earthwatch volunteers.

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[1]A compact tree (6 × 5 m) with very dense foliage was located in the land of Ixtlán de Juárez, which would be valuable for gardens in zone VIII-IX; for availability and further reference, contact Mr. Gustavo Santiago Ramírez, Ixtlán de Juárez, Oaxaca. Gray-blue forms of *Pinus lawsonii* are particularly spectacular in Guerrero, in the Chilpancingo region, *e.g.*, along the road from Xochipala to Yextla.

[2]M.C. Guízar N. Enríque, Div. de Ciencias Forestales, Universidad Autónoma Chapingo, México.

[3]Rosalva Miranda Salazar, UCODEFO No. 6, El Salto, Durango, México.

[4]Biól. Gustavo Ramírez Santiago, of Ixtlán de Juárez, Oaxaca, México.

[5]Note: We believe that *Pinus oaxacana* (Mart.) Mirov should be the properly authorized name. No better description with precise and clear illustrations could be given, than what was provided by Maximino Martínez with his *P. pseudostrobus* Lindl. var. *oaxacana* Mart. Unfortunately, in most literature Martinez's name has been improperly dropped after Mirov elevated the variety to species rank.

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NOMENCLATURAL COMBINATION IN POACEAE

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ABSTRACT

The following nomenclatural change in Poaceae is proposed: ***Sporobolus compositus*** var. ***clandestinus*** (J. Biehler) *comb. nov.*

KEY WORDS: *Sporobolus*, nomenclature, Poaceae

Sporobolus compositus (J. Poiret) E. Merrill var. ***clandestinus*** (J. Biehler) J. Wipff & S.D. Jones, *comb. nov.* BASIONYM: *Agrostis clandestina* J. Biehler, *Plantarum Novarum ex Herbario Sprengelii Centuriam* 8. 1807. *Muhlenbergia clandestina* (J. Biehler) K. von Trinius, *De Graminibus Unifloris et Sesquifloris* 190. 1824. *Vilfa clandestina* (J. Biehler) Nees von Esenbeck *ex* E. von Steudel, *Nomenclator Botanicus*, ed. 2, 2:767. 1841. *Sporobolus clandestinus* (J. Biehler) A. Hitchcock, Contributions of the U.S. National Herbarium 12:150. 1908. *Sporobolus asper* (P. de Beauvois) K. Kunth var. *clandestinus* (J. Biehler) L. Shinners, Rhodora 56:30. 1954. TYPE: UNITED STATES. Pennsylvania: *Muhlenberg 115* (TYPE: PH; Type Fragment: US).

Sporobolus canovirens G. Nash *in* N. Britton, *Man.* 1042. 1901. *Sporobolus asper* (P. de Beauvois) K. Kunth var. *canovirens* (G. Nash) L. Shinners, Rhodora 56:30. 1954. *Sporobolus clandestinus* (J. Biehler) A. Hitchcock var. *canovirens* (G. Nash) J. Steyermark & J. Kucera, Rhodora 63:24. 1961. TYPE: UNITED STATES. Kansas: St. George, 3 September 1890, *Kellerman* (TYPE: NY).

Kartesz & Gandhi (1995) reported that the basionym of *Sporobolus asper* [*Agrostis aspera* A. Michaux (1803)] is a later homonym and illegitimate, and that *Agrostis composita* J. Poiret is the earliest available name for this taxon. *Sporobolus clandestinus* (J. Biehler) A. Hitchcock and *S. compositus* (J. Poiret) E. Merrill are very similar morphologically. Riggins (1977) separated the two taxa by the following characters: *Sporobolus clandestinus* has sparsely, appressed, pubescent lemmas and a pericarp loose when moist, whereas, *S. compositus* has glabrous lemmas and a pericarp gelatinous when moist. We believe that this kind of morphological variation is best recognized at the variety level; thus making the above combination necessary.

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NEW DATA ON DISTRIBUTION AND MORPHOLOGY FOR THE RARE *HASTEOLA ROBERTIORUM* (ASTERACEAE)

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ABSTRACT

Newly discovered localities and their somewhat different habitats are described for the rare Florida endemic *Hasteola robertiorum*. The basic species description is modified to include minor variations found in these new populations.

KEY WORDS: *Hasteola robertiorum*, Asteraceae, Florida, range extension, morphological variation

DISCUSSION

The recently described *Hasteola robertiorum* L.C. Anderson is a very rare Florida endemic related to the more widespread *H. suaveolens* (L.) Pojarkova, formerly known as *Cacalia suaveolens* L. (Anderson 1994). *Hasteola robertiorum* was described from only a few populations in Levy County, Florida. New populations

were discovered in 1994 from somewhat different habitats in Lake County, Florida, in an area disjunct 120 km from the Levy County sites. Additionally, the species description must be emended slightly to accommodate certain features found on plants from these new populations.

The abbreviated collection data of the Lake County populations are: soggy black muck of seepage-saturated hydric hammock along spring-fed blackwater stream (Sulphur Run) in Seminole State Forest, ca. 1 air km SE of Lake Jordan, ca. 25 air km ENE of Eustis, 18 Oct 1994, *S.L. Orzell, E.L. Bridges, & G. Reese 23332* (FLAS, FSU,FTG,NY,TEX,USF); soggy, often quaking, deep black muck of hydric hammock along Sulphur Run, Seminole State Forest, ca. 0.8 air km SE of Lake Jordan, ca. 24 air km ENE of Eustis, 18 Oct 1994, *S.L. Orzell, E.L. Bridges, & G. Reese 23336* (FSU,FTG,TEX,USF).

Many thousand plants of *Hasteola robertiorum* are found over a distance of at least one km in the Sulphur Run hydric hammock. The two collection sites are firm to quaking muck microhabitats that are scattered within a blackwater creek valley hydric hammock. There are some isolated areas of saline seepage; the surface soil pH ranges from generally 6.8 to 7.2 (near saline seeps). The canopy of the quaking muck site is dominated by *Magnolia virginiana* L., *Sabal palmetto* (Walt.) Lodd. *ex* Schult. & Schult., and *Acer rubrum* L., with a tall shrub layer of *Cornus foemina* Mill., *Myrica cerifera* L., and *Leucothoe racemosa* (L.) A. Gray. The canopy dominants of the firmer muck site are *Sabal palmetto, Quercus laurifolia* Michx., and *Tilia caroliniana* Mill., with a subcanopy-shrub layer of *Carpinus caroliniana* Walt., *Agarista populifolia* (Lam.) Judd, and *Myrica cerifera.* Herbaceous taxa found at both sites include: *Boehmeria cylindrica* (L.) Sw., *Carex leptalea* Wahl., *Dryopteris ludoviciana* (Kunze) Small, *Mikania cordifolia* (L.*f.*) Willd., *Oplismenus setarius* Lam., *Osmunda cinnamomea* L., *Panicum commutatum* Schult., *Rhynchospora miliacea* (Lam.) A. Gray, and *Thelypteris palustris* Schott. An additional 63 vascular plant species were associated with *Hasteola* in at least one microhabitat.

Rare species found at one of both of the Lake County sites include *Carex chapmanii* Steud., *Cirsium muticum* Michx., *Rhapidophyllum hystrix* (Pursh) Wendl. & Drude, and *Salix floridana* Chapm.; of these, only *Carex chapmanii* is found at the Levy County sites. The relatively drier Levy County sites also differed noticeably in that they had very few *Sabal palmetto*, which was abundant in the Lake County sites.

Lake County plants (especially those of *Orzell et al 23332*) are generally more robust than those from Levy County. Plants are up to 15 dm tall with basal (radical) leaves up to 54 cm long with petioles up to 32 cm long. Lower cauline leaves are up to 38.5 cm long and 16.5 cm wide. These measurements surpass those of any wild-collected Levy County plants (Anderson 1994), but the progeny of Levy County plants that were garden-grown by Anderson in Tallahassee were even larger. Lake County plants also have more purple pigmentation on lower stems and petioles, and the prominent basal auricles on some cauline leaves measure up to 9 mm long.

Involucres on Lake County plants have average lengths for the species, but the phyllaries number only 7-8, and the 4-7 subtending bracteoles are only 4-6 mm long. Flowers are fewer (8-10 per head). Corollas are average in length, but the tubes are generally longer (5.0-5.4 mm long), the throats concomitantly shorter (1.7-2.4 mm long), and the lobes 2.0-2.8 mm long. Anthers are somewhat shorter (2.0-2.5 mm long). The balusterform anther collars and enlarged stylopodia are typical for the species.

Achenes are shorter (6-7 mm long), and the pappus somewhat longer (5-6 mm long) on Lake County plants compared to 7-9 mm long and 4-5 mm long, respectively, for Levy County plants. The carpopodium on Lake County plants has 4-

6 rows of distinctive square to procumbent cells; those of Levy County plants consistently had 6 rows.

In general, the involucral characters of the Lake County plants, particularly phyllary number and number of flowers per head, expand the variation of *Hasteola robertiorum* away from the related species, *H. suaveolens*, providing further evidence of its distinctness. However, floral characters generally indicate more overlap in floral measurements between *H. robertiorum* and *H. suaveolens* than had previously been known. This is not surprising considering that *H. robertiorum* had been described from only a few populations in a very narrow local area, and the Lake County populations may have been isolated from those in Levy County for a significant period. Nevertheless, the consistent trend in reduction of phyllary number and number of flowers per head in Florida *Hasteola* suggests that they are remnants of a once more continuous range.

The Lake County plants, though slightly different in some aspects of morphology from those of Levy County, are not sufficiently distinctive to warrant special taxonomic recognition as a variety or subspecies. The discovery of *Hasteola robertiorum* in Lake County has greatly enlarged the known range for this species (the species being more abundant here than in Levy County), but it still remains a very rare endemic. The Florida Endangered Plant Advisory Council has recommended that it be listed as "endangered" in Florida.

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CAREX INVERSA R. BR. (CYPERACEAE), NEW TO HAWAII AND THE UNITED STATES

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ABSTRACT

Carex inversa R. Br., a rhizomatous perennial species endemic to Australia and New Zealand, is reported for the first time from the Hawaiian Archipelago. The taxon was discovered in an area known as the Kipuka Alala near the center of the island of Hawaii at an elevation of approximately 1675 m (5500 ft). The species occurs in *Styphelia* Mixed Shrubland, Dense *Dodonaea* Shrubland, and Sparse *Metrosideros* Montane Treeland plant communities. Two other introduced Australian species [*Lepidium hyssopifolium* Desv. and *Crassula sieberiana* (Schult.) Druce] are restricted to the same general area as *Carex inversa.* The occurrence of the taxon probably represents an inadvertent introduction by domestic livestock or in grass seed mixtures. Long distance transport by wind or birds is another possible but highly improbable mode of introduction for the species. Rather large clones, some up to 4 m in diameter, and occurrence of the taxon in several diverse habitats suggests that the original introduction may not be recent.

KEY WORDS: *Carex*, Hawaii, Australia, New Zealand, introduction

The first taxonomic revision of the *Carex* of the Hawaiian Islands listed nine species which were all thought to be native (Krauss 1950). The most recent revision of the carices recognizes eight species from the Islands (Koyama 1990); however, only four species are listed as endemic and four are indigenous. The geographic affinities for the indigenous species are: one with Eurasia, one with Europe and Pacific North America, one with the Caroline Islands, and one possibly with eastern Asia.

Carex inversa R. Br. (Figures 1, 2), commonly known as knob sedge, is being reported for the first time from the Hawaiian Islands. This taxon is a member of subgenus *Vignea* and section *Inversa*. It is a perennial herb (0.25-0.75 m high) that occurs frequently in clonal swards because of its spreading rhizomes. Culms are slender and leaves are basal as well as cauline. The leaf blades are linear (1-4 mm wide) and involute at the tip. The leaf sheaths tightly clasp the stem and project beyond the juncture with the blade producing a membranous appendage (contra-ligule). The gynecandrous inflorescence is composed of 2-3(-4) short, ovoid terminal spikes (5-15 mm long). The lowermost spike is subtended by leaf-like involucral

bracts, at least one of which surpasses the entire inflorescence. Each perigynium is subtended by an ovate, short-awned scale (2.0-3.0 mm long). The midribs of the scale are prominent and pale green, and margins are broad, translucent and entire. Male flowers have 3 stamens (1.9-2.1 mm long), and the anthers are 2-celled (1.1-1.6 mm long, including the anther hairs) with numerous basally-fused hairs present at the anther's apex. Female flowers are comprised of a single pistil with 2 stigmas. The pistil is contained within a beaked perigynium (~ 3 mm long) and the branches extrude from a small bifid orifice at the apex. The perigynium is slightly winged above the middle, and the margin is finely serrate. Abaxial and adaxial faces are strongly veined (9-11 and 6-8, respectively). The achene is flattened, lenticular and reaches ~ 2 mm in length at maturity. Our collections were verified by comparison with specimens from Australia (US 31117, 1349954, 2072356, 2072359, 2072373, 2126591, 3165854) and New Zealand (US 1239957, 3165853, 3165855, 3203467) at the US National Herbarium and by Drs. Anton A. Reznicek (University of Michigan) and Karen Wilson (New South Wales Herbarium). Bentham (1878), Moore & Edgar (1970), and Black (1978) all listed varieties for *C. inversa*; however, most recent usage suggests that separation into intraspecific categories is unwarranted without further study.

Carex inversa grows in the Australian states of Queensland, New South Wales, Victoria, Tasmania, South Australia, and West Australia. The taxon also is reported from both the North and South Islands of New Zealand. Burbidge & Gray (1970) described the plant as a weedy sedge which forms dense patches or swards in poorly sown or modified natural grasslands. In New Zealand tussock grassland communities, *C. inversa* grows in association with *Poa caespitosa* Spreng., *Festuca novae-zealandiae* (Hack.) Cockayne, *Danthonia gracilis* Hook., *Danthonia unarede* Raoul, and *Dichelachne crinita* (L.) Hook. (Cockayne 1967). Burbidge & Gray (1970) and Beadle *et al.* (1972) reported the species from *Eucalyptus* woodlands and swampy areas or creek banks. Within its range, the taxon is relatively common and widespread in mesic sites of localized communities. Healy & Edgar (1980) reported that *C. inversa* is a troublesome weed in lawns, paths, and rockeries. Because of its rhizomatous habit, *C. inversa* may be invasive and difficult to eradicate (Willis 1962). It appears to be tolerant of grazing and may be of value in providing a limited amount of fair quality forage when it occurs in quantity (Leigh & Malham 1965). The plant also appears to be resistant to trampling and mowing.

Carex inversa was discovered during floristic inventories on the Pohakuloa Training Area (PTA), Hawaii (Figure 3). PTA is the largest U.S. Army installation in Hawaii, over 43,700 ha (108,000 ac) in size, and is situated in the saddle between two volcanoes (Mauna Kea and Mauna Loa) which are over 4200 m (13,800 ft) in elevation. Approximate average annual precipitation for the saddle area is 39 cm (15 in) [data from Bradshaw Army Airfield which is 14 km (9 mi) northeast and 200 m (650 ft) higher in elevation than the collection sites for *C. inversa*]. Substrate on the installation is composed of numerous younger (<10,000 year old) Mauna Loa lava flows and some older (>10,000 year old) Mauna Kea flows. The diversity in lava substrates combined with the fairly wide altitudinal gradient gives rise to a complex mosaic of plant communities. Castillo *et al.* (1994) have delineated 24 plant communities on the installation. Shaw & Douglas (1995) have documented ten endangered or threatened species, five Category 2 candidate species, and one presumed extinct species on the installation. *Carex wahuensis* C.A. Mey. subsp. *wahuensis* and subsp. *rubiginosa* (R. Krauss) T. Koyama are the only other members of the genus found on the installation.

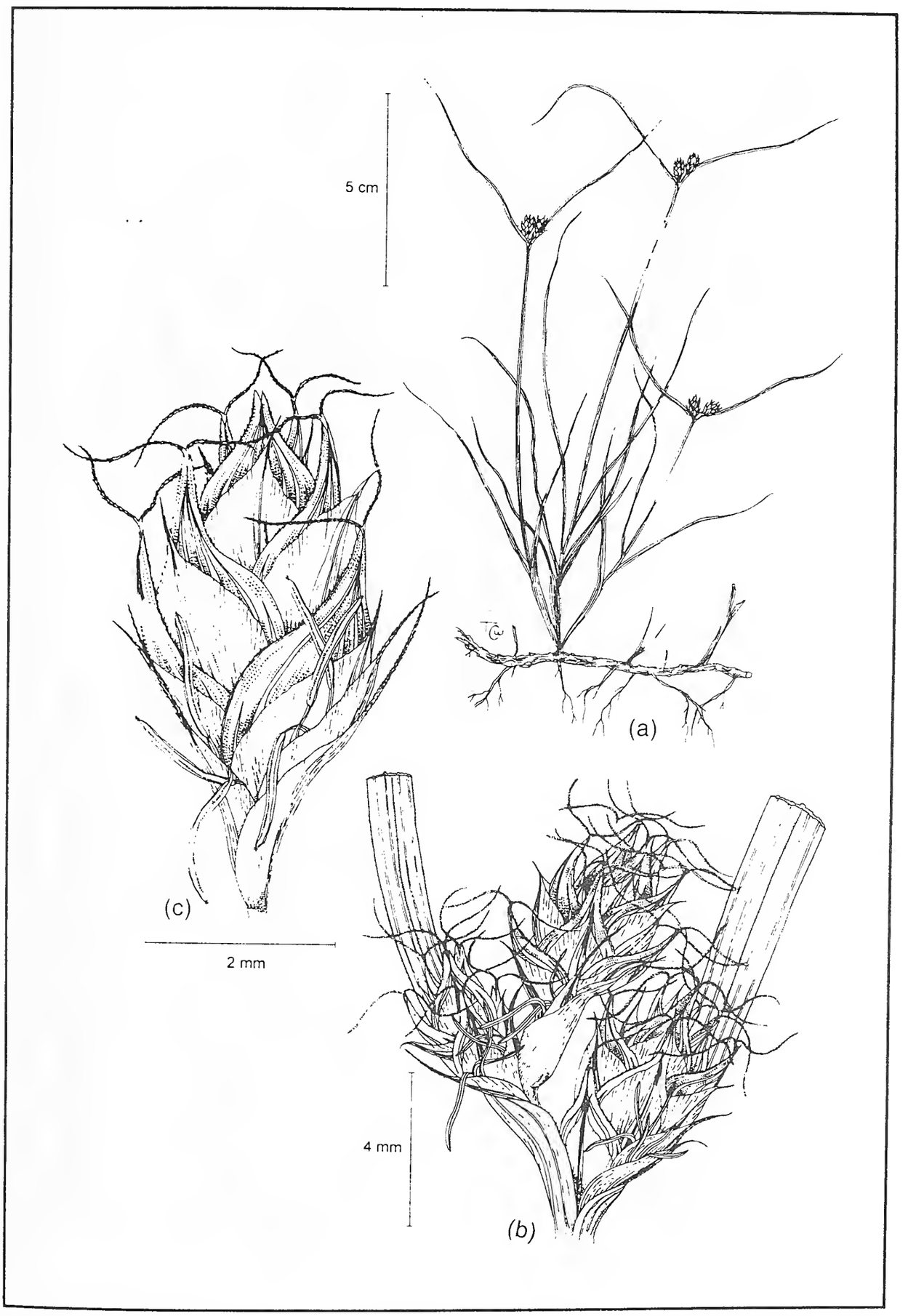

FIGURE 1. Carex inversa R. Br. (Douglas et al. 4618) a. general habit illustrating extensive rhizome development, b. inflorescence composed of three spikes, and c. single gynecandrous spike

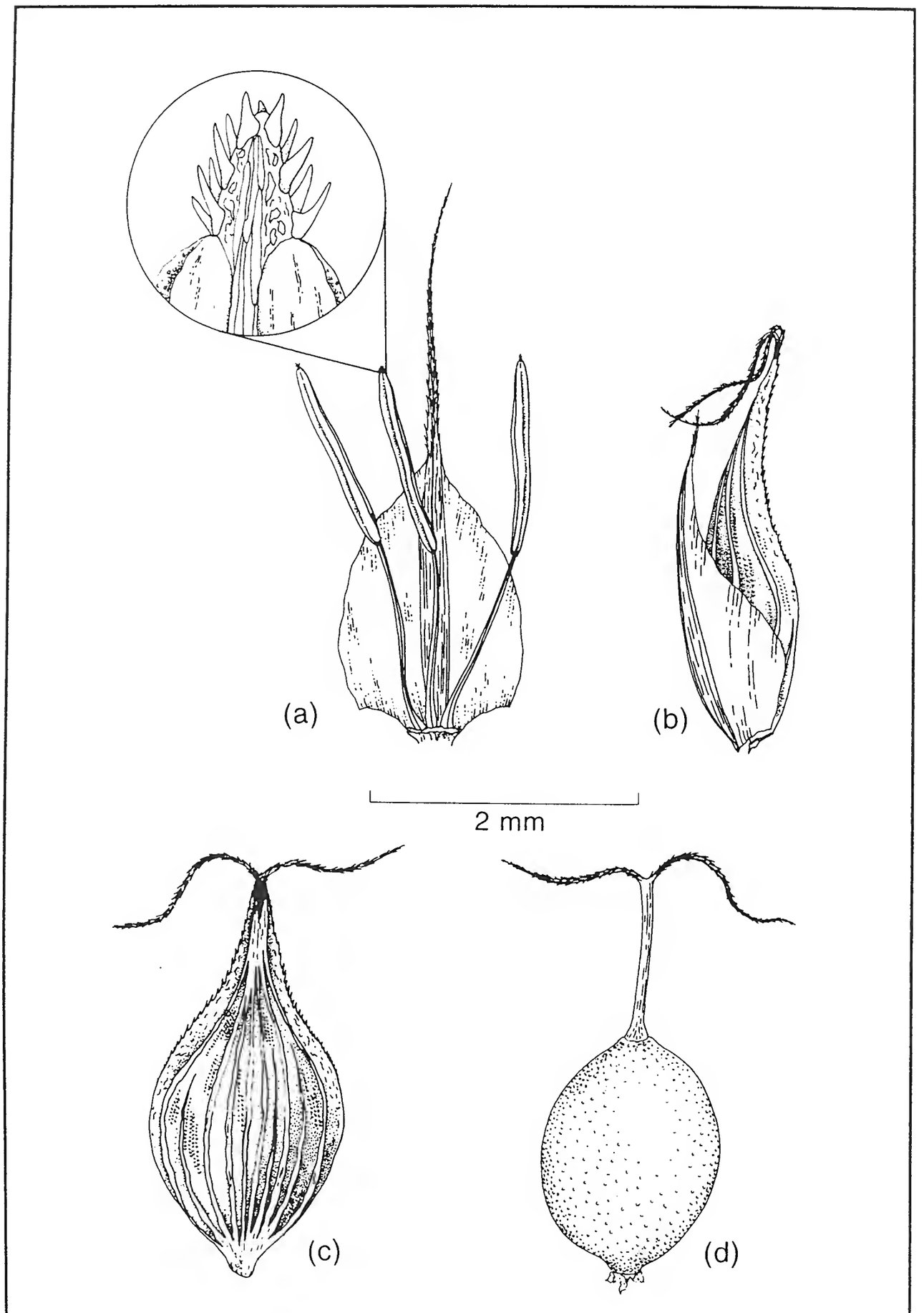

FIGURE 2. Carex inversa R. Br. (Douglas et al. 4618) a. Male flower with insert showing terminal anther hairs, b. perigynium with bract, c. abaxial face of the perigynium, and d. leticular achene

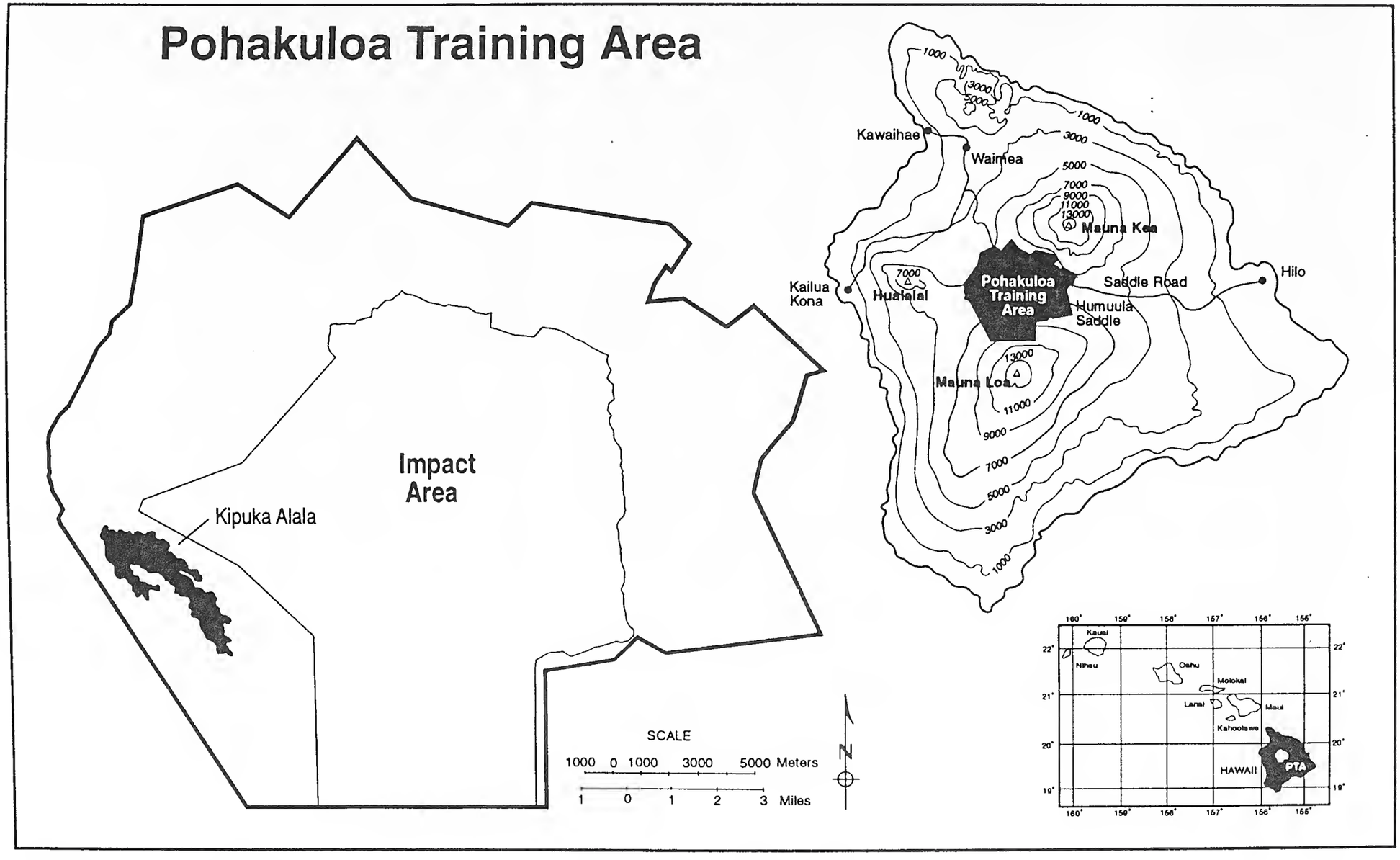

FIGURE 3. Location of Kipuka Alala in the southwest portion of Pohakuloa Training Area on the island of Hawaii, Hawaii.

Carex inversa was first collected near and in Kipuka Alala, on the southwestern portion of the installation (Figure 2) (*Douglas et al. 3507* [MICH], *3508* [BISH], *4612* [CS], *4618* [CS], *5045* [RM], *5048* [CS]). A kipuka is an older and more heavily vegetated lava flow that is surrounded and isolated by younger flows with sparser vegetation. Kipuka Alala is approximately 1750 ha (4325 ac) in size and the substrates are Mauna Loa lavas ranging in age from 1500 to > 4000 years old (Lockwood *et al.* 1988). Vegetation within Kipuka Alala consists of *Dodonaea*, *Styphelia*, and *Myoporum* dominated shrublands (Castillo *et al.* 1994). Adjoining younger flows (< 1500 years old) support open *Metrosideros* treelands.

Carex inversa is rare to scattered in the following plant communities: *Styphelia* Mixed Shrubland, Dense *Dodonaea* Shrubland, and Sparse *Metrosideros* Treeland (Castillo *et al.* 1994). Plants occur in soil and/or ash accumulations which are slightly more mesic than the surrounding landscape. The taxon generally grows in full sun. Plants were observed flowering during the wet period of the year (November to February), which differs from the flowering period for Australian and New Zealand populations (October to April) (Marchant *et al.* 1987). Plants grazed by feral sheep and/or goats were seen; however, no adverse effects of grazing were noticed.

A vascular plant survey of the installation documented 249 species growing on PTA (Shaw & Douglas 1995). Approximately 61% (157 species) of these taxa are naturalized. Nineteen taxa are introduced species from Australia and/or New Zealand. Three Australian introduced grass species [*Danthonia pilosa* R. Br., *Ehrharta stipoides* Labill., and *Eragrostis brownei* (Kunth) Nees *ex* Steud.] are common within the area.

There are two other examples of Australian or New Zealand species introduced only into the saddle area and PTA (Shaw & Douglas 1995; Wagner *et al.* 1990). *Lepidium hyssopifolium* Desv. (Brassicaceae) was first found in 1975 in the saddle area and was known from only two collections until recently verified from PTA (Wagner *et al.* 1990). *Crassula sieberiana* (Schult.) Druce (Crassulaceae) is a widespread interstitial species throughout the installation. Wagner *et al.* (1990) reported that this taxon was first collected in 1978 and apparently was a recent introduction.

Several explanations exist for the occurrence of these Australian species only in the saddle region of the island of Hawaii. First, a single natural event may have brought the species to the saddle area (*i.e.*, storm or birds). Second, the species were introduced by humans in forage seed mixtures, by herds of grazing animals, or by military vehicles. Third, the introduction of these taxa may be completely unrelated and represent separate events. Prior to the mid 1970's, relatively few introduced taxa were reported from the saddle region which suggests the region was either still fairly pristine at this time or poorly collected. If the former is true, then the Australian species may indeed be rather recent introductions. Conversely, the large clones indicate that *Carex inversa* may have occurred at PTA before this date. Studies are ongoing to examine the genetic variability throughout the species and to determine similarities between Hawaiian and Australian/New Zealand material. These data should help determine the origin of the Hawaiian populations as well as the approximate time of introduction.

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NEW RECORDS AND NOTES CONCERNING *CASTILLEJA SPIRANTHOIDES* (SCROPHULARIACEAE)

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ABSTRACT

Newly identified collections of the little-known *Castilleja spiranthoides* are documented, and a summary of its morphology, ecology, distribution and possible relationships is provided. This species appears to be an anomalous member of sect. *Castilleja*, with its nearest relative probably being *Castilleja ctenodonta*.

KEY WORDS: *Castilleja, Castilleja spiranthoides, Castilleja ctenodonta*, Scrophulariaceae, chromosome numbers, Sinaloa, México

Castilleja spiranthoides Standley is a distinctive but little known taxon previously reported only from the type collection (*Ortega 6896* [F!]), made in the vicinity of Los Gusanos, San Ignacio in south-central Sinaloa. Its description by Standley (1936) contains only the Latin description, the collection number, the location cited above and the sparse collection notes, "in dry soil, March 1931". Since that time references to *C. spiranthoides* appear to be absent from the botanical literature.

Recently, a review of undetermined collections of Mexican *Castilleja* from the herbaria of ASU and ARIZ revealed three additional collections of *Castilleja spiranthoides*, extending its known range at least 70 km to the southeast. More importantly, they provide additional insight into the morphology and possible relationships of this rather unusual species within *Castilleja*.

The three newly identified collections, all from Sinaloa, México are as follows:

1. Near El Batel, along highway from Mazatlán to Durango, mixed oak and pine forest with steep southerly slopes, elevation 5,000 to 6,000 ft., 6 February 1952, *Gentry 11562* (ARIZ!). The specimen label also contains the notation, "annual with red flowers". This sheet holds four complete plants. Unpublished collection records in Gentry's hand list the collection date as 5 February 1952 and include the locality notation of "Palmito-Batel, Sinaloa" (P. Jenkins, ARIZ, pers. comm.). A duplicate of this collection is deposited at MICH and was independently identified as *Castilleja spiranthoides* by G.L. Nesom in 1992 (Nesom, pers. comm.).

2. Just west of El Palmito, Rancho El Liébré, pine forest hillside and deep barranca, elevation ca. 7,000 ft., 13 March 1980, *Lehto 24384* (ASU!). This sheet holds four complete plants and two partial stems.

3. About 1 mi. north of Mexican Highway 40, between Villa Unión and Ciudad Durango, about 5 miles west of Durango state border, elevation ca. 7,600 ft., 14 March 1985, *Daniel 4028* (ASU!). This sheet holds two complete plants. The specimen label also provides the notation, "Bracts reddish; occasional."

In addition, a fourth new collection of *Castilleja spiranthoides* is deposited at UCR, according to notes and photographs of the collection on file at UC(!). This sheet was annotated as *C. spiranthoides* by L.R. Heckard in 1992. The original citation is as follows: Rancho Libre Barranca, 2 air miles northwest of El Palmito, north of Hwy. 40 and very near the Durango state line, 27 March 1984, *Sanders 4903.* Additional notes by the collector indicate that the plants occurred in cloud forest on north slopes in pine/oak vegetation on exposed ridges and that the plants were "fairly common in duff under pines". The annotation by Heckard also notes that the calyx is divided more deeply in front than behind and that the lobes of the lower lip of the corolla are infolded.

While the Latin description by Standley appears to accurately represent the plants in the newly identified collections, a few additional and potentially diagnostic characters are apparent in these plants. The plants represented in the collections of Lehto and Daniel are vigorous specimens in prime flowering condition, and the measurements from these plants for all vegetative and flowering parts are consistently and proportionately larger than are those found in the holotype or in the Gentry collection, which appear to possess somewhat depauperate and/or desiccated inflorescences. Measurements from the description by Standley (1936) of the type collection more closely resemble those of the Gentry collection. Whether these differences are due to ecological conditions or to natural variation among healthy plants is unknown. However, it is clear that all five of these collections are of a single species. The following notes are based upon Standley's description combined with data from the newly identified collections and are intended to supplement Standley's type description of *Castilleja spiranthoides*:

Plants annual; stems 25-35 cm tall, mostly simple, erect, slender and densely villosulous with gland-tipped hairs; leaves numerous, crowded and ascending below, becoming shorter, widely spaced, erect, and with a finely sinuate-margined apex above, 15-50 mm, entire, linear and narrowly acuminate, sessile to subclasping but not at all auriculate, villosulous with gland-tipped hairs; inflorescence at first a subcapitate spike, the internodes elongating with age; bracts (15-)20-24 mm long, usually entire (occasionally with several short, acuminate, apiculate teeth) greenish basally, becoming pink to light red-purple above with prominent dark red-purple veins, bluntly ensiform to narrowly pandurate with a rounded, sinuate-margined, petaloid tip, moderately to densely villosulous with gland-tipped hairs; calyx (10-)18-27 mm long, entirely pink to red-purple with prominent dark red-purple veins, sparsely stipitate-glandular, tube 2-3 mm wide for most of its length, then widening to 3-5 mm near the base of the lobes, abaxial cleft 12-16 mm long, adaxial cleft 6-8 mm long, with secondary clefts 2-4 mm long, narrowly acuminate, slightly unequal, often falcately upturned; corolla (12-)20-30 mm long with tube and beak of about equal length, only slightly exceeding the calyx in length but often at least partially exserted

outward from the abaxial calyx cleft, mostly glabrate, tube pale, beak becoming entirely reddish except for a pale green and shortly bearded dorsal surface, lower lip of three dark greenish, incurved teeth, 1.0-1.5 mm in length.

Castilleja spiranthoides appears to flower during most of February and March, although the full duration of the flowering period has yet to be determined. Little is known of its ecology, although it is now known to occur in pine-oak forests on steep slopes between 1,500-2,300 m. It appears to be a rare endemic to the western slopes of the Sierra Madre Occidental in southeastern Sinaloa, but it likely occurs in adjacent western Durango as well. The locations of all four of the newly identified collections cited above are within a few kilometers of each other in the vicinity of the botanically well-explored highway from Mazatlán to the Durango border. Also, it seems likely that the range of *C. spiranthoides* may be more or less continuous from the vicinity of the type collection to the area of the new collections, as the intervening mountainous terrain provides similar habitat but is relatively inaccessible and poorly known botanically.

The relationships of *Castilleja spiranthoides* within the genus remain somewhat unclear. Based on coloration and morphology of the inflorescence, this species is surely a member of subg. *Castilleja*, as defined by Chuang & Heckard (1991). More equivocally, its irregularly cleft and conspicuously colored calyx, somewhat pendulously exserted corolla, and relatively long corolla beak appear to place *C. spiranthoides* within sect. *Castilleja*, as defined by Holmgren (1976) and by Nesom (1992). However, neither of these authors includes *C. spiranthoides* among the sect. *Castilleja* found within their area of treatment. This apparent oversight may be due to the paucity of specimens of this species previously available for comparative study. Nesom (pers. comm.) now considers *C. spiranthoides* to be a member of sect. *Castilleja*, based on calyx and corolla morphology.

While it does appear to belong to sect. *Castilleja*, *Castilleja spiranthoides* is a rather anomalous member of that group, with the only other annual species apparently being *Castilleja filiflora* Nesom, a limited endemic from Chiapas, México (Nesom 1992) that is unlike *C. spiranthoides* in a number of morphological features. The species to which *C. spiranthoides* is perhaps most closely related and which it most resembles in form, leaf arrangement, vestiture, coloration, and numerous features of the inflorescence is the rarely collected *C. ctenodonta* Eastwood. Apparently, *C. ctenodonta* is known only from a few collections made in the vicinity of the type locality in the Sierra de Clavellinas in Oaxaca, although, as Nesom (1992) pointed out, *C. ctenodonta* is very closely related also to the Guatemalan endemic species, *C. altorum* Standley & Steyermark. Eastwood's (1909) description of the type of *C. ctenodonta* indicates that this is a perennial species, although its stems are very slender and apparently rhizomatous in the specimens I have seen, including an isotype of *Pringle 4986* (UC!) and two sheets of *Smith 539* (NY!,UC!). *Castilleja ctenodonta* differs from *C. spiranthoides* most strongly in that both the leaves and bracts of *C. ctenodonta* have short, narrow, nearly pectinate divisions and that the bracts are not at all apically pandurate.

Some aspects of the morphology of *Castilleja spiranthoides* are atypical of sect. *Castilleja*. In such features as its annual duration, basally clumped but then more widely spaced, upright to erect cauline leaf arrangement, often sinuate-margined upper leaves and bracts, and often pandurate bract shape, *C. spiranthoides* more closely resembles some species of sect. *Euchroma* (Nutt.) Benth., such as *C. macrostigma* Robinson and *C. ornata* Eastwood. However, the calyx and corolla morphology of *C. spiranthoides* appear to preclude its placement in that group. Both additional field

work, and chromosomal and biochemical analyses of this species would be desirable in sorting out its evolutionary relationships.

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LITHOCYSTS AS TAXONOMIC MARKERS OF THE SPECIES OF *CORDIA* L. (BORAGINACEAE)

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ABSTRACT

The structure and distribution of lithocysts in the foliar epidermis of eight species of the genus *Cordia* of Boraginaceae are studied. These are mostly distributed on the adaxial surface of the leaf and are restricted to the epidermis only. The qualitative and quantitative characteristics of these cystolith containing cells are found to be useful as taxonomic markers in the identification of the various species of *Cordia*.

KEY WORDS: *Cordia*, Boraginaceae, foliar epidermis, lithocysts

INTRODUCTION

Lithocysts are the cystolith containing cells. These are situated in the epidermis of leaf, usually on the adaxial surface and occasionally on both the surfaces. A perusal of the so far available literature (Solereder 1908; Metcalfe & Chalk 1950, 1979, 1983) clearly reveals that the information available on this aspect in the family Boraginaceae is highly limited. Therefore, in the present investigation, eight species of *Cordia* are studied with emphasis on the structure and distribution of lithocysts.

MATERIALS AND METHODS

Fresh leaf material of *Cordia alba* L.; *C. dichotoma* Forst.; *C. monoica* Roxb.; *C. sebestena* L., and *C. wallichii* G. Don were collected and fixed in Formalin-Aceto-Alcohol, whereas herbarium specimens were secured for *C. domestica* Roth., *C. evolutior* Gamble, and *C. macleodii* Hook. *f.* & Thomps. For the latter, the material was initially rehydrated by boiling in water. Whole mounts, epidermal peels and transverse sections of the leaf were prepared using traditional methods and microtomy. The frequency, were prepared using traditional methods and microtomy. The frequency, distribution, and size (length and width in surface view and depth in sectional view) were recorded. The presence of calcium carbonate in the cystoliths, was confirmed adopting methods of Jane (1970).

OBSERVATIONS AND DISCUSSION

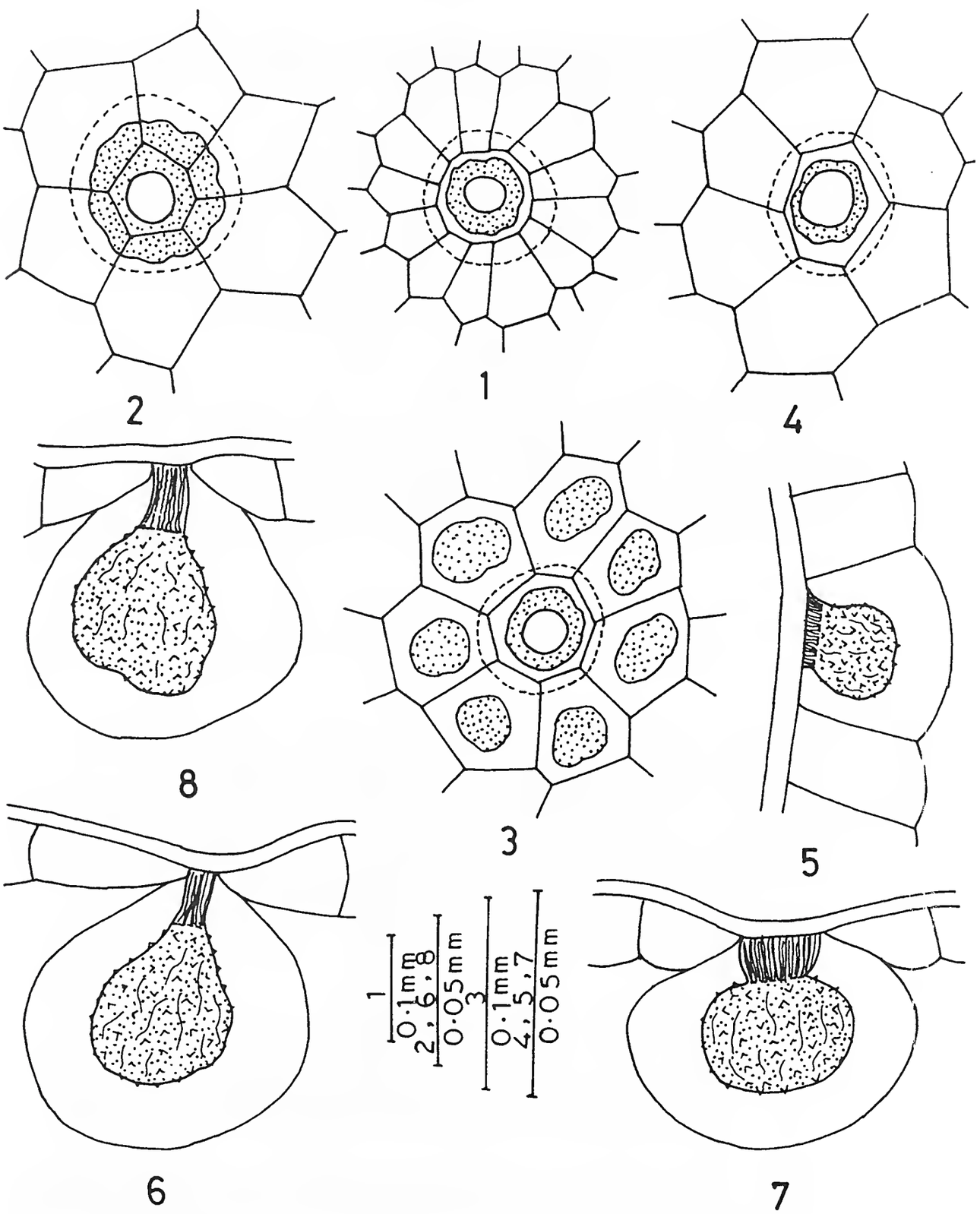
Lithocysts are observed in all these species of *Cordia* (Figures 1-8). The quantitative features of them are presented in Table 1. These are distributed in the costal and intercostal regions of both the epidermal layers in *C. dichotoma* and *C. sebestena*, whereas these are restricted to the adaxial surface only in the remainder of the species. The lithocysts are usually larger than the adjacent epidermal cells and protrude into the mesophyll region in the form of cell cavities (Figures 5-8). In surface view a ring of radiating epidermal cells encircles them, giving the total structures the appearance of trichome bases (Figures 1-4). But the sectional view confirmed the presence of cystoliths inside their cell cavities (Figures 5-8). Sometimes the cystoliths protrude above the general surface giving a papillate appearance as in *C. monoica*, *C. dichotoma*, and *C. macleodii*. A limited number of epidermal cells encircles the lithocysts in *C. evolutior* and *C. sebestena*, (Figures 2,4) whereas numerous small epidermal cells surround them in *C. domestica* (Figure 1). In *C. wallichii*, lithocysts form a characteristic feature of the surface morphology with deeply stained encircling cells giving a rosette appearance to them. The maximum frequency of the lithocysts is recorded in *C. wallichii* (28 per mm^2). The largest and smallest lithocysts are observed in *C. monoica* and *C. evolutior* (Figure 7) to ellipsoidal as in *C. wallichii* (Figure 8). Their surface is uniformly verrucose (Figures 5-8).

Table 1. Quantitative characteristics of lithocysts in different species of *Cordia* in the present investigation.

Species Number	Species Name	Frequency (per mm^2)	Length (μm)	Width (μm)	Depth (μm)
1.	*Cordia alba*	6	95.40	76.32	43.29
2.	*C. dichotoma*	27	81.40	71.86	58.17
3.	*C. domestica*	12	78.86	71.23	64.00
4.	*C. evolutior*	14	70.40	64.05	56.00
5.	*C. macleodii*	7	208.29	195.57	73.26
6.	*C. monoica*	20	77.59		66.48
7.	*C. sebestena*	3	61.05	61.05	52.16
8.	*C. wallichii*	28	77.59	70.73	69.25

The lithocysts in *Cordia alba* are less specialized with isolated groups of cells in the upper epidermis having thicker outer walls from which knob-like processes impregnated with calcium carbonate project into the cell cavity. In addition to the original lithocyst, adjacent epidermal cells around it may also contain cystolith-like bodies as in *C. macleodii* (Figure 3). Such groups of lithocysts were earlier reported in the family Opiliaceae (see Mauseth 1988).

The lithocysts containing the cystoliths are generally treated as the excretory bodies with reference to their function. Haberlandt (1914) stated that these excretory structures become transformed into repositories of reserve materials and the lime is



Figures 1 -8. Lithocysts of *Cordia*. 1-4. Surface view. 1. *C. domestica*; 2. *C. evolutior*; 3. *C. macleodii*; 4. *C. sebestena*. 5-8. T.S. of adaxial epidermis. 5. *C. alba*; 6. *C. dichotoma*; 7. *C. monoica*; 8. *C. wallichii*.

reintroduced into the metabolic cycle. Bider (1935), on the other hand, considered that the species which possess these lithocysts and related bodies do not flourish unless lime is present in the soil. Therefore, species of *Cordia* may be useful as indicators of lime in the soil.

On the basis of a few available characteristics of lithocysts of the various species of *Cordia* studied here, a tentative key is presented.

1. Lithocysts distributed on both surfaces of the leaf. 2
   2. Lithocysts small and less frequent. ..... *C. sebestena*
   2. Lithocysts large and more frequent. ..... *C. dichotoma*
1. Lithocysts distributed only on the adaxial surface of the leaf. 3
   3. Lithocysts not protruding into the mesophyll ..... *C. alba*
   3. Lithocysts protruding into the mesophyll in the form of deep cavities. 4
      4. Lithocysts in groups. ..... *C. macleodii*
      4. Lithocysts solitary 5
         5. Lithocysts surrounded by numerous small epidermal cells. ..... *C. domestica*
         5. Lithocysts surrounded by limited number of large epidermal cells. 6
            6. Cystoliths ellipsoidal ..... *C. Wallichii*
            6. Cystoliths spherical. 7
               7. Stalk of the cystolith is wide ..... *C. monoica*
               7. Stalk of the cystolith is narrow ..... *C. evolutior*

Thus the variability expressed in different qualitative and quantitative features by the lithocysts and the cystoliths in the foliar epidermal cells of the species of *Cordia* provide useful taxonomic markers in the infrageneric classification of *Cordia*.

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A FLORISTIC SURVEY OF FALLS HOLLOW SANDSTONE GLADES, PULASKI COUNTY, MISSOURI

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ABSTRACT

The vascular flora of Falls Hollow sandstone glades, Pulaski County, Missouri, is reported. A total of 137 species is listed. Twenty-three new taxa are added to the known vascular flora of Pulaski County. Three species collected during this study are on the Missouri Department of Conservation's list of Rare and Endangered Species.

KEY WORDS: Sandstone glade, flora, Missouri

INTRODUCTION

Missouri glades are open expanses of bare rock in non-prairie areas characterized by a herbaceous flora, a lack or scattered occurrence of woody plants, and droughty soils that are often seasonally saturated. The original objective of this study was to survey the vascular flora of three sandstone glades at Falls Hollow on Fort Leonard Wood Army Base, Pulaski County, Missouri, to determine their suitability for nomination as a natural area by the Missouri Department of Conservation. These three glades were located by Skinner (1991), and I located a fourth glade during the present study. The purpose of this paper is to present the results of a floristic survey of these previously unbotanized sandstone glades in Missouri.

DESCRIPTION OF STUDY AREA

Falls Hollow glades are located approximately 17.7 km south-southeast of St. Roberts, Pulaski County, Missouri, on Fort Leonard Wood Military Installation (Bloodland Quadrangle, T34N, R11W, Sec. 22 NW1/4). Pulaski County lies within the Upper Ozark Section of the Ozark Natural Division (Thom & Wilson 1980). Falls Hollow consists of four glades totaling 2.0 ha. The largest of these glades is 0.8 ha., whereas the three smaller glades are approximately 0.4 ha each. The aspect of the glades at Falls Hollow is neutral and the slope is mostly flat to gentle. Each glade is separated from the others by dry to mesic sandstone forest dominated by *Quercus* spp. In the case of the three smaller glades a narrow ecotone exists between the forest and

the glades, with *Vaccinium arboreum* Marshall and *Quercus marilandica* Muenchh. most common in this zone. The substrate of the glades at Falls Hollow is Roubidoux sandstone (Ryan 1992; Wolf 1989), a medium to fine-grained, sparsely fossiliferous sandstone that originated during the Ordovician Period (Koenig 1961). Although sandstone occurs widely in the Missouri Ozarks, exposed areas of sandstone bedrock in non-prairie regions large enough to warrant the name glade are now uncommon (Nelson 1987); this is particularly so with sandstone glades of the Roubidoux formation. Known glades on this formation are rare (< 10 ha) and restricted to four counties in south-central Missouri (Nelson 1987; Currier 1991; Ryan 1992; Ryan & Smith 1991).

The glades at Falls Hollow are particularly interesting in that they are exclusively associated with intermittent streams. During heavy rains, which are frequent in the spring, these streams flood the glades. The impact of such flooding is evident in the obvious patterns of erosion present (Figure 1). Frequent flooding has been a significant factor in keeping these glades open, whereas fire has probably played a secondary role in maintaining these sites historically. Although flooding has kept substantial areas of bedrock open and largely free of vegetation, it has also created habitats suitable for certain plants. Because sections of the sandstone are more resistant to erosion and weathering (Beveridge 1990), the glades have developed ledges, depressions, and other structures where water pools and soil accumulates. These processes have added floristic richness to the glades by creating areas where plant species not ordinarily associated with glades, such as *Alopecurus carolinianus* Walter, *Cyperus acuminatus* Torrey & Hook., *Gratiola neglecta* Torrey, *Leersia oryzoides* (L.) Swartz, *Lythrum alatum* Pursh, and *Rotala ramosior* (L.) Koehne, can thrive.

There is no evidence of prior botanical work at Falls Hollow. Prior to 1940 this area was utilized for farming and grazing, and in 1940 the land was purchased by the Department of the Army for the construction of Fort Leonard Wood. Given the small size of each glade and their location on a military reservation, it is likely that previous workers either overlooked or were unable to access these glades (Steyermark 1963; Johnson *et al.* 1990). Skinner (1991) located the glades at Falls Hollow and Ryan (1992) assessed them as part of a natural features inventory, but neither botanized the site intensively.

METHODS

Forty-one trips were made to Falls Hollow on a weekly basis from 1 April to 23 October 1994, and all glades were surveyed during each visit; during late spring and early fall, the glades were often visited twice weekly. Vouchers were deposited at UMO, with the exception of specimens representing county records and rare and endangered species, which were deposited at MO. Verification of county records and difficult taxa was made by Dr. George Yatskievych of the Missouri Department of Conservation. Grasses were verified by Dr. Michel Lelong of the University of South Alabama, and Dr. Robert Kral of Vanderbilt University verified the sedges.

Determinations were made principally using Steyermark (1963). Plants were occasionally identified with Gleason & Cronquist (1991). Identification of *Aster* spp. was made with Jones (1989). Nomenclature follows Yatskievych & Turner (1990), with the exception of *Panicum*, which follows Lelong (1986), and *Heuchera* × *hirsuticaulis* (Wheelock) Rydb. which follows Gleason & Cronquist (1991).

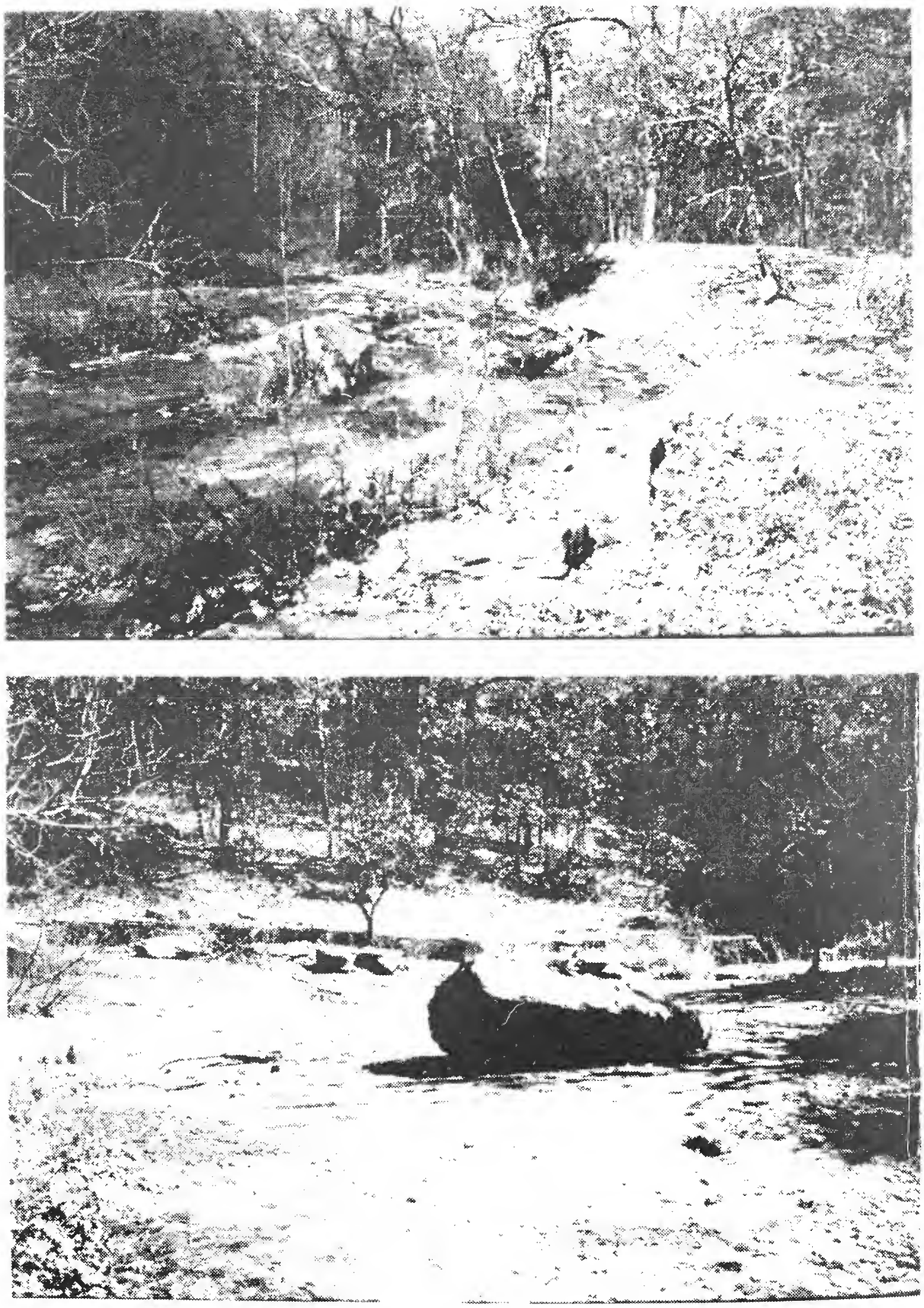

Figure 1. Glade at Falls Hollow, as seen from south (top photo), and west (bottom photo). Top photo shows course of intermittent stream; arrow indicates the point where the stream enters the glade.

RESULTS/DISCUSSION

Only the flora of the three smaller glades is reported here. My decision to exclude the largest (0.8 ha) glade is based upon the severe impact that has occurred due to the construction of a military firing range adjacent to the glade. Large amounts of soil (in the form of numerous dirt mounds), gravel, and other debris (expended rifle shells, glass and metal containers and plastic items) were deposited on the glade during the construction of the range; frequent maintenance of the range has produced a constant supply of fresh debris. It is, in fact, often hard to determine which parts of the glade are natural and which ones are the result of intense human activity. By comparison, the three smaller glades show no signs of recent disturbance and are comparable to other Roubidoux sandstone glades judged to be high quality communities (Ryan 1992). It was felt that the inclusion of the largest glade, with its large number of non-native and weedy taxa, would misrepresent the true nature of the Falls Hollow glade community.

Due to the rarity of sandstone glades in Missouri, I would encourage those involved with land management at Fort Leonard Wood to conserve Falls Hollow glades. The greatest potential for conservation lies with the three smaller, high quality glades. These glades are not directly impacted by the firing range, as is the largest glade, and management efforts would be minimal. In fact, as long as there is no human disturbance in the form of logging, construction, or vehicular traffic, these three glades would require only slight management in the form of a prescribed burn plan. Although they are maintained principally by flooding, rather than by fire, a fire management plan would nonetheless be beneficial. By reducing woody invasion along the borders of the glades - the areas least affected by flooding - fire would diversify the habitat around the glades by maintaining or expanding (or in some cases creating) the ecotone between the forest and each glade.

A total of 137 taxa, representing 48 families and 104 genera, was collected. A list of the plant taxa collected at Falls Hollow glades follows. Poaceae (26) and Asteraceae (13) are the two families with the largest number of representatives. Three species identified during this study, *Silene regia* Sims, *Sporobolus ozarkanus* Fernald, and *Trifolium reflexum* L. var. *reflexum*, are currently on the Missouri Department of Conservation's list of Rare and Endangered Species (1992). Due to the rarity of *Silene regia* at Falls Hollow, a photo voucher was made in lieu of an actual collection.

Plants characteristic of Falls Hollow glades include *Crotonopsis elliptica* Willd., *Diodia teres* Walter, *Hypericum gentianoides* (L.) Britton, *Juniperus virginiana* L., *Schizachyrium scoparium* (Michaux) Nash, *Sporobolus* spp., *Vaccinium arboreum*, and *Vulpia octoflora* (Walter) Rydb. Each of these species, with the exception of *Juniperus virginiana* and *Sporobolus* spp., is listed as characteristic of sandstone glades in Missouri by Nelson & Ladd (1983). Studies indicate that the species composition of sandstone glades vary, however, based upon the age and origin of the substrate, slope and aspect, and recent vegetational history. Based on the list of taxa reported from previous work, only *Quercus marilandica*, *Schizachyrium scoparium*, and *Vaccinium arboreum* are known to occur on all sandstone glades (Bacone *et al.* 1983; Jefferies 1985, 1987; MacRoberts & MacRoberts 1992, 1993). The literature also indicates that dominants vary. Bacone *et al.* (1983), Jefferies (1987), and MacRoberts & MacRoberts (1992, 1993), list *Schizachyrium scoparium* as the dominant or co-dominant plant species on sandstone glades. Jefferies (1985) found *Coreopsis grandiflora* (Hogg) *ex* Sweet and *Crotonopsis elliptica* to be dominant on calico sandstone in northern Arkansas. At Falls Hollow, *Schizachyrium scoparium* and *Sporobolus* spp. were apparently co-dominants at one glade, whereas *Sporobolus*

spp. and *Aristida* spp. were apparently co-dominants on the other two glades. This is interesting, because glades where *Sporobolus* spp. were previously noted as dominant or abundant had substrates other than sandstone (Quarterman 1950; Kucera & Martin 1957; Baskin & Baskin 1973, 1977, 1978; Nelson 1987). But as MacRoberts & MacRoberts (1993) and Jefferies (1985) have noted, sandstone glades are less studied than glades of other substrates. Future studies should reveal more about the similarities and differences among sandstone glades.

Scientific names of new taxa for Pulaski County are preceded by an asterisk. Within each group, families, genera, and species are arranged alphabetically.

PTERIDOPHYTA

Adiantaceae

Cheilanthes lanosa (Michaux) D. Eaton

Aspleniaceae

Asplenium platyneuron (L.) Britton, Sterns, & Pogg. var. *platyneuron*

Dryopteridaceae

**Cystopteris tennesseensis* Shaver
Dryopteris marginalis (L.) A. Gray

PINOPHYTA

Cupressaceae

Juniperus virginiana L. var. *virginiana*

MAGNOLIOPHYTA

MAGNOLIOPSIDA

Acanthaceae

Ruellia humilis Nutt.

Anacardiaceae

Rhus copallina L.
R. glabra L.

Asteraceae

Ambrosia artemisiifolia L.
Ambrosia bidentata Michaux
Antennaria plantaginifolia (L.) Hook.
Aster linariifolius L. var. *linariifolius* forma *linariifolius*
Aster pilosus Willd.
Aster sericeus Vent. forma *sericeus*
**Heliopsis helianthoides* (L.) Sweet var. *occidentalis* (T. Fisher) Steyerm.
Hieracium gronovii L.
Krigia dandelion (L.) Nutt.
K. virginica (L.) Willd.
Rudbeckia missouriensis Pursh
Solidago nemoralis Dryander
S. ulmifolia Muhlenb. *ex* Willd.

Brassicaceae

Cardamine concatenata (Michaux) O. Schwarz
C. parviflora L. var. *arenicola* (Britton) O. Schwarz
Draba brachycarpa Nutt. *ex* Torrey & A. Gray

Cactaceae

**Opuntia humifusa* (Raf.) Raf. var. *humifusa*

Caesalpinaceae

Cercis canadensis L.

Callitrichaceae

Callitriche heterophylla Pursh var. *heterophylla*

Caprifoliaceae

Lonicera flava Sims
Symphoricarpos orbiculatus Moench
Viburnum rufidulum Raf.

Caryophyllaceae

Arenaria serpyllifolia L.
Cerastium brachypetalum Pers.
**Paronychia fastigiata* (Raf.) Fernald var. *paleacea* Fernald
Silene regia Sims

Clusiaceae

Hypericum gentianoides (L.) Britton
H. punctatum Lam.

Cornaceae

Cornus florida L.

Ebenaceae

**Diospyros virginiana* L. var. *platycarpa* Sarg. forma *platycarpa*

Ericaceae

Vaccinium arboreum Marshall

Euphorbiaceae

Croton capitatus Michaux var. *capitatus*
Crotonopsis elliptica Willd.
Euphorbia corollata L.
Tragia betonicifolia Nutt.

Fabaceae

Baptisia alba (L.) Vent.
Stylosanthes biflora (L.) Britton, Stearns, & Pogg
Tephrosia virginiana (L.) Pers.
Trifolium reflexum L. var. *reflexum*

Fagaceae

Quercus alba L.
Q. marilandica Muenchh.
Q. stellata Wangenh. var. *stellata*

Juglandaceae

Carya texana Buckley

Linaceae

Linum medium (Planchon) Britton var. *texanum*

Lythraceae

Cuphea viscosissima Jacq.
Lythrum alatum Pursh var. *alatum*
Rotala ramosior (L.) Koehne

Mimosaceae

Schrankia nuttallii (DC. *ex* Britton & Rose) Standley

Oleaceae

Fraxinus americana L.

Onagraceae

Ludwigia alternifolia L.
Oenothera linifolia Nutt.

Oxalidaceae

Oxalis violacea L.

Plantaginaceae

Plantago aristata Michaux
P. pusilla Nutt. var. *pusilla*
P. virginica L.

Polemoniaceae

**Phlox pilosa* L. subsp. *ozarkana* (Wherry) Wherry

Polygalaceae

Polygala sanguinea L. forma *sanguinea*

Polygonaceae

Polygonum tenue Michaux
Rumex acetosella L.

Portulacaceae

Portulaca oleracea L.
Talinum calycinum Engelm.

Ranunculaceae

Ranunculus fascicularis Muhlenb. *ex* Bigelow
R. harveyi (A. Gray) Britton forma *harveyi*

Rhamnaceae

Rhamnus caroliniana Walter

Rosaceae

**Prunus hortulana* L.
P. mexicana S. Wats.
Rosa carolina L.
Rosa setigera Michaux var. *setigera* forma *setigera*
Rosa setigera Michaux var. *tomentosa* Torrey
Rubus flagellaris Willd.
**Rubus invisus* (L. Bailey) Britton

Rubiaceae

Cephalanthus occidentalis L.
Diodia teres Walter
Hedyotis crassifolia Raf.

Sapotaceae

Bumelia lanuginosa (Michaux) Pers.

Saxifragaceae

Heuchera × *hirsuticaulis* (Wheelock) Rydb.

Scrophulariaceae

Agalinis tenuifolia (M. Vahl) Raf.
**Gratiola neglecta* Torrey
Leucospora multifida (Michaux) Nutt.
**Nuttallanthus canadensis* (L.) D. Sutton
Penstemon pallidus Small

Ulmaceae

Celtis tenuifolia Nutt. var. *tenuifolia*
Ulmus rubra Muhlenb.

Violaceae

Viola pedata L. forma *pedata*
V. rafinesquii Greene

LILIOPSIDA

Commelinaceae

Tradescantia ohiensis Raf.

Cyperaceae

**Bulbostylis capillaris* (L.) C.B. Clarke
Carex bushii Mackenzie
Carex flaccosperma Dewey var. *glaucodea* (Tuckerman) Kük.
Cyperus acuminatus Torrey & Hook.
Cyperus aristatus Rottb.
Fimbristylis autumnalis (L.) Roemer & Schultes
Lipocarpha micrantha (M. Vahl) G. Tucker
**Rhynchospora globularis* (Chapman) Small var. *recognita* Gale

Iridaceae

Sisyrinchium campestre E. Bickn. forma *campestre*

Juncaceae

Luzula bulbosa (Alph. Wood) Rydb.
Juncus interior Wieg.

Liliaceae

Allium canadense L. var. *canadense*
Allium canadense L. var. *mobilense* (Regal) F. Ownbey
Camassia scilloides (Raf.) Cory forma *scilloides*
Hypoxis hirsuta (L.) Cov. forma *vilosissima*
Nothoscordum bivalve (L.) Britton

Orchidaceae

**Spiranthes tuberosa* Raf.

Poaceae

Agrostis elliottiana Schultes
Agrostis hyemalis (Walter) Britton, Sterns, & Pogg var. *hyemalis*
Agrostis perennans (Walter) Tuckerman
**Alopecurus carolinianus* Walter
Andropogon gerardii Vitman var. *gerardii*
Aristida dichotoma Michaux var. *dichotoma*
**Aristida longespica* Poiret var. *longespica*
**Aristida purpurascens* Poiret
Danthonia spicata (L.) P. Beauv. *ex* Roemer & Schultes var. *spicata*
**Digitaria cognata* (Schultes) Pilger var. *cognata*
**Leersia oryzoides* (L.) Swartz
L. virginica Willd.
**Muhlenbergia mexicana* (L.) Trin.
Panicum acuminatum Swartz var. *acuminatum*
P. depauperatum Muhlenb.
P. flexile (Gattinger) Scribner
**P. philadelphicum* Trin. var. *philadelphicum*
P. virgatum L.
Schizachyrium scoparium (Michaux) Nash
Sphenopholis obtusata (Michaux) Scribner var. *obtusata*
**Sporobolus asper* (Michaux) Kunth var. *asper*
Sporobolus clandestinus (Biehler) A. Hitchc.
**Sporobolus ozarkanus* Fernald
**Sporobolus vaginiflorus* (Torrey) Alph. Wood
Tridens flavus (L.) A. Hitchc. var. *flavus*
Vulpia octoflora (Walter) Rydb. var. *glauca* (Nutt.) Fernald

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STUDIES ON THE ISOZYME VARIATION PATTERN AMONG INDIVIDUALS AND POPULATIONS OF THE ENDANGERED SPECIES *DEUTZIA MULTIRADIATA* (HYDRANGEACEAE) ON MT. JINFO OF NANCHUAN

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ABSTRACT

With the electrophoretic technique, we studied the peroxidase (PER), catalase (CAT), esterase (ES), amylase (AA), citric acid dehydrogenase (CDH), and glutamate dehydrogenase (GDH) in leaves of 41 plants from five small populations with different altitudes and habitats of the endangered species *Deutzia multiradiata* which is endemic to Mt. Jinfo of Nanchuan, China. The band number variation of those isozymes is studied by clustering analyses on Manhattan metric by UPGMA. The result indicates that though individuals within the same population show certain similarities in the isozyme band number, the electrophoretic difference in the band number and the genetic divergence within the same populations are notable, while most individuals from different populations show higher resemblance in the band number of those isozymes, which reveals that there are few relations between the band number of those isozymes and the collecting habitats of those plants.

KEY WORDS: multivariate analyses, isozyme variation, *Deutzia multiradiata*, Hydrangeaceae, China

Deutzia multiradiata W.T. Wang is a species endemic to Mt. Jinfo (29° 05′ N, 107° 10′ E) of Nanchuan County in Sichuan Province and belongs to subsect. *Cymosae* Rehder of sect. *Deutzia* in the genus *Deutzia* Thunberg of Hydrangeaceae (He 1989, 1990). It was published as a new series named ser. *Multiradiatae* P. He because of its unique morphological characteristics in subsect. *Cymosae* Rehder (He & Hu 1989; He & Pan 1994). Further studies show it also possesses some unique biological features. It is scattered as small populations in a very restricted area smaller than 10 km^2 from 600-1200 m altitude on Mt. Jinfo of Nanchuan. Based on our detailed observations and statistical works in the field over many years, we found there are no more than 800 living individuals of the species within its entire geographic distribution and that it is indeed an endangered species. It competes poorly when growing with other species such as Compositae and Poaceae with strong competitive abilities, but because of its highly developed root system, it mostly favors those exposed habitats with water-exuded limestone crevices where other plant species

cannot survive. Whether it is an adaptive strategy for a species such as *Deutzia multiradiata* to occupy the exposed micro-habitats where other species cannot survive, or this distribution is a retrogressive phenomenon, is not known. It is known that the survivorship and development of a given species is not only affected by the environmental conditions, but also regulated by its own genetic features. It is necessary to understand the genetic variation of such a restricted endemic and endangered species as *Deutzia multiradiata*.

MATERIAL AND METHODS

After multiple field observations and collections, the authors dug 78 living individuals from five populations of *Deutzia multiradiata* in April 1994. and transplanted them in native soil to plastic pots. These pots were then moved to the Botanical Garden of Southwest China Normal University. The collecting locations and their micro-habitats are shown in Table 1.

Table 1. The collecting localities and micro-habitats for the living material used in this study.

Population	Elevation (m)	Locality	Micro-habitat
A	600	Shanquan	limestone crevice
B	720	Banhe	damp scrub
C	800	Lower Daheba	cliff crevice
D	760	Yihaoqiao	slightly dry scrub
E	1200	Upper Daheba	talus slope

Sample preparation follows Wu (1979). The vertical plate polyacrylamide gel electrophoresis was conducted following Wu (1979) and Hu & Wan (1985).

Based on the schematic figures of the enzyme bands, we obtained the total band number for each individual and then inserted them into the original data matrix which was processed on a 386DX40 computer using BASIC programs for clustering analyses using a Manhattan metric under UPGMA (Zhong *et al.* 1990).

RESULTS AND DISCUSSION

In the isozymic dendrogram produced as a result of this study (Figure 1), 41 individuals were clustered into four Manhattan metric-0.82 isozymic phenons. The "A" Manhattan metric-0.82 phenon is composed of fifteen individuals from among populations A, B, C, D, and E, while the "B" Manhattan metric-0.82 phenon is composed of five individuals originating from populations A and C. The "C" Manhattan metric-0.82 phenon consists of thirteen individuals collected from populations A, B, C, and E. The "D" Manhattan metric-0.82 phenon is formed of a mixture of eight individuals from populations A, B, and D. Generally speaking, though some groups of individuals from particular populations cluster very closely (such as numbers 1-2-8, 12-17, 15-19, 3-4, and 21-22) and show high resemblance in

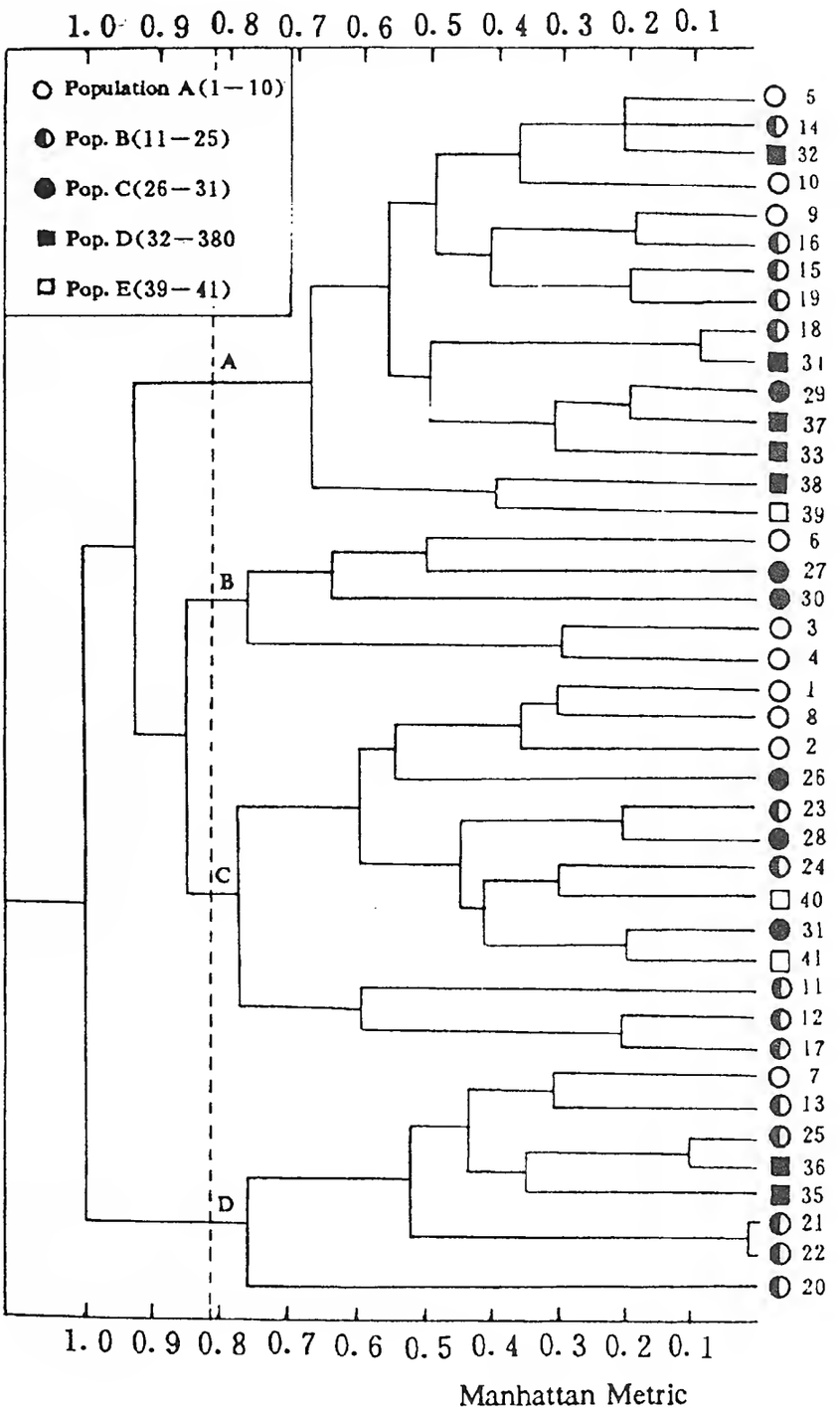

Fig.1 Dendrogram by the Manhattan metric with WPGMA, showing the variation in band number of six isozymes in leaves of 41 individuals from 5 populations of Deutzia multiradiata.

isozyme band number, most clusters are composed of individuals from several populations. On the other hand, some individuals from separate populations (*e.g.*, numbers 31-41, 40-24, 9-16, 29-37, 32-14-5, 18-34, and 36-25) have great similarity in band number. Therefore, isozyme band numbers of a plant do not show good correlation with the habitat from which it was collected.

Though there are similarities in band numbers for PER, CAT, ES, AA, CDH, and GDH in leaves of some individuals from the same population, certain genetic variation does occur among individuals within the same population. Conversely, some individuals from different populations show notable convergence in the isozyme band numbers. This indicates that isozyme band numbers of given plants are not correlated with the micro-habitat from which the plant was collected. *Deutzia multiradiata* was supposedly widely distributed in the past, with the current distribution restricted to a small area around Mt. Jinfo. During the long evolutionary history of the species, the isolated distribution of different populations limits gene exchange between individuals of different populations, which explains why some individuals from different populations show higher similarities in the isozyme band numbers, while the remarkable hybridizations among individuals of the same population lead to greater gene exchange and stronger divergence in the isozyme band numbers among individuals within the same population. Because the species can flower and pollinate easily, but most of its seeds are abortive, which makes the transferring of those rich genetic variations within the same population to their offspring nearly impossible so that it is more difficult for the fixation of those genetic variations as a genetic resource for the development of such a narrowly distributed endangered species as *D. multiradiata*. Though a few scattered habitats such as moist limestone crevices in a restricted area from 600 to 1200 m altitude on Mt. Jinfo can be favorable for the survival of *D. multiradiata* presently, owing to its paucity of genetic variation, it does not have a bright future if these habitats are changed.

ACKNOWLEDGMENTS

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A NEW VARIETY OF *DEUTZIA* (HYDRANGEACEAE) IN CHINA

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ABSTRACT

A new variety named ***Deutzia discolor*** Hemsl. var. ***bicruristyli*** P. He collected from Hubei Province in China is described.

KEY WORDS: *Deutzia*, Hydrangeaceae, new taxon, China

Deutzia discolor Hemsl. var. ***bicruristyli*** P. He, *var. nov.* Plate 1. TYPE: CHINA. Hubei: Enshi, Damuxiang, 1380 m alt., frutex 2 mm altus, foliie albidis, 25 June 1958 (fr), *Fang Minyuan 24492* (Typus var. in SZ conserv.); eodem loco, 25 June 1958 (fr), *Fang Minyuan 24192* (SZ).

Frutex 1-2 m altus; ramuli purpureo-brunnei vel fumeus, glabri, cortice non delapso. Folia petiolata; lamina chartacea, ovato-lanceolata vel oblongo-lanceolata, 3-7 cm longa, 1-2 cm lata, apice acuminata, basi cuneata, margine denticulata (dentis 1-2 mm longis), supra viridis, pilis stellatis 5-8-radiatis sparse conspersa, subtus albida, pilis 10-15-radiatus dense obtecta ad costam nervosque sine simpliciter puberula, nervis lateralibus utrinsecus 4-5; petiole 3-6 mm longi. Cyma multiflora, 3-7 cm diam., pedicelli purpureo-brunnei, 7-15 mm longi, pilis 10-14-radiatis sparse conspersis; lobis calyx lanceolatis, persistentibus, ca. 3 mm longis; styli 3-4, 5-6 mm longi, apice bicruris. Capsula subglobosa, 4-5 mm diam.

A *Deutzia discolor* Hemsl. typica differt plerumque cortice ramulis non delapso; foliis supra 5-8-radiatis stellato-pilosis pilis adpressis conspersis; subtus sine simpliciter puberulis; pedicellis 7-15 mm longis; stylus bicruris.

This variety differs from *Deutzia discolor* var. *discolor* mainly because its twigs are not fissured, upper side of leaf blades are sparsely covered with 5-8-rayed appressed stellate hairs, lower side of leaf blades lacking simple hairs, pedicels 7-15 mm long, and most importantly because its style apex is two-lobed.

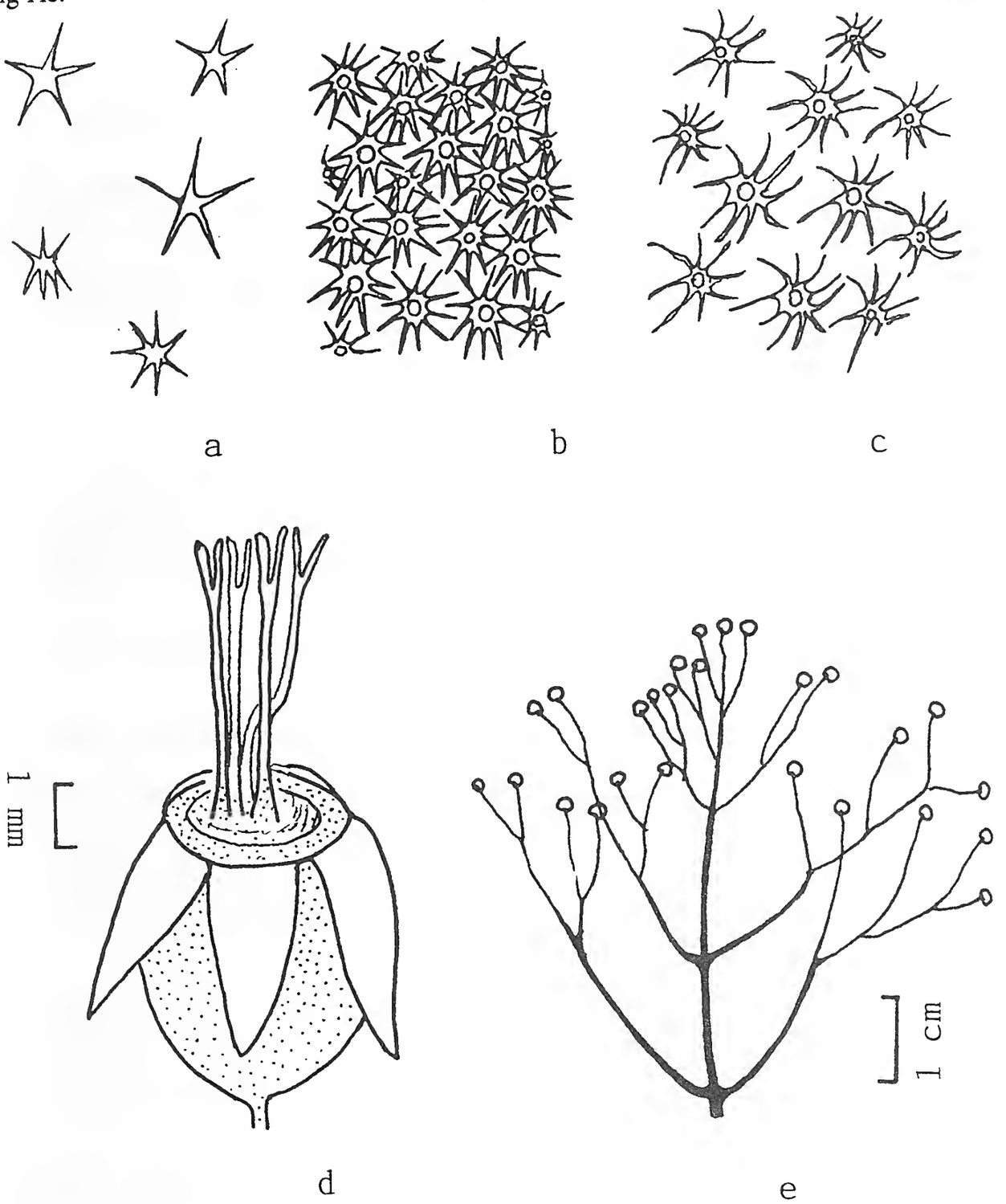

Fig.1 Morphology of Deutzia discolor var. bicruristyli P. He

a. stellate hairs on upper side of lamina, X 40;

b. stellate hairs on lower side of lamina, X 40;

c. stellate hairs on fruiting pedicel, X 50;

d. fruit;

e. fruiting inflorescence.

ACKNOWLEDGMENTS

This study was supported by the "National Science Foundation of China" (NSFC) with grant no. 39270058 and partly supported by "Sichuan Youth Science and Technology Foundation" (SYSTF). Much thanks are due to Prof. Dr. L.C. Hu of Sichuan University and J.H. Xiong in Southwest China Agricultural University for their critical review of the paper.

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A NEW SPECIES OF *POTENTILLA* (ROSACEAE) FROM CERRO QUIEXOBRA, OAXACA

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ABSTRACT

A new species of *Potentilla*, ***P. macdonaldii*** B.L. Turner, is described from the subalpine areas of Cerro Quiexobra, Oaxaca. It is perhaps most closely related to *P. richardii* Lehm. of the sect. *Multijugae* but differs in having thinner more dentate leaves, flowers 2-5 arranged in open cymes, and smooth achenes.

KEY WORDS: Rosaceae, *Potentilla*, México

Routine identification of Mexican plants has revealed the following novelty.

POTENTILLA MACDONALDII B.L. Turner, *spec. nov.* TYPE: MEXICO. Oaxaca: Mpio. Miahuatlán, 35 km ESE of Miahuatlán, 5 km NE of Santo Domingo Ozolotepec, Cerro Quiexobra, "subalpine glades surrounded by pine forests on ridgetops and in mountain saddles", 3500-3700 m, 3 Oct 1990, *Andrew McDonald 2995* (HOLOTYPE: TEX!; Isotype: MEXU).

Potentillae richardii Lehm. similis sed differt foliolis tenuioribus dentibus numerosioribus (dentes marginales 5-9 per foliolum vs. dentes 3-5 per foliolum), floribus in cymis laxis dispositis in pedunculis 1-4 cm longis (vs. plerumque solitariis axillaribus in pedunculis 1 cm longis vel minus), et acheniis laevibus (vs. ornatis nervatura prominenti).

Prostrate or subprostrate perennial herbs 5-18 cm high, arising from woody taproots. Stems moderately villous-hirsute, the hairs mostly 0.8-1.5 mm long. Leaves mostly (3-)5-7 pinnately parted, the lower mostly 3-6 cm long, 1.5-2.5 cm wide; stipules united for ca. 1/2 their length to the lower petiole proper; petioles 1.5-2.0 cm long, pubescent with silky-villous spreading hairs 1-2 mm long; divisions of the leaf flabellate, irregularly dentate with 5-9 teeth, the latter 0.6-1.4 mm long. Inflorescences cymose, 2-5 flowers per primary stems; peduncles mostly 1-4 cm long, pubescent like the stems. Receptacle conical, pubescent. Bracts of the calyx 3.5-4.5 mm long, broadly ovate in outline, clearly 3-lobed. Sepals lanceolate, 5-6 mm long, ca. 2 mm wide, united below, sparsely villous without, glabrous within. Petals yellow, spreading, 6-7 mm long, 5-6 mm wide, the apices emarginate, the cleft ca. 1

mm deep. Stamens 18-21 in 2-3 series. Styles terete-conical, outcurved, ca. 0.5 mm long, glabrous. Seeds ovoid, brown, ca. 0.75 mm long, glabrous, smooth.

ADDITIONAL SPECIMEN EXAMINED: MEXICO. Oaxaca: about same location as the type, 3650-3800 m, 10 Dec 1989, *McDonald 2919* (TEX).

This taxon, because of its pinnately compound leaves, is obviously related to *Potentilla richardii* but can be readily recognized by characters indicated in the following couplet.

1. Flowers 2-5, arranged in open cymose panicles, the ultimate peduncles 1-4 cm long; petals spreading, mostly 6-7 mm long; bracts at base of sepals mostly 3-cleft, rarely not; achenes smooth..... *P. macdonaldii*
1. Flowers mostly solitary, axillary, the peduncles 1 cm long or less; petals erect, mostly 4-5(-6) mm long; bracts at base of sepals mostly elliptical, sometimes 2-cleft; achenes nervate..... *P. richardii*

While compared with *Potentilla richardii* of the sect. *Multijugae* (*sensu* Rydberg 1902) in the above diagnosis and key, *P. macdonaldii* also possesses characters suggestive of *P. heterosepala* Fritsch., namely flowers arranged in leafy cymes and bractlets 3-lobed. In Johnston's (1985) key to sections, *P. macdonaldii*, largely because of its pinnately compound leaves and small styles, will key to the sect. *Multifidae*. In truth, *P. macdonaldii* appears to combine characters of both *P. heterosepala* (a poorly studied complex of Guatemala and southernmost México) and *P. richardii* (a better known complex of the trans-volcanic belt of southcentral México), standing somewhat between these in both morphology and geography.

It is a pleasure to name this species for its only known collector, Dr. Andrew McDonald, currently at Harvard University and first botanist to ascend and collect on Cerro Quiexobra, from which numerous novelties have been named, many in his honor (*cf.* Nesom 1995).

ACKNOWLEDGMENTS

I am grateful to Guy Nesom for the Latin diagnosis, and to him and Piero Delprete for reviewing the manuscript.

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A REVISED SYNOPSIS OF THE PINES 6: SUPPLEMENT TO THE SUBGENERA

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ABSTRACT

This chapter presents an alternate key to the subgenera, eliminating the complex morphology of the twigs, but keeping in accordance with Linnean philosophy. Basic particulars of the seven subgenera are given. The conclusion is made that plant behavior is an important part of plant systematics. The proposed division of *Pinus* into seven subgenera is presented as natural and clear-cut. Such a treatment eliminates artificial groups such as sect. *Parrya* Mayr *emend.*, by splitting them.

KEY WORDS: *Pinus*, Pinaceae, systematics

A NEW MORPHOLOGICAL KEY TO THE SUBGENERA

In the previous chapter, (Landry 1994, pp. 74-75) a traditional (Linnean) key to the subgenera was given. This key was influenced partly with the characters of the twigs. These characters are now known to be very complex. In order to simplify the key structure, we hereunder present a new key without twig characters. We have replaced features of the twigs by leaf characters.

This alternate key is more detailed, having in mind the promotion of the relations of morphology with behavior.

A. Cones spend three growth seasons to mature, as witnessed by their double concentric umbos (for *Pinus torreyana* Parry *ex* Carrière, a hand lens is useful to see them)..... 1. *Pinus* subgenus *Pinea*

A. Cones spend two growth seasons to mature, as witnessed by their simple umbos.. ..... B

B. Seeds bodies three times longer than broad..... 2. *Pinus* subgenus *Gerardia*

B. Seeds bodies less than two times longer than broad. C

C. The persistent stalks (peduncles) of the cones (and conelets) are thick (4-8 mm diam.) (very long, turning at least 60°. The conelets continue growth for over three months. Fresh seeds yellow with a faint reddish area at the apex. Leaves connate, but easily separated. ....3. *Pinus* subgenus *Tamaulipasa*

C. The stalks not persistent, or when persistent do not show the same combination of thickness, length and degree of curvature. The conelets grow for at most one month. Fresh seeds colored otherwise. Leaves not connate..... D

D. Umbos are dorsal (central) at least on the interior (inner) face of the middle part of the cones..... E

E. Leaves grouped in such a way that they form dense, long, brush-like masses. Leaves persist at least ten years..... .....4. *Pinus* subgenus *Balfouria*

E. Leaves grouped into rather sparse masses, when examined closely. Leaves persist less than ten years.....5. *Pinus* subgenus *Pinus*

D. Umbos are terminal or simili-terminal on all faces of the middle part of the cones. All the subtending apophyses long taper to a point, or are thin..... F

F. Umbos stout, massive, curved slightly or much, simili-terminal. ... .6. *Pinus* subgenus *Sabinia*

F. Umbos not massive, not curved, truly terminal..... ..... 7. *Pinus* subgenus *Strobus*

PARTICULARS

1. *Pinus* subgenus *Pinea* (Endlicher) Landry comprises three species:
   Pinus pinea Linné, Type;
   Pinus leiophylla Schiede & Deppe;
   Pinus torreyana Parry *ex* Carrière.
2. *Pinus* subgenus *Gerardia* E. Murray is monotypic:
   Pinus gerardiana Wallich *ex* D. Don.
3. *Pinus* subgenus *Tamaulipasa* Landry is also monotypic:
   Pinus nelsonii Shaw.
4. *Pinus* subgenus *Balfouria* E. Murray comprises only the Foxtail Pines:
   Pinus balfouriana Greville & Balfour is their type species.
5. *Pinus* Linné subgenus *Pinus* comprises a large number of species.
   Its type species is *Pinus sylvestris* Linné.
6. *Pinus* subgenus *Sabinia* E. Murray is constituted by two species:
   Pinus sabiniana Douglas *ex* D. Don, type, and
   Pinus coulteri D. Don
   Note: See photo (Figure 1) of a closed cone of *Pinus sabiniana*, herewith reproduced from Chaumeton & Durand (1990, species 44) (with their authorization), showing that the degree of terminality of the apophyses is similar to that of *Pinus albicaulis* Engelmann, of subgenus *Strobus* Lemmon.

7. *Pinus* subgenus *Strobus* Lemmon comprises a large number of species.
   Its type is *Pinus strobus* Linné.

CONCLUSION

This chapter concludes "A Revised Synopsis of the Pines".

This revision enhances the importance of plant behavior for dividing and subdividing a genus. Four sections:

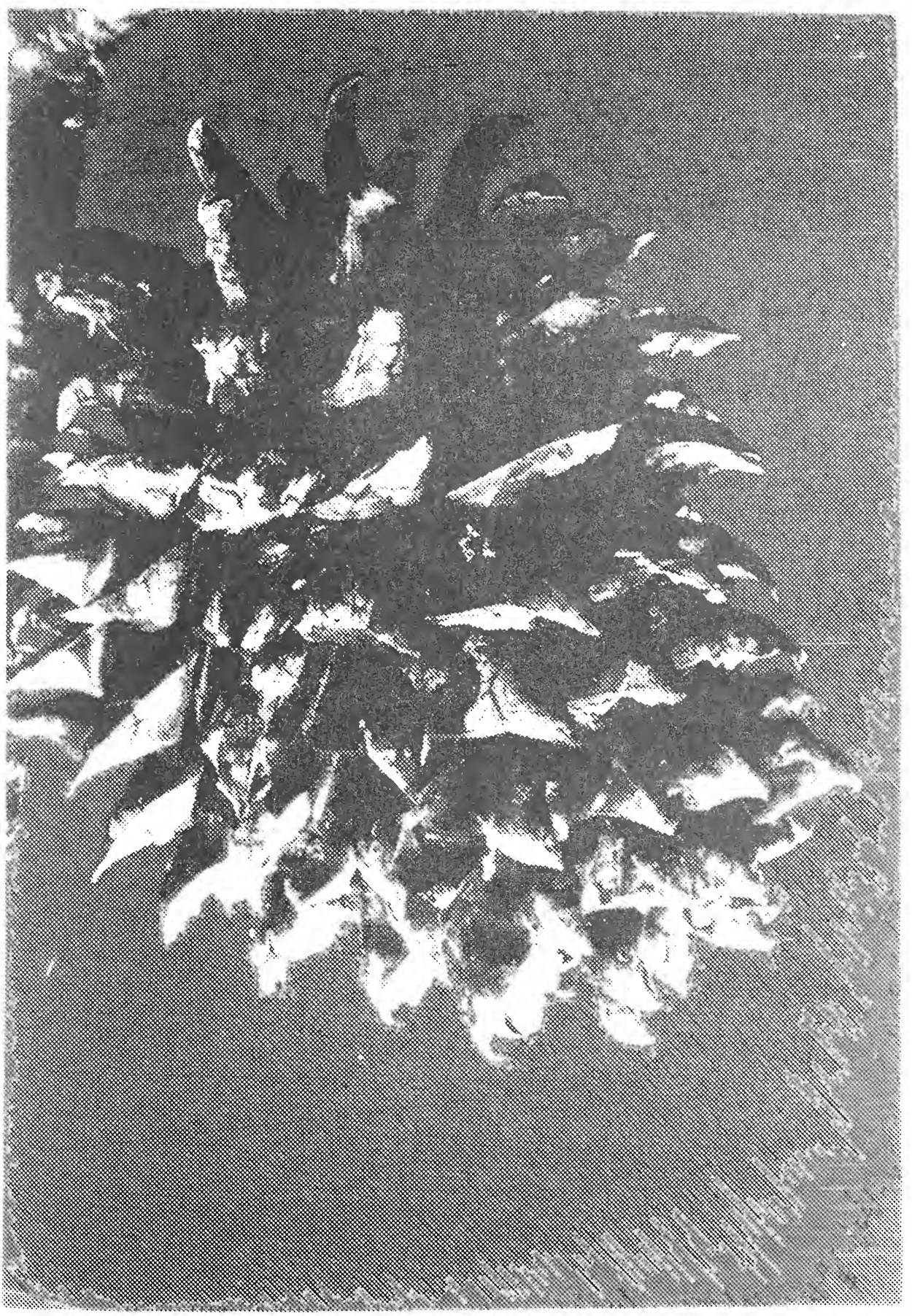

Figure 1. *Pinus sabiniana* an example of a closed cone pine.

Pinus sect. *Quinquefoliis* Duhamel Du Monceau emended Landry (Landry 1989a [chapter 1]),
Pinus sect. *Cembra* Spach (Landry 1989b [chapter 2]),
Pinus sect. *Pinea* Endlicher emended Landry (Landry 1989c [chapter 3]),
Pinus sect. *Leiophylla* Van der Burgh (Landry 1992 [chapter 4]),
were used to do so.

A new division of *Pinus* into seven subgenera is proposed. This treatment is very natural and clear-cut. It moreover eliminates artificial groupings of species (such as *Pinus* sect. *Parrya* Mayr emended), by splitting them.

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Landry, P. 1989c. A revised synopsis of the pines 3: The Parasol Pine (*Pinus*, sect. *Pinea*). Phytologia 66:477-481.

Landry, P. 1992. A revised synopsis of the pines 4: The Chihuahua Pine (*Pinus*, section *Leiophylla*). Phytologia 72:373-377.

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NOTEWORTHY VASCULAR PLANT COLLECTIONS ON THE KISATCHIE NATIONAL FOREST, LOUISIANA

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ABSTRACT

Eighty plant species that are recognized as sensitive, threatened, or endangered by the Kisatchie National Forest or by the Louisiana Natural Heritage Program, or that are on the Louisiana Natural Heritage "watch list," are known to occur on the Kisatchie National Forest, Louisiana. Over the past few years, surveys have been undertaken by various botanists and ecologists to locate and census many of these species. The results add to the growing botanical knowledge of the West Gulf Coastal Plain.

KEY WORDS: Rare, threatened, endangered plants; Kisatchie National Forest; Louisiana; West Gulf Coastal Plain

INTRODUCTION

Many authors have pointed out the relatively poor state of knowledge of the Louisiana and east Texas vascular flora (Thieret 1967b, 1968; MacRoberts 1984; Bridges & Orzell 1989a, 1989b). In 1967, Thieret stated that although there had been resident botanists in Louisiana for the past two hundred years "... the flora of Louisiana is probably the least known of any state in the union" (Thieret 1967b: v). Two decades later, Bridges & Orzell (1989a: 12) maintained that, although the general flora of the West Gulf Coastal Plain is fairly well known, "... more exploration of rare localized and specialized habitats is still needed in order to fully document the occurrence of plants which are very rare or restricted in their habitat preference ...."

The Kisatchie National Forest is located in western Louisiana in the center of the West Gulf Coastal Plain. Over the past few years, a number of surveys have been conducted of localized and specialized habitats on Forest Service land, one aim of which was to gather data on rare and specialized plant species. A large body of data on these species and their micro-distribution now exists, which should be made accessible in order to further the understanding of plant ecology in the West Gulf Coastal Plain.

Therefore, like Bridges & Orzell (1989a, 1989b) before us, we turn from the macro-distribution of species as reported in atlases or floras (MacRoberts 1989; Thomas & Allen 1993) to the micro-distribution in the existing landscape. Knowledge of locally rare species aids in pinpointing rare and vanishing habitat as well as

assessing the conservation value (rarity, diversity, and representativeness) of an area (Bourgeron *et al.* 1995).

This paper is based on our own surveys, on the rare species files of the Kisatchie National Forest and the Louisiana Natural Heritage Program, herbarium specimens, published papers, and unpublished reports. We include only data collected before 1995.

Since texts can be read in many ways, and since one of our reviewers mistook this to be an historical account, let us at the outset explain that our purpose is not historical but biogeographical. Our aim is not to provide a chronology of discovery and document collectors' priority on the Kisatchie National Forest, but to provide documentation for the occurrence of the taxa discussed. Consequently, we document occurrences emphasizing our own collections since we can vouch for them: we have had many vetted by experts and we know their provenance. Additionally, we emphasize the collections in the Kisatchie National Forest herbarium (SFRP) because we are most familiar with them. The history of botany and plant collecting in Louisiana and on the Kisatchie National Forest has yet to be written (MacRoberts 1984, 1989; Ewan 1967; Sundell 1979).

Unfortunately, only some plant communities on the Kisatchie National Forest have been systematically inventoried and censused, notably, bogs, glades, prairies, sandy woodlands, and sandstone outcrops. Consequently, information on rare species is biased in the direction of these communities. It is hoped that, in time, other communities will receive equal attention.

As in any endeavor like this, we keep turning up new records and finding mistakes in existing ones. But if we were to wait until all inconsistencies and mistakes are corrected and each report triple checked, nothing would get published. We provide the following account in the hope that future researchers will use it as a baseline to make emendations.

The Kisatchie National Forest consists of six districts that comprise about 242,000 hectares, or about two percent of Louisiana (Figure 1) (Caldwell 1991). The major community types in the Forest are upland longleaf pine forest, riparian forest, pine flatwoods/savannah, shortleaf pine/oak-hickory forest, and mixed hardwood-loblolly forest (Martin & Smith 1991, 1993). There are also many inclusion communities such as bogs, prairies, glades, outcrops, baygalls, and sandylands (Smith 1988; Smith *et al.* 1989; MacRoberts & MacRoberts 1993a, 1993b, 1993c, 1994, 1995; Martin & Smith 1991, 1993; Guillory *et al.* 1990). The majority of the plant survey work has been done on the Vernon, Kisatchie, and Winn districts. The Caney, Evangeline, and Catahoula districts have been relatively neglected except for brief surveys undertaken in 1993 and 1994 to examine some of their more promising habitats.

About half of the endangered, threatened, and sensitive plant species (ETS) on the Kisatchie National Forest are also on the threatened and endangered list for the Texas National Forests and Grasslands (Anon. 1994; Orzell 1990; Natural Heritage 1994).

There are two classes of plants reported on in this paper. The first are plants that are on both the Kisatchie National Forest ETS list and the Louisiana Natural Heritage "Rare Plants Species" list. The second are the Louisiana Natural Heritage "watch list" species. These are species that are of interest either because their distribution is imperfectly known or because they may be decreasing in numbers. For this work, we use the last 1994 Natural Heritage list dated "Nov. 1994." Because records on watch list species are not kept by the Forest Service, in the accounts that follow, information on them is more anecdotal and scanty than that on ETS species. We use Kartesz (1994) for nomenclature, adding synonyms where recent name changes could be confusing.

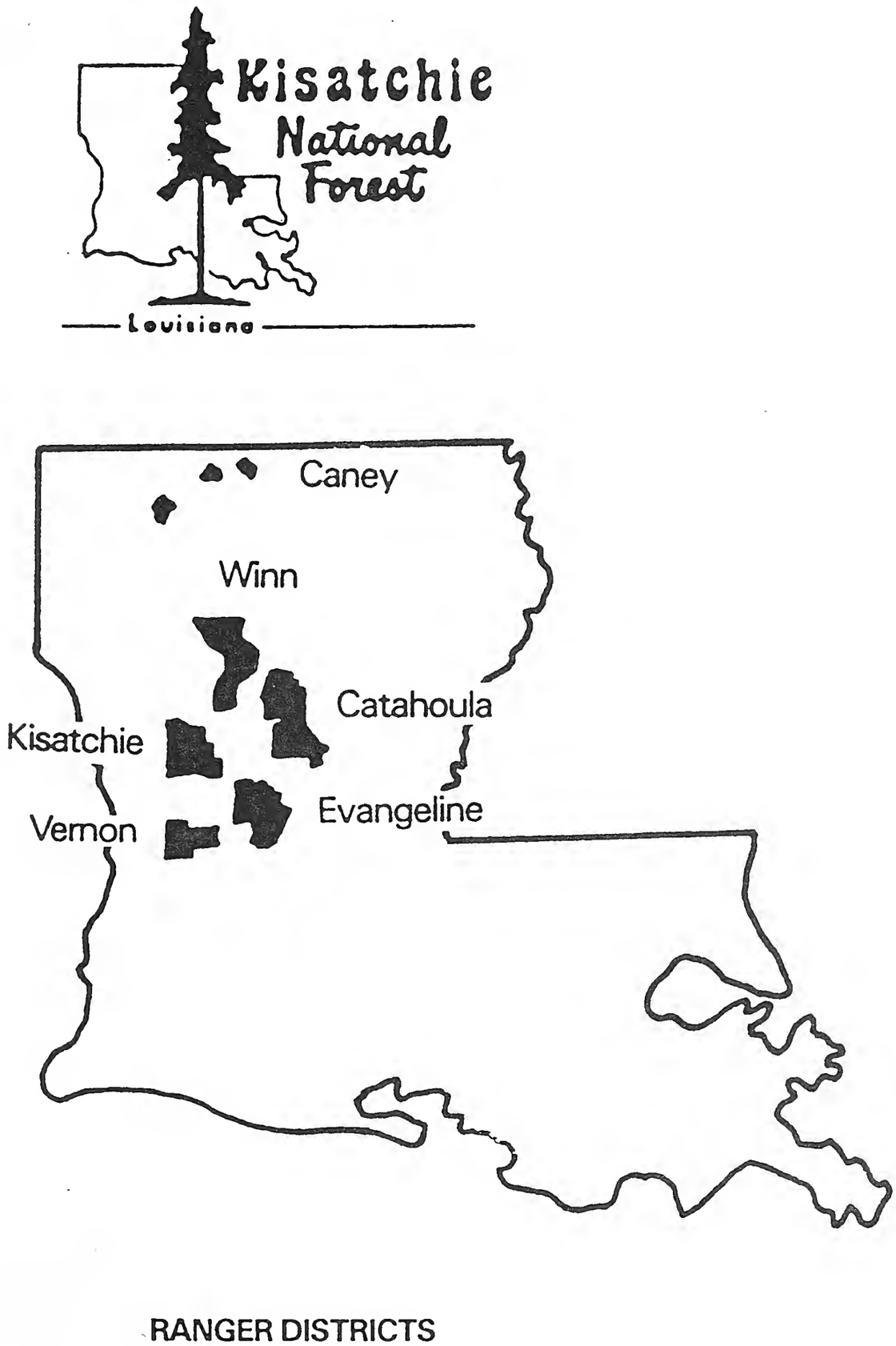

Figure 1. Locations of Ranger Districts in the Kisatchie National Forest.

Figure 2. Louisiana parishes.

We follow recent authors (*e.g.*, Bridges & Orzell 1989a) in giving detailed distributional information in order to make our data useful to present and future botanists interested in the plants and habitats; they need not borrow herbarium specimens, or more important in this case, try to locate the many site records that are presently scattered among many agencies, organizations, and individuals and which have no voucher specimens. However, we give only Township/Range/Section since this will suffice for most botanical/ecological needs and is general enough to discourage unscrupulous collectors.

In addition to Township/Range/Section, plant locations are given by Ranger District and Parish. For the sake of completeness, using the Louisiana Natural Heritage rare species list and other sources (*e.g.*, Larke & Smith 1994) we give the other parishes in Louisiana where the species is reported (Figure 2).

The following abbreviations are used:

KNF = Kisatchie National Forest
WGCP = West Gulf Coastal Plain (west Louisiana and east central Texas)
CatD = Catahoula District (Grant Parish)
CnyD = Caney District (Webster and Claiborne parishes)
ED = Evangeline District (Rapides Parish)
KD = Kisatchie District (Natchitoches Parish)
VD = Vernon District (Vernon Parish)
WD = Winn District (Natchitoches, Winn, and Grant parishes)
LAF = Herbarium, Department of Biology, University of Southwestern Louisiana, Lafayette, Louisiana
LSU = Herbarium, Department of Botany, Louisiana State University, Baton Rouge, Louisiana
LSUS = Herbarium, Biology Department, Louisiana State University, Shreveport, Louisiana
LTU = Herbarium, Biology Department, Louisiana Tech University, Ruston, Louisiana
NATC = Herbarium, Biology Department, Northwestern State University, Natchitoches, Louisiana
NLU = Herbarium, Biology Department, Northeast Louisiana University, Monroe, Louisiana
SFRP = Herbarium, Range Management Research, Southern Forest Experiment Station, U.S. Forest Service, Pineville, Louisiana
VDB = Herbarium, Botany Department, Vanderbilt University, Nashville, Tennessee

SPECIES ACCOUNTS

Amsonia ludoviciana Vail. (*Martin 364* [SFRP]; *MacRoberts & MacRoberts 1578* [VDB], *1629, 2209* [SFRP]). Louisiana blue star is a near Louisiana endemic with its main populations centering on the KNF. It has been found at 21 sites in three districts: KD (Natchitoches Parish, nine sites, T5N R6W Sec. 29; T5N R7W Secs. 2, 14, 20, 21, 23, 37; T5N R8W Sec. 24), WD (Winn, Grant, and Natchitoches parishes, nine sites, T13N R5W Secs. 2, 29, 30; T12N R6W Sec. 1; T9N R3W Sec. 36), and CatD (Grant Parish, three sites, T8N R2W Secs. 16, 29; T8N R3W Sec. 1). It grows in wet areas such as roadside ditches and riparian forest (Lemke 1987; Larke & Smith 1994). The habitat in which this species occurs has not been the focus of any specific

survey on the KNF. Louisiana blue star is also reported from Allen, Bienville, Calcasieu, Red River, and Vernon parishes (Natural Heritage 1994).

Asclepias stenophylla A. Gray. (*Urbatsch 4468* [LSU]). Narrow-leaved milkweed, a western species that reaches its eastern limit in Louisiana, is known from a single calcareous prairie on the WD (Winn Parish, T11N R4W Sec. 7). It was originally reported from Louisiana by Riddell in 1852 under the synonym *Aceretes angustifolia* (Nutt.) Dcne. (MacRoberts 1984, 1989) but not reported again until recently (S. Lynch, pers. comm.; Natural Heritage 1994).

Asclepias viridiflora Raf. (*MacRoberts & MacRoberts 1730* [VDB], *2032, 2439* [SFRP]). This species is on the Louisiana Natural Heritage watch list. While we have not systematically kept records on its occurrence and the Forest Service does not monitor it, we have noted it regularly in calcareous prairies and calcareous soils in sandstone outcrops on the KD and WD (Natchitoches and Winn parishes) (MacRoberts & MacRoberts 1993c). It has been reported from scattered locations statewide (MacRoberts 1989).

Astragalus crassicarpus Nutt. var. *trichocalyx* (Nutt.) Barneby. (*Brown & Lenz 7620, 7617* [LSU]; *Martin s.n.* [LSU]; *Thomas et al. 92314, 95456* [NLU]; *Gilmore & Smith 3561* [LSU]). Ground-plum, a mid-central U.S. species, is known from four calcareous prairies in the WD (Winn Parish, T11N R4W Sec. 18; T11N R5W Secs. 13, 24, 26). It was first collected on the WD in 1939 by C.A. Brown and W. Lenz but was not correctly identified and was not relocated there until the mid-1980's (Smith *et al.* 1989; Lasseigne 1973; MacRoberts 1989). It has also been reported from Natchitoches and Cameron parishes (Natural Heritage 1994).

Burmannia biflora L. (*MacRoberts & MacRoberts 2484* [SFRP]; *Thomas 33333, 74027* [NLU]). Two locations for Northern Burmannia are known on the KNF. One is on the CatD (Grant Parish, T8N R1W Sec. 11) in a hillside wooded seep, the other is on the VD (Vernon Parish, T1N R6W Sec. 31) in riparian woodland. This is a southeastern and coastal plain species that is near the periphery of its range in the WGCP (Thomas 1970). It has also been reported from Bienville, DeSoto, Ouachita, and Webster parishes (Natural Heritage 1994).

Calopogon barbatus (Walt.) Ames. (*Holmes 3007* [NATC]; *MacRoberts & MacRoberts 304* [LSUS], *660* [VDB], *1917* [SFRP], *1610* [NLU]). We know of five locations for Bearded grass-pink on the KNF. Four are in the VD (Vernon Parish, T1S R8W Sec. 26; T1N R7W Sec. 29; and T1N R5W Sec. 20) and one is in the KD (Natchitoches Parish, T6N R7W Sec. 22). The KD site has been known since the 1970's (Holmes & Mathies 1980; MacRoberts & MacRoberts 1988). Four of the five populations occur in bogs and one is in the upslope mesic area above a bog (MacRoberts & MacRoberts 1993b; Hart & Lester 1993). This is a coastal plain species that reaches its western limits in the WGCP. It has also been reported from Allen, Jefferson Davis, and St. Tammany parishes (Natural Heritage 1994), but since it is likely that *C. barbatus* and *C. pallidus* Chapman could be confused, the published distributions of these species need verification (MacRoberts 1989; Thomas & Allen 1993a).

Camassia scilloides (Raf.) Cory. (*Allen 17637* [NLU]; *McInnis & Smith s.n.* [LSU]). Wild hyacinth, an eastern species, has been found at two locations in the WD

(Winn Parish, T11N R5W Secs. 24, 35). It is a calcareous forest species (Larke & Smith 1994). It has also been reported from Bossier, Caddo, Natchitoches, and Webster parishes (Natural Heritage 1994).

Carex hyalina Boott. (*Allen 17890* [NLU]). This species has been found at one location on the ED (Rapides Parish, T3N R2W Secs. 23, 25). It occurs in wet bottomland hardwoods (Thomas & Allen 1993b). It has only been recorded for Rapides Parish in Louisiana (Natural Heritage 1994).

Carex meadii Dewey. (*MacRoberts & MacRoberts 1889, 2216* [VDB], *1903, 1924, 2186* [SFRP], *1889, 2289* [NLU], *1970* [LSU]). Mead's sedge, a widespread northern species, is known from five locations on the KD (Natchitoches Parish, T5N R6W sec. 4; T5N R7W Sec. 2; T6N R7W Sec. 35; T6N R8W Secs. 28, 29, 32; T5N R8W Sec. 1) and two locations on the WD, (Winn and Grant parishes T9N R2W Sec. 6; T12N R4W Sec. 34). It grows in sandstone outcrop communities and in calcareous prairies (Williams 1977; MacRoberts & MacRoberts 1993c). It is also reported from Acadia, Allen, and Jefferson Davis parishes (Natural Heritage 1994).

Carex microdonta Torrey & Hook. (*MacRoberts & MacRoberts 1945, 2220* [VDB], *2215, 2220, 2284* [SFRP], *2272* [NLU], *2285, 2286* [LSU]). Small-toothed sedge, a species of the south central U.S., has been found at 20 sites on the WD (Winn and Grant parishes, T11N R4W Secs. 7, 8, 18; T11N R5W Secs. 13, 24, 25, 26, 35; T12N R4W Secs. 33, 34, 35; T9N R2W Secs. 5, 6). It is abundant in calcareous prairies. It has also been reported from Acadia, LaSalle, and Vernon parishes (Natural Heritage 1994).

Carex tenax Chapman. (*MacRoberts & MacRoberts 2282* [VDB], *2295, 2296, 2339* [SFRP], *2294* [NLU], *2334* [LSU]). Strong sedge has been found at eighteen sites in KD (Natchitoches Parish, T7N R6W Sec. 64; T6N R6W Sec. 6; T6N R7W Secs. 1, 2, 4, 5, 9, 15, 16, 17, 18, 20, 21; T7N R7W Secs. 33, 34, 36) and three in WD (Natchitoches Parish, T13N R6W Secs. 7, 18) (MacRoberts & MacRoberts 1994). It occurs in upland xeric sandhill woodlands. It was for a long time known from only one site in Louisiana (Williams 1977; MacRoberts 1989). This species is also recorded from Vernon Parish (Thomas & Allen 1993a).

Ceanothus herbaceous Raf. (*MacRoberts & MacRoberts 2018* [VDB]). Prairie redroot has been found in one calcareous prairie on the WD (Winn Parish, T11N R5W Sec. 13; T11N R4W Sec. 18). The only other Louisiana location is one calcareous prairie remnant in Caddo Parish (Natural Heritage 1994).

Chamaelirium luteum (L.) A. Gray. Fairy wand, an eastern species, has been found at one wooded seep on the KNF (WD, Natchitoches Parish, T13N R6W Sec. 8). The species was not collected because of its rarity and because there were only seven stems in the population. It has also been recorded from Lincoln, Ouachita, St. Helena, St. Tammany, Tangipahoa, Washington, and W. Feliciana parishes (Natural Heritage 1994).

Cheilanthes lanosa (Michx.) D.C. Eat. (*MacRoberts & MacRoberts 2401* [VDB]; *Thomas & Carroll 73889 & 2383* [SFRP]). Hairy lip-fern was first found on the KD, Natchitoches Parish, in the late 1930's (Brown & Correll 1942). It has been monitored over the years and still grows in the same place in crevices of sandstone

boulders in shaded upland longleaf pine forest (T6N R8W Sec. 27). While we have searched many boulders in the KNF for this species, it is still known only from the original locality. From earlier accounts, it apparently has become more restricted at the original location (Brown & Correll 1942; Thieret 1980). It is widespread in the eastern U.S.

Cyperus grayioides Mohlenbrock. (*MacRoberts & MacRoberts 1801, 2072* [VDB], *1798, 2071* [SFRP], *2070* [NLU], *1803* [LSU]). Mohlenbrock's umbrella sedge has been collected many times in eastern Texas and western Louisiana. There are seven known sites for it on the KD (Natchitoches Parish, T6N R6W Sec. 6; T6N R7W Secs. 1, 2, 18, 21, 34; T6N R8W Sec. 21; T7N R7W Sec. 33), and four sites on the WD (Winn and Natchitoches parishes, T13N R7W Secs. 2, 11; T13N R6W Sec. 7; T13N R5W Sec. 32; T12N R5W Sec. 28). It grows in open areas in upland and stream terrace xeric sandhill woodlands (MacRoberts & MacRoberts 1994). It seems to be associated with deep sands especially in Illinois, Missouri, Texas, and Louisiana (Bridges & Orzell 1989a; Orzell 1990; Carter & Bryson 1991). In Louisiana it is recorded from Allen, Bienville, and Vernon parishes (Natural Heritage 1994).

Cypripedium kentuckiense C.F. Reed. Kentucky yellow lady's slipper occurs at scattered localities in the south central U.S. extending south into the WGCP. It has been reported from many northern parishes in Louisiana, but most records are relatively old (MacRoberts 1989; Thomas & Allen 1993a; Natural Heritage 1994). Its only known occurrences in the KNF are on the CatD (Grant Parish, one site, T9N R1W Sec. 32) and the ED (Rapides Parish, three sites, T2N R3W Secs. 11, 12). It occurs in mixed hardwood-loblolly forest and hardwood slope forest. Because of its extreme rarity, we photographed it rather than collect it.

Dodecatheon meadia L. (*MacRoberts & MacRoberts 2240* [VDB,SFRP]). Shooting star has been found at one location on the KD (Natchitoches Parish, T5N R7W Sec. 14) in mixed hardwood-loblolly forest. It is a widespread northern species that reaches its southern limit in the WGCP. It is also reported from Bossier and Caddo parishes (Natural Heritage 1994).

Draba cuneifolia Nutt. *ex* Torrey & A. Gray. (*Brown 5184* [LSU]). Wedge-leaf whitlow-grass is widely scattered through the south and central U.S. Brown collected it in 1934 in the vicinity of Goldonna, Louisiana. The herbarium label says "Goldiana [*sic*], La., Winn Parish," but Brown's field notebook says only "Goldiana" [*sic*], which is in Natchitoches Parish. And his notebook shows that on March 27 he had moved around a good bit collecting in both parishes. The exact habitat is also unclear: on the herbarium label it says "mixed hardwoods," but his notebook reads "roadside, mixed pine and hardwoods." The Natural Heritage data files record it as T12N R5W Sec. 28 assuming it was collected in Winn Parish. With this confusion, it is probably safe to say only that it was collected in the vicinity of Goldonna on a private inholding in the Winn District. This species is also known from Caddo Parish (Natural Heritage 1994).

Eriocaulon texense Körn. (*MacRoberts & MacRoberts 1589* [VDB], *1579* [SFRP]). This species is on the Louisiana Natural Heritage watch list. While we have not kept precise records on its occurrence, we have found it only in VD (Vernon Parish) bogs where it can be plentiful (MacRoberts & MacRoberts 1993b). It is also reported from a few other west central parishes (MacRoberts 1989; Thomas & Allen 1993a).

Eriogonum longifolium Nutt. (*MacRoberts & MacRoberts 1800* [VDB], *1797* [SFRP]). Long-leaved wild buckwheat, a Great Plains species, is known from one stream terrace sandhill woodland in an inholding on the WD (Winn Parish, T12N R5W Secs. 28, 29). It is also reported from Caddo and Vernon parishes (Natural Heritage 1994).

Eriogonum multiflorum Benth. (*MacRoberts & MacRoberts 1808* [VDB], *1850, 2084* [SFRP], *1820* [NLU]). Many-flowered wild buckwheat, a species that ranges from northeast México to Oklahoma and western Louisiana, has been located at ten sites in two districts (WD, Winn and Natchitoches parishes, five sites, T13N R5W Secs. 7, 33; T13N R6W Secs. 2, 7; T13N R7W Secs. 2, 11; KD, Natchitoches Parish, five sites, T6N R6W Sec. 6; T6N R7W Secs. 5, 20; T7N R6W Sec. 64; T7N R7W Sec. 36). It grows in xeric sandhill woodlands. It also is reported from Bienville, Caddo, and Webster parishes (Natural Heritage 1994).

Erythronium rostratum W. Wolf. (*MacRoberts & MacRoberts 2169* [VDB], *2169, 2204* [SFRP], *2169* [LSU]). Yellow trout-lily, a species of the south central U.S., is on the Louisiana Natural Heritage watch list. We found it at one location in the ED (Rapides Parish) and two locations on the WD (Natchitoches Parish). It prefers riparian forest (Kral 1966). It has been found in a number of north Louisiana parishes (Thomas & Allen 1993a; MacRoberts 1989).

Euphorbia bicolor Engelm. & A. Gray. (*MacRoberts & MacRoberts 2415* [NLU], *2435* [SFRP]). This western prairie species, called snow-on-the-prairie, while common in Texas is rare in Louisiana and is on the Louisiana Natural Heritage watch list. It is known to occur in one WD (Winn Parish, T1N R4W Secs. 7, 8) calcareous prairie. It is also known from Vernon Parish (MacRoberts 1989).

Evolvulus sericeus Sw. (*MacRoberts & MacRoberts 1948* [VDB]). Creeping morning glory is on the Louisiana Natural Heritage watch list. While we have not regularly searched for it, we found it in sandstone outcrops on the KD (Natchitoches Parish, MacRoberts & MacRoberts 1993c). It has also been reported from a number of parishes in northeastern and southwestern Louisiana (MacRoberts 1989).

Heliotropium tenellum (Nutt.) Torrey. (*MacRoberts & MacRoberts 2019* [VDB], *2019, 2417* [SFRP]). Slender heliotrope, a calcareous prairie species of the south central U.S., has been found at fourteen sites on the WD (Winn and Grant parishes, T11N R4W Secs. 7, 18; T11N R5W Secs. 13, 24, 26; T9N R2W Secs. 5, 6, 7, 8) (Smith *et al.* 1989). It is also known from Vernon Parish (Natural Heritage 1994).

Hexalectris spicata (Walt.) Barnh. (*Rhodes 16606* [LTU]). Crested coral-root has been found once on the CnyD (Claiborne Parish, T23N R4W Sec. 34). Recent attempts to relocate these populations have failed. It is an uncommon but wide-ranging species extending across the southern United States to New Mexico and México. In our area it is found in mixed hardwood loblolly and hardwood slope forest (Larke & Smith 1994). It has also been reported from a number of central and north Louisiana parishes (Natural Heritage 1994; Thomas & Allen 1993a; MacRoberts 1989).

Houstonia purpurea L. var. *calycosa* A. Gray. [SY = *Hedyotis purpurea* (L.) Torrey & A. Gray var. *calycosa* (A. Gray) Fosberg]. (*MacRoberts & MacRoberts 2206* [VDB], *2205, 2271, 2273* [SFRP], *2207* [LSU]). Purple bluet, a calcareous prairie species has been found at nineteen sites in the WD (Winn and Grant parishes, T9N R2W Secs. 5, 6; T11N R4W Secs. 7, 8, 18; T11N R5W Secs. 13, 23, 24, 26, 35; T12N R4W Secs. 33, 34, 35) (Smith *et al.* 1989; Martin & Smith 1991). It has also been reported from Bossier, Caddo, LaSalle, Caldwell, and Webster parishes (Natural Heritage 1994).

Koeleria macrantha (Ledeb.) J.A. Schultes. (*MacRoberts & MacRoberts 2021a* [VDB], *2440* [SFRP]). June grass, a widely distributed grass in North America, is known from three calcareous prairies on the WD (Winn Parish, T11N R4W Sec. 18; T11N R5W Secs. 13, 26). It is reported from no other parish (Smith *et al.* 1989; Allen 1992; Natural Heritage 1994).

Lachnocaulon digynum Körn. (*MacRoberts & MacRoberts 531, 1776* [VDB], *1777B, 2471* [SFRP], *1470* [LSU]). Pineland bog buttons, a coastal plain species, was not reported for the WGCP until the late 1980's (Bridges & Orzell 1989a; MacRoberts 1989; Thomas & Allen 1993a). It has been found in one bog on the WD (Natchitoches Parish, T12N R6W Sec. 12) and in just over 50 bogs on the VD (Vernon Parish; there are so many widely scattered sites that we do not give locations here) (Hart & Lester 1993; MacRoberts & MacRoberts 1993b). It is also recorded from Beauregard, Sabine, St. Tammany, and Washington parishes (Natural Heritage 1994; MacRoberts 1989; Julia Larke, pers. comm.).

Liatris tenuis Shinners. (*Grelen 1821* [NLU]). Slender gay-feather, a WGCP endemic, has been found at a single location on the VD (Vernon Parish, T1S R6W Sec. 6) in upland longleaf pine forest (Gandhi & Thomas 1989). It is also reported from Caddo, Calcasieu, DeSoto, Rapides, and Sabine parishes (Natural Heritage 1994).

Lilium michauxii Poir. (*MacRoberts & MacRoberts 2457* [SFRP]). Carolina lily is on the Louisiana Natural Heritage watch list. It has not yet been carefully monitored. We have found it in a couple of beech-magnolia riparian forest areas on the KD (Natchitoches Parish). It is probably locally common but generally rare on the forest. It has been reported from a number of parishes in western and southeastern Louisiana (MacRoberts 1989; Thomas & Allen 1993a).

Lithospermum caroliniense (Walt. *ex* J.F. Gmel.) MacM. (*MacRoberts & MacRoberts 2223* [SFRP]). Puccoon is on the Louisiana Natural Heritage watch list. It appears to be locally common in upland xeric sandhill woodlands and upland longleaf pine forest, notably on the KD (Natchitoches Parish) and WD (Natchitoches and Winn parishes) and in central and northwestern Louisiana (MacRoberts 1989).

Lycopodiella cernua (L.) Pichi Sermolli [SY = *Lycopodium cernuum* L.]. (*Holmes 3360* [NATC]; *Thomas 74133* [NLU]). Nodding clubmoss, a coastal plain species, has been found at only one site in the KNF. In the 1970's it was found in a bog on the KD (Natchitoches Parish, T6N R7W Sec. 22) (Thomas *et al.* 1978). While it apparently persisted at this location for a number of years, it has not been found there for more than a decade (MacRoberts & MacRoberts 1988, 1993b). It is also reported from Ouachita and St. Tammany parishes (Natural Heritage 1994).

Lyonia mariana (L.) D. Don. (*Latimore Smith s.n.* [LSU]). Staggerbush lyonia, an eastern species that reaches its western limit in east Texas, is known from one site on the CnyD (Claiborne Parish, T2N R4W Sec. 13). It has also been found in Caddo Parish (Natural Heritage 1994).

Maianthemum racemosum (L.) Link [SY = *Smilacina racemosa* (L.) Desf.]. (*Thieret 24686* [LAF]). There is only one known occurrence of False solomon seal, a northern species, on the KNF (Thieret 1967a). This species has been repeatedly searched for at the original site (CnyD, Claiborne Parish, T22N R4W Sec. 10) but without success. It occurs in mixed hardwood slope forest. This is the only parish for which this species has been reported (Natural Heritage 1994).

Malaxis unifolia Michx. (*MacRoberts & MacRoberts 341* [VDB]). We have found Green adder's mouth, a Louisiana Natural Heritage watch list species, at several scattered locations on the KD and WD, Natchitoches and Winn parishes. There has been no systematic survey for it. It is never common where found and appears to prefer shaded areas in mixed hardwood-loblolly forest, often under dogwood (*Cornus florida* L.). Its secretive habit and short stature may account for its apparent rareness. It has been found in many parishes in northern and southeastern Louisiana (MacRoberts 1989; Thomas & Allen 1993a).

Mayaca fluviatilis Aubl. [SY = *Mayaca aubletii* Michx.]. (*Hampsten et al. s.n.* [SFRP]; *MacRoberts & MacRoberts 2160, 2466* [VDB]). Bog moss, a coastal plain species, is known only from the ED (Rapides Parish). A survey for this species in 1993 revealed six ED locations (T3N R2W Secs. 17, 18, 20; T3N R3W Secs. 24, 25). It occurs in shallow water in bayhead swamps. It is also reported from southeastern Louisiana in St. Tammany, Tangipahoa, and Washington parishes (Natural Heritage 1994).

Monotropa hypopithys L. (*Rhodes 14856* [LTU]; *Carr & Bruser s.n.* [SFRP]). American pinesap, a widespread northern species, has been found in several locations in northern Louisiana, but only three are on the KNF. Two are on the CnyD (T22N R4W Sec. 10; T23N R4W Sec. 34) in Claiborne Parish, and one is on the WD in Winn Parish (T11N R5W Sec. 13). One of the CnyD populations has not been relocated in recent years. It grows in shortleaf pine/oak-hickory forest and mixed hardwood loblolly forest in filtered shade (Larke & Smith 1994). It is found in a number of parishes on the northern tier of Louisiana (Natural Heritage 1994).

Obolaria virginica L. (*Carr, MacRoberts, & MacRoberts 2168* [VDB]; *MacRoberts & MacRoberts 2254* [SFRP]). Pennywort is on the Louisiana Natural Heritage watch list. We have encountered it only twice on the Kisatchie National Forest in deeply shaded hardwood slope forest (ED, Rapides Parish, T2N R3W Secs. 11, 12). How common it may be is not known since very little surveying has been done in mixed hardwood slope forest. It is known from a number of north Louisiana parishes (MacRoberts 1989).

Orobanche uniflora L. (*McInnis 3990* [personal collection]). Broomrape, a widespread northern species that also occurs in Texas and Arkansas, was first reported for Louisiana in 1852 (MacRoberts 1984, 1989). But it was not reported again until 1990 when it was found in upland longleaf pine forest on the VD (Vernon Parish,

T1N R8W Sec. 36) (Hart & Lester 1993). It has also been reported for Rapides Parish (Natural Heritage 1994).

Panicum flexile (Gatt.) Scribn. (*Brown & Lenz 8236* [LSU]; *Smith & Gilmore 3713* [LSU]; *Thomas & Allen 94224 & 13430* [NLU]). Wiry witchgrass, a widespread eastern species that is uncommon at most localities where it occurs, is recorded from four calcareous prairies in the WD (Winn and Grant parishes, T9N R2W Sec. 5; T11N R4W Sec. 18; T11N R5W Secs. 13, 26) (Smith *et al.* 1989; Allen 1992). It has also been reported for Caddo, Ouachita, and Vernon parishes (Natural Heritage 1994).

Paronychia drummondii Torrey & A. Gray. (*MacRoberts & MacRoberts 2083* [VDB], *2281, 2344* [SFRP], *1805* [LSU]). Drummond's nailwort, a Texas near endemic that reaches its eastern limit in western Louisiana, is known from eight locations on the WD (Natchitoches Parish, T12N R5W Sec. 8; T31N R6W Secs. 7, 12, 18; T13N R7W Secs. 2, 11; Winn Parish, T12N R5W Sec. 28; T13N R5W Sec. 17). It occurs in upland and stream terrace xeric sandhill woodlands. It has also been recorded from Bienville and Caddo parishes (Natural Heritage 1994).

Pediomelum hypogaeum (Nutt. *ex* Torrey & A. Gray) Rydb. [SY = *Psoralea subulata* Bush]. (*MacRoberts & MacRoberts 2236* [LSU,VDB,SFRP,NLU]). Awl-shaped scurf-pea occurs in east Texas, south Oklahoma, southwest Arkansas, and western Louisiana (Lasseigne 1973). It has been found at one location on the KD (Natchitoches Parish, T7N R7W Sec. 36) in upland xeric sandhill woodlands. It also has been found in Caddo Parish (Natural Heritage 1994).

Penstemon murrayanus Hook. (*MacRoberts & MacRoberts 1612* [VDB]; *Grelen 2052* [SFRP]). The only known KNF site of cupleaf beardtongue is in a stream terrace sandhill woodland in an inholding on the WD (Winn Parish, T12N R5W Secs. 28, 29). This species is found in Arkansas, Oklahoma, Texas, and in northwestern Louisiana (Vincent 1982) where it has been found in Caddo Parish (Natural Heritage 1994).

Phacelia strictiflora (Engelm. & A. Gray) A. Gray. (*MacRoberts & MacRoberts 2211* [VDB], *2532* [SFRP]; *Thomas & Kessler 75762 & 1334* [NLU]). Phacelia, a species of the south central U.S., is known from two WD stream terrace sandhill woodlands (Winn Parish, T13N R5W Secs. 32, 33; T12N R5W Sec. 28) (Thieret 1967a). It has also been recorded for Caddo, Natchitoches, and Bienville parishes (Natural Heritage 1994).

Platanthera blephariglottis (Willd.) Lindl. White-fringed orchid, an eastern species, was first found as a single stem on the VD (Vernon Parish) in August 1990 (Parker 1990). In September 1992, the site was revisited and three stems were found at two locations. It occurs in T1N R6W Sec. 14 in bog habitat. The species has not been collected (although it has been photographed) because there were too few individuals (MacRoberts & MacRoberts 993b; Hart & Lester 1993). It is also reported from St. Tammany Parish (Natural Heritage 1994).

Platanthera integra (Nutt.) A. Gray *ex* Beck. (*MacRoberts & MacRoberts 1146* [VDB], *886* [SFRP]). Yellow fringeless orchid, a coastal plain bog species, was unknown on the KNF until 1980 (Holmes 1983). It was known from only one site until systematic bog surveys revealed it at nine KD (Natchitoches Parish, T6N R7W

Secs. 11, 14, 22, 24, 25, 35, 36; T5N R8W Sec. 36) and twelve VD bogs (Vernon Parish, T1N R5W Sec. 33; T1N R6W Secs. 14, 15, 17, 23, 26, 35; T1N R7W Secs. 21, 28; T1S R8W Secs. 14, 15, 17, 20, 21) (MacRoberts & MacRoberts 1988, 1990a, 1990b, 1991, 1993b; Hart & Lester 1993). Its range is New Jersey to Florida and along the Gulf Coastal Plain to Texas, where it is very rare (Bridges & Orzell 1989a; Orzell 1990; Grace 1993). In Louisiana it is also reported from Beauregard and St. Tammany parishes (Natural Heritage 1994).

Polanisia erosa (Nutt.) Iltis. (*MacRoberts & MacRoberts 1802* [VDB], *2340, 2431* [SFRP], *1821* [LSU]). Clammy weed, a species apparently confined to Texas, Oklahoma, Arkansas, and western Louisiana, has been found at four sites in upland and stream terrace xeric sandhill woodlands in the KD (Natchitoches Parish, T6N R7W Secs. 5, 12; T7N R7W Secs. 29, 36), and three sites on the WD (Winn and Natchitoches parishes, T12N R5W Sec. 28; T13N R6W Sec. 7) (MacRoberts & MacRoberts 1994). It has also been reported from Bienville and Sabine parishes (Natural Heritage 1994).

Polygala verticillata L. (*MacRoberts & MacRoberts 1975* [VDB], *1968, 2363* [SFRP], *1666* [LSU]). Prairie milkwort is on the Louisiana Natural Heritage watch list. It has not been monitored on the KNF. While often difficult to find because of its small size, we have found it regularly in sandstone outcrop and calcareous prairie communities in Natchitoches and Winn parishes (KD and WD) (MacRoberts & MacRoberts 1993c). It appears to be scattered widely around the state (MacRoberts 1989).

Polygonella americana (Fisch. & C.A. Mey.) Small. (*MacRoberts & MacRoberts 1799* [VDB], *2428* [SFRP]). Southern jointweed, a species found in xeric sandylands from South Carolina to New Mexico, occurs at one xeric stream terrace sandhill woodland in an inholding on the WD (Winn Parish, T12N R5W Sec. 28). It has also been recorded from Bienville, Caddo, and Sabine parishes (Natural Heritage 1994).

Polygonella polygama (Vent.) Engelm. & A. Gray. (*MacRoberts & MacRoberts 2128* [VDB], *920, 2147* [SFRP]; *Gilmore, Smith, & Johnson 3729* [NLU]). October flower, an upland xeric sandhill woodland plant, was first found in Louisiana in 1988 on the WD (Natchitoches Parish, T13N R6W Secs. 7, 18) where it is abundant (Johnson & Johnson 1990). However, it is not known from any other locality in Louisiana. It ranges across the southern U.S. from Virginia to Texas.

Polytaenia nuttallii DC. (*MacRoberts & MacRoberts 2377* [SFRP]; *Thomas et al. 92238, 104893* [NLU]). Prairie parsley is on the Louisiana Natural Heritage watch list. It has not been specifically monitored so records are not available, but it occurs in several calcareous prairies on the WD (Winn Parish) (Smith *et al.* 1989). It occurs in several scattered locations in western and central Louisiana (MacRoberts 1989).

Prenanthes barbata (Torrey & A. Gray) Milstead. (*MacRoberts & MacRoberts 2082* [VDB]; *Thomas 78298* [SFRP]). Barbed rattlesnake-root, a southeastern species, is found in mixed hardwood-loblolly and riparian forest. It has been found at nine locations on the WD (Winn Parish, T13N R5W Secs. 2, 3, 4, 9, 10, 14, 15, 22, 24; Natchitoches Parish, T13N R6W Sec. 1), and one location on the ED (Rapides Parish, T3N R2W Sec. 29) (Gandhi & Thomas 1989). It is also reported from Vernon Parish (Natural Heritage 1994).

Pteroglossaspis ecristata (Fernald) Rolfe. [SY = *Eulophia ecristata* (Fernald) Ames]. (*Thomas et al. 12265* [NLU]). Wild coco, a southeastern species, is known from only one site in the KNF. This is a wooded seep in the CatD (Grant Parish, T8N R1W Sec. 11) (Thomas 1972). Although found in the late 1960's, it has not been regularly monitored. It was apparently found at this location again in 1978 but not relocated in a 1986 survey. We did not relocate it in our survey of the site in 1994. It has also been recorded for Allen, Beauregard, Jefferson Davis, St. Tammany, Tangipahoa, and Washington parishes (Natural Heritage 1994).

Rhynchospora, macra (C.B. Clarke) Small. (*MacRoberts & MacRoberts 1432, 1469* [VDB], *1430, 1467* [SFRP], *1464, 1494* [NLU], *1434, 1787* [LSU]). Large beakrush, a coastal plain species that reaches the periphery of its range in the WGCP, was first found in Louisiana in the early 1970's in a bog on the KD. This remained the only known WGCP site until extensive bog surveys on the VD and KD in the late 1980's and early 1990's located it in eight KD (Natchitoches Parish, T5N R8W Sec. 3; T6N R6W Sec. 34; T6N R6W Secs. 11, 17, 22) and 22 VD (Vernon Parish, T1S R6W Sec. 6; T1S R7W Secs. 2, 3; T1S R8W Secs. 1, 13, 20, 21; T1N R5W Sec. 28; T1N R6W Secs. 13, 14, 15, 17, 20, 21, 22, 23, 24) bogs (MacRoberts & MacRoberts 1988, 1992, 1993b; Buras 1993; Hart & Lester 1993). It has not been reported from any other parishes in Louisiana.

Rhynchospora oligantha A. Gray. (*MacRoberts & MacRoberts 956* [LSU], *701, 769, 924* [VDB], *934, 1259* [SFRP]). This bog fidel is on the Natural Heritage watch list. We have found it to be abundant in most bogs in the WD; KD, and VD (Vernon and Natchitoches parishes). Thomas & Allen (1993a) also report it from Beauregard and Allen parishes.

Rudbeckia laciniata L. (*MacRoberts & MacRoberts 2468* [SFRP]). Goldenglow, a watch list species, is known from one riparian woodland on the ED (Rapides Parish, T3N R2W Secs. 28, 29). It is also reported from Caddo, Evangeline, West Feliciana, and Washington parishes (MacRoberts 1989; Gandhi & Thomas 1989). Gandhi & Thomas (1989) state that *R. laciniata* is cultivated and can escape. Whether or not the population in Rapides Parish is natural is not known.

Rudbeckia scabrifolia L.E. Brown. (*MacRoberts & MacRoberts 859, 1686, 1747* [VDB], *1468, 1748, 2331* [SFRP]). Sabine coneflower, a recently recognized WGCP endemic (Brown 1986), has been found in about 50 VD (Vernon Parish) bogs and baygalls (there are so many sites that we do not give locations except to point out that the species appears to be confined to the western half of the VD). It also occurs in two WD (Winn and Natchitoches parishes, T13N R5W Sec. 9; T13N R7W Sec. 2) sites; one is a bog, the other a wooded seep (Bridges & Orzell 1989a; MacRoberts & MacRoberts 1993b; Hart & Lester 1993; Orzell 1990). It has also been recorded from Sabine Parish (Natural Heritage 1994).

Sabatia macrophylla Hook. (*MacRoberts & MacRoberts 1722* [VDB], *1704* [SFRP]; *Grelen & Thomas 1780* [SFRP]). Large-leaved rose gentian, a coastal plain species that reaches the limit of its range in the WGCP, has been found in about 50 VD (Vernon Parish) bogs. Since these are scattered over the entire district, we do not give precise locations (MacRoberts & MacRoberts 1993b; Hart & Lester 1993). It has also

been reported for Beauregard, St. Tammany, and Washington parishes (Natural Heritage 1994).

Schoenolirion croceum (Michx.) Wood. (*MacRoberts & MacRoberts 1586* [VDB], *1920* [SFRP]). Yellow sunny-bells is on the Louisiana Natural Heritage watch list. It has not been monitored on the KNF. It is abundant in some, but by no means all, bogs on the VD (Vernon Parish). It has been reported from Beauregard, Natchitoches, and Sabine parishes (MacRoberts & MacRoberts 1993b; Thomas & Allen 1993a).

Schoenolirion wrightii Sherman. (*MacRoberts & MacRoberts 1901* [VDB], *1914* [LSU,NLU], *1914, 1921* [SFRP]). Texas sunny-bells was first found on the KNF in 1993 on sandstone outcrops. A survey of nineteen outcrops located it in five. At one site up to 1000 plants were found. All sites are on the KD (Natchitoches Parish, T6N R8W Secs. 27, 28, 29, 32; T6N R7W Sec. 35) where the plant grows on unshaded thin soils on open rock pavement. In the KNF, Texas sunny-bell is always associated with *Talinum parviflorum* Nutt. (MacRoberts & MacRoberts 1993c). The species has an unusual distribution of disjunct populations from Alabama, Arkansas, Louisiana, and Texas (Nixon & Ward 1981; Orzell 1990; Sherman & Becking 1991). These KNF populations may be some of the most protectable in the world. It has also been found in Red River Parish (Natural Heritage 1994).

Selaginella arenicola Underw. subsp. *riddellii* (Van Eselt.) R. Tryon. (*MacRoberts & MacRoberts 1809* [VDB], *1779* [SFRP]; *Thomas & Kessler 75765 & 1337* [SFRP]). Riddell's spikemoss has been known since the middle of the last century from areas now probably part of the KNF (Brown & Correll 1942; Thieret 1980). On the KD, it is known from nine sites (Natchitoches Parish, T6N R6W Sec. 21; T6N R7W Sec. 5; T6N R8W Secs. 27, 29, 32, 35, 36; and T7N R7W Sec. 36) (MacRoberts & MacRoberts 1994). It occurs in two communities: sandstone outcrops, and upland and stream terrace xeric sandhill woodland. In the former, it grows on sandstone pavements (MacRoberts & MacRoberts 1993c), in the latter in deep xeric sands. On the WD (Natchitoches and Winn parishes) it is known from three sites in sandy woodlands (T13N R6W Sec. 7; T13N R5W Sec. 32; T12N R5W Sec. 28). This is a coastal plain species that is rare in the WGCP. It has also been reported from Bienville, Caddo, Sabine, and Vernon parishes (Natural Heritage 1994).

Solidago auriculata Shuttlw. *ex* S.F. Blake. (*MacRoberts & MacRoberts 2498* [SFRP], *2495, 2496* [NLU], *2497* [LSU]). Clasping goldenrod is a Louisiana Natural Heritage watch list species that is sometimes abundant in mixed hardwood slope forest. We have found it at several locations on the KD (Natchitoches Parish). It has also been reported from several northwestern parishes (Gandhi & Thomas 1989).

Sporobolus ozarkanus Fernald. (*Gilmore & Smith s.n.* [NLU]; *McInnis & Smith 3695* [LSU]). Ozark dropseed has been found at one calcareous prairie in the WD (Winn Parish, T11N R4W Sec. 18; T11N R5W Sec. 13) (Smith *et al.* 1989). It also occurs in Missouri, Arkansas, and Texas. It has yet to be reported from any other parish in Louisiana (Natural Heritage 1994; Allen 1992).

Stenanthium gramineum (Ker-Gawl.) Morong. (*MacRoberts & MacRoberts 737* [VDB], *811, 1724* [SFRP]). Featherbells is a Louisiana Natural Heritage watch list

species. We have found it in several communities on the KD (Natchitoches Parish), often in large numbers, specifically in damper areas of upland longleaf pine forest and in riparian forest. It has also been reported from Beauregard, Caddo, Red River, Sabine, St. Tammany, Washington, and Winn parishes (Thomas & Allen 1993a).

Streptanthus hyacinthoides Hook. (*MacRoberts & MacRoberts 2298* [VDB], *2332, 2347* [SFRP]). Smooth twistflower occurs in upland and stream terrace xeric sandhill woodlands at two locations on the WD (Winn Parish, T13N R5W Sec. 32; T12N R5W Sec. 28) and one location on the KD (Natchitoches Parish, T7N R7W Sec. 36). It is also found in Bienville and Caddo parishes (Natural Heritage 1994), and in Arkansas, Texas, and Oklahoma.

Stylisma aquatica (Walt.) Raf. (*MacRoberts & MacRoberts 1696* [SFRP]). Stylisma is on the Louisiana Natural Heritage watch list. We know it from only one site on the VD (Vernon Parish). It was found in an open mesic area just above a bog in conjunction with *Viola lanceolata* L. and *Calopogon barbatus*. It appears to be scattered around the state (MacRoberts 1989).

Taenidia integerrima (L.) Drude. (*MacRoberts & MacRoberts 2180* [VDB], *2372* [SFRP]). Yellow pimpernel is an eastern species that is rare in the WGCP. It has been found at three locations on the WD (Natchitoches and Winn parishes, T13N R6W Sec. 32; T11N R4W Sec. 18) where it occurs in riparian calcareous forest (Larke & Smith 1994). It is also reported from Bienville, Caddo, and Caldwell parishes (Natural Heritage 1994).

Talinum parviflorum Nutt. (*MacRoberts & MacRoberts 1759, 1780* [VDB], *2056* [SFRP], *1493, 1758* [LSU]. Small-flowered flame flower, a Great Plains species, was known from only a few sites on the KD (Natchitoches Parish) since the 1930's . A survey of sandstone outcrop communities in 1992 and 1993 located it at 24 sites scattered over the southern half of the KD (T5N R6W Secs. 4, 5, 25, 33; T5N R7W Sec. 6; T5N R8W Sec. 1; T6N R8W Secs. 26, 28, 29, 32, 35, 36). It grows, often in large number (> 1000), in full sun almost exclusively in thin soils in slight depressions on flatrock pavements (MacRoberts & MacRoberts 1993c; Thieret 1969). It also is recorded from Caddo, Red River, Sabine, and Winn parishes (Natural Heritage 1994).

Tetragonotheca ludoviciana (Torrey & A. Gray) A. Gray *ex* Hall. (*MacRoberts & MacRoberts 1988* [VDB], *1691* [SFRP], *2371* [LSU]). There are six known locations for Louisiana square-head, a WGCP endemic, on the KD (Natchitoches Parish, T6N R7W Secs. 1, 2, 5, 9, 17), and one on the VD (Vernon Parish, T1N R7W Sec. 22) (Hart & Lester 1993). It grows in upland xeric sandhill woodlands (Grace 1993; Gandhi & Thomas 1989; Turner & Dawson 1980). It has also been reported from Allen, Caddo, and Sabine parishes (Natural Heritage 1994).

Tradescantia reverchonii Bush. (*MacRoberts & MacRoberts 1565* [VDB], *2276, 2407* [SFRP]). This species is on the Louisiana Natural Heritage watch list. It is found almost exclusively in upland and stream terrace xeric sandhill woodlands of western Louisiana and eastern Texas south to the Rio Grande Valley. It is common in all sandylands in both the KD and WD (Natchitoches and Winn parishes). It appears to especially like disturbed areas (MacRoberts 1980). It has been reported from Caddo, Beauregard, Bienville, Sabine, and Vernon parishes (MacRoberts 1989).

Triphora trianthophora (Sw.) Rydb. (*MacRoberts & MacRoberts 2509* [SFRP]). Three-birds orchid, a widespread eastern species, has been found only twice on the KNF, KD (Natchitoches Parish, T7N R7W Sec. 20) in "damp, shady woods" in September 1977 (Mathies *et al.* 1983; Holmes & Mathies 1980) and ED (Rapides Parish, T2N R3W Sec. 11) in hardwood slope forest in 1994. It has also been recorded for Caddo and West Feliciana parishes (Natural Heritage 1994).

Utricularia juncea Vahl. (*MacRoberts & MacRoberts 825, 1179* [VDB], *872* [SFRP], *1442* [LSU]). This bladderwort is on the Louisiana Natural Heritage watch list. It is locally common in bogs on the KD and VD (Natchitoches and Vernon parishes) (MacRoberts & MacRoberts 1988). It has also been reported from Beauregard, St. Tammany, and Washington parishes (MacRoberts 1989).

Utricularia purpurea Walt. Purple bladderwort is on the Louisiana Natural Heritage watch list. It has been reported from only one bog on the VD (Vernon Parish, T1N R6W Sec. 22), but there is no known voucher specimen (Parker 1990). It has been reported from Evangeline, Cameron, Tangipahoa, and St. Tammany parishes (MacRoberts 1989).

Uvularia sessilifolia L. (*McInnis 4003, s.n.* [personal collection]). Sessile-leaved bellwort, a northeastern species, known from the northern tier of Louisiana parishes, has been found at two locations on the VD (T1N R7W Secs. 13, 33) (Hart & Lester 1993) and one location on the WD (Natchitoches Parish, T13N R6W Sec. 8). It occurs in wooded seeps and bayhead swamps. It is also recorded from Caddo, Claiborne, Lincoln, Morehouse, Union, and Webster parishes (Natural Heritage 1994).

Xanthorhiza simplicissima Marsh. (*Allen 14892; Thomas & Allen 98050* [NLU]). Yellowroot, a southeastern species that is rare in the WGCP, was first found in Louisiana on the VD (Vernon Parish) in 1986 and has subsequently been found at another location about three miles away (T1N R7W Sec. 34 and T1S R8W Sec. 1) (Allen *et al.* 1987; Buras 1993; Hart & Lester 1993). It favors shaded riparian forest sites. These are the only locations reported in Louisiana (Natural Heritage 1994).

Xyris drummondii Malme. (*MacRoberts & MacRoberts 868, 885* [VDB], *1158, 1775A* [SFRP], *841, 1775B* [NLU], *1781, 1841* [LSU]). Drummond's yellow-eyed grass, a coastal plain species, was first reported for the WGCP in the mid-1970s from a bog in the KD (Natchitoches Parish, Kral 1983). Surveys of bogs on the KNF since the late 1980's have located it in about 75 bogs on the KD and VD (Natchitoches and Vernon parishes, Hart & Lester 1993, MacRoberts & MacRoberts 1988, 1990a, 1991, 1992, 1993b) It is so widespread in these two districts that we will not give locations. It is also known from many other bogs in western Louisiana and eastern Texas (Bridges & Orzell 1989a; Orzell 1990). It is also found in Beauregard Parish (Natural Heritage 1994).

Xyris scabrifolia Harper. (*MacRoberts & MacRoberts 1491, 1543* [VDB], *1448, 1793* [SFRP], *1754, 1782* [NLU]). Rough-leaved yellow-eyed grass, an uncommon coastal plain species, was first reported for the WGCP in the early 1980s. It has been found in sixteen bogs scattered widely over both the KD (Natchitoches Parish, T5N R8W Sec. 3; T6N R7W Secs. 12, 21, 22; T6N R8W Sec. 35) and VD (Vernon

Parish, T1S R8W Secs. 12, 14; T1N R5W Sec. 28; T1N R6W Secs. 14, 20, 21, 23, 25; T1N R7W Sec. 29; T1N R8W Secs. 1, 34) (MacRoberts & MacRoberts 1992, 1993b; Bridges & Orzell 1989a; Hart & Lester 1993). It also occurs in Beauregard Parish (Natural Heritage 1994).

Zigadenus densus (Desr.) Fernald. (*MacRoberts & MacRoberts 1646* [VDB], 1966 [SFRP], 1646 [LSU]; *Hampsten s.n.* [SFRP]). While black snakeroot and other *Zigadenus* species have been reported from Louisiana for a long time, there has been confusion over taxonomic status and distribution (Thieret 1972). *Zigadenus densus* is a coastal plain species. During surveys in 1992 and 1993, it was found in fifteen VD bogs (Vernon Parish, T1N R5W Secs. 28, 30, 31, 32; T1N R6W Secs. 21, 23; T1N R7W Secs. 24, 25, 27; T1N R8W Secs. 15, 22) (MacRoberts & MacRoberts 1993b; Hart & Lester 1993). It is also reported from St. Tammany and Washington parishes (Natural Heritage 1994).

Zornia bracteata J.F. Gmel. (*MacRoberts & MacRoberts 1897* [VDB], *1807, 2413* [SFRP]). Viperina, a southeastern species, occurs in a stream terrace sandhill woodland at one inholding on the WD (Winn Parish, T12N R5W Secs. 28, 29) (Lasseigne 1973). It has also been reported for Caddo, Natchitoches, Vernon, and Tangipahoa parishes (Natural Heritage 1994).

EXCLUDED SPECIES

Two species that have been on the KNF rare species list have not been verified. One is *Xyris stricta* Chapman reported from several localities on the VD (Vernon Parish, and from southern Natchitoches Parish) (Hart & Lester 1993). The voucher specimens for these reports turn out to be other *Xyris* species (Linda Watson and Bruce Hoagland, pers. comm.). The other is *Asclepias hirtella* (Pennell) Woodson reported for the KD (Natchitoches Parish). After repeated searches, the voucher specimen for this has been located and it turns out to be *A. longifolia* Michx. (S. Lynch, pers. comm.).

DISCUSSION

The Kisatchie National Forest comprises about two percent of the Louisiana land surface. The 1994 Louisiana Natural Heritage rare species and watch lists contain 407 species. Eighty, or 20%, of these have been found on the KNF. The Natural Heritage has 2071 rare plant species site records for the entire state (Julia Larke, pers. comm.). Add to this many records from the KNF not yet in their data base, and the figure probably approaches 2500. There are about 570 rare species site records for the KNF. The KNF therefore accounts for about 23 percent of the Louisiana total. Relatively speaking, therefore, the KNF is either very rich in rare species sites or has been exceptionally well surveyed. The latter, of course, is the case largely because it is open to investigation, because it has relatively vast tracts of undisturbed habitat, and because several community types within it have been the subject of special surveys.

Comparing these records with what was known about these species in the WGCP ten years ago makes it obvious that while much work has been done, much remains to be done in documenting the flora of the WGCP (Bridges & Orzell 1989a: 63). For

example until two decades ago, *Xyris drummondii* was not known to occur in the WGCP, and for years after its discovery it was known from only one bog. Recent surveys of bogs in west Louisiana and east Texas have found it in over 100 locations (Bridges & Orzell 1989a; Orzell 1990; MacRoberts & MacRoberts 1993b; Hart & Lester 1993), its highest known concentration. *Rudbeckia scabrifolia* was not recognized as a separate species until 1986 (Brown 1986). Due to intensive bog surveys, it too has now been documented from over 100 WGCP bogs and baygalls (Bridges & Orzell 1989a; Orzell 1990; MacRoberts & MacRoberts 1993b; Hart & Lester 1993; Parker 1990).

The same applies to community types. A concerted effort is currently under way to negotiate a taxonomy of community types for the WGCP (Smith 1988, in prep.; Diamond *et al.* 1987; Bridges & Orzell 1989b; Orzell 1990; Martin & Smith 1991, 1993), but as more research is undertaken, it is clear that these taxonomies are preliminary.

At the same time, we are only beginning to map the extent and location of different communities. Surveys of major community types, as well as those of inclusion communities, are beginning to uncover the distribution, extent, and condition of these rare, localized, and specialized habitats where rare plants often occur in surprising abundance. Unfortunately, progress is slow since, in the entire WGCP, only a handful of botanists and ecologists are working.

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Phytologia (April 1995) 78(4):314.

BOOKS RECEIVED

Aquatic Weeds, The Ecology and Management of Nuisance Aquatic Vegetation. Arnold H. Pieterse & Kevin J. Murphy (eds.). Oxford Science Publications, Oxford University Press, 200 Madison Avenue, New York, New York 10016. 1994. xviii. 593 pp. $49.95 ISBN 0-19-854840-0 (paper).

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Phytologia (April 1995) 78(4):315.

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